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Niyazi Serdar Sariciftci
Johannes Kepler
University, Linz
Austria

Invıted Speakers



İmran Avcı Akça
Vrije Universiteit Amsterdam
Netherlands



Feridun Ay
Eskişehir Technical University
Türkiye



Ömer Aydın
Erciyes University
Türkiye



Antonio Di Bartolomeo
University of Salerno
Italy



Emine Güler Çelik
Ege University
Türkiye



Burak Gültekin
Ege University
Solar Energy Institute
Türkiye



Selim Hanay
Bilkent University
Türkiye



Didem Şen Karaman
İzmir Katip Çelebi University
Türkiye



Hülya Ayar Kayalı
İzmir Biomedicine and Genome Center (IBG)
Türkiye



Aşkın Kocabaş
Koç University
Türkiye



Coşkun Kocabaş
The University of Manchester
United Kingdom



Sezer Özerinç
Middle East Technical University
Türkiye



Nihan Kosku Perkgöz
Eskişehir Technical University
Türkiye



Tommaso Salzillo
University of Bologna
Italy



Nurdan Demirci Sankır
TOBB University of Economics and Technology
Türkiye



Steven R. Schofield
University College London
UK



Elias Stathatos
University of the Peloponnese
Greece



Hüseyin Cumhur Tekin
İzmir Institute of Technology
Türkiye



Serpil Tekoğlu
Johannes Kepler University, Linz
Austria



Hüsnü Emrah Ünalan
Middle East Technical University
Türkiye



Caner Ünlü
Istanbul Technical University
Türkiye



Mehmet Yağmurcukardeş
İzmir Institute of Technology
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Preface

Welcome to the 17th edition of the NanoTR Conference series, encapsulated in this comprehensive book of abstracts. As the series has evolved over the years, so too has the field of nanoscience and nanotechnology. With every passing year, we witness exponential growth and innovation, and NanoTR-17 stands as a testament to the strides made in these areas.

Gathered within these pages are abstracts from some of the brightest minds and thought leaders in the nanotechnology realm. From established researchers to budding scientists, NanoTR-17 serves as a convergence point, offering a myriad of perspectives, methodologies, and findings. These abstracts represent not only the depth and breadth of current research but also the potential for future advancements.

Organizing such a conference, and compiling this book, is no small feat. It's a collaborative effort, and the fruition of countless hours of rigorous work, discussions, reviews, and revisions. We are grateful to all contributors who have shared their valuable insights and research with us. This collective wisdom not only benefits the immediate attendees but also the broader scientific community and society at large.

As you peruse this book, we hope it serves as both an informative guide to the conference and a source of inspiration. May the abstracts within spark curiosity, foster collaborations, and drive the relentless pursuit of knowledge.

Thank you for being an integral part of NanoTR-17. Whether you're presenting, attending, or simply reading, your involvement pushes the boundaries of what we know and what we can achieve in the world of nanoscience and nanotechnology.

Warm regards,

Co-chairs

Dr. Canan Varlıklı
Dr. Cem Çelebi

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ORAL PRESENTATIONS

ID: 332

Solar Energy Conversion into Chemical Fuels

Niyazi Serdar Sariciftci
Linz Institute for Organic Solar Cells (LIOS) and Institute of Physical Chemistry Johannes Kepler University of Linz Altenbergerstrasse 69, A-4040 Linz, Austria

In order to account for a sustainable future, the transport and storage of renewable energy are necessary. For this problem, we suggest the conversion of CO_2 to chemical energy carrying compounds like methane, methanol and/or other synthetic fuels using renewable energy. This is a possible and viable method to make efficient, large scale energy storage. At the same time this will make a cyclic and sustainable CO_2 economy. This research is mainly driven by nanoscience and nanotechnology of catalyst nanosystems.

We report studies on materials like conducting polymers of the third generation, functionalized with bio-organic catalysts which can be used in photo-electro-catalytic conversion devices. Going one step further, bio-catalysts such enzymes as well as living bacteria can be immobilized on electrodes. We report alternatively on immobilizing of enzymes onto functionalized graphene units creating a nano-bio-catalytic platform. Selectivity of such bio-catalysts is very high and combined with the room temperature operation of such bio-electro-catalytic systems this makes them industrially highly attractive.

DRAFT

ID: 335

Advancing optical imaging and sensing using photonic integrated circuits

İmran Akça Avcı
Vrije Universiteit, Amsterdam, Netherlands

Photonic integrated circuits (PIC) hold great promise for optical imaging and sensing. In my group, we are working on PIC-based new sensing and imaging concepts. Toward this goal, we developed a fast and affordable way of making PIC devices, which I will introduce during my talk. Later I will discuss the applications of PICs in optical coherence tomography imaging and optical biosensing of cancer biomarkers. Different designs and new measurement methods will be introduced as well.
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DRAFT

ID: 163

Unlocking the Potential of Atomic Layer Deposition: Advancements in Integrated Optical Devices and 2D Optoelectronics

Feridun Ay
Eskisehir Technical University, Department of Electrical and Electronics Engineering, 26555 Eskisehir, Türkiye

This work focuses on the utilization and optimization of Atomic Layer Deposition (ALD) for applications in integrated optical devices and 2D optoelectronics. Initially, we present the development of ALD-grown ultralow loss host Al2O3 planar waveguides on Si substrates, followed by the successful realization of ALD-grown Er3+ doped on-chip Al2O3 waveguide-based high-gain amplifier devices. Al2O3, an innovative optical material, offers superior properties such as a relatively high refractive index, rare earth ion doping capabilities, high light confinement efficiency, low loss, thermal stability, wide transparency range, and good compatibility with optical fibers. The ALD method employed for material production enables high controllability, precise doping ratios, and cost-effectiveness.

The optimization processes involve both thermal and plasma-enhanced ALD techniques. We fine-tune the optical properties of Al2O3 and Er2O3 films by optimizing their growth conditions. This optimization leads to the realization of chip-scale single-mode Er3+ doped Al2O3 ridge waveguide amplifiers with a small-signal gain exceeding 13 dB/cm over the C band. Furthermore, the reported ALD-based growth process can be adapted for active ion doping of various oxide systems, offering new opportunities for active on-chip applications with precise concentration and profile control.

In addition, we explore the integration of ALD-grown Al2O3 with other optical elements, such as waveguides and a ring resonator, enabling the design and partial realization of integrated optical devices. We employ numerical methods, including Finite-Difference Time-Domain (FDTD) and Finite Element Method (FEM), for the optimization studies and mechanical analyses of the designed accelerometer using the Ansys program. Moreover, we present a methodology that combines the Particle Swarm Optimization algorithm with a Finite-Difference Time-Domain electromagnetic solver to create a design tool capable of finding optimal geometries for single-mode optical waveguides while satisfying fabrication constraints. Specifically, we showcase the optimization of a Y-branch waveguide geometry using this approach with a 1 μm-resolution standard lithography with multiple crossings.

Additionally, we demonstrate a procedure for obtaining large-area covered 2D chalcogenide (e.g. MoS2) layers. By using Atomic Layer Deposited (ALD) MoO3 films as Mo precursors, followed by a chemical vapor deposition (CVD)/sulfurization step, we achieve uniform and controllable growth of MoS2 structures with excellent layer and size control over the entire substrate. The densification of nucleation domains results in multi-layered MoS2 structures. These findings open new possibilities for controlling 2D MoS2 structures for targeted customization in various optoelectronic applications. Furthermore, we explore the hybrid use of MoS2 layers with optical waveguides as a novel avenue for future research.

In conclusion, this work demonstrates the use and optimization of ALD for integrated optical devices and 2D optoelectronics, offering enhanced performance, controllability, and compatibility with existing fabrication processes. The presented findings provide valuable insights and opportunities for advancing the field of integrated photonics and optoelectronics.

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Keyword: *Atomic Layer Deposition (ALD), Integrated optical devices, 2D materials, 2D optoelectronics*

DRAFT

ID: 324

Applications of Surface-enhanced Raman Scattering in Medicine in the Age of Artificial Intelligence

Ömer Aydın[1,2,3,4]

[1] *Department of Biomedical Engineering, Erciyes University, 38039, Kayseri, Türkiye*

[2] *NanoThera Lab, Drug Application and Research Center (ERFARMA), Erciyes University, 38039 Kayseri, Türkiye*

[3] *Clinical Engineering Research and Implementation Center (ERKAM), Erciyes University, 38030, Kayseri, Türkiye*

[4] *Nanotechnology Research and Application Center (ERNAM), Erciyes University, 38039, Kayseri, Türkiye*

Raman spectroscopy is an optically non-destructive and non-intrusive analytical technique that facilitates swift and economically efficient identification of biomedical samples. A notable advantage of Raman spectroscopy lies in its capability to function effectively in aqueous environments, rendering it particularly valuable for investigations involving biological specimens in their undisturbed habitats. Nonetheless, Raman Spectroscopy encounters a significant drawback stemming from the inherent weakness of Raman signals leading to posing challenges in acquiring high-resolution spectra. To surmount this limitation, plasmonic metallic nanostructures are strategically positioned in close vicinity to the analyte, inducing a remarkable increase in Raman signals by several orders of magnitude, leading to the phenomenon known as Surface-Enhanced Raman Scattering (SERS). SERS provides a label-free detection approach that eliminates the need for specific markers or probes to identify biological analytes. This feature simplifies the detection process significantly, as it removes the requirement for additional steps or the use of extra reagents. Furthermore, SERS presents exceptional molecular specificity, enabling comprehensive insights into the chemical composition and structural characteristics of the analyzed molecules. Notwithstanding these benefits, SERS frequently encounters limitations in resolving the complexity and variability of susceptible biological analytes, particularly in regions with low signal-to-noise ratio bands within the SERS spectra. State-of-the-art machine learning techniques play a crucial role in overcoming the challenges associated with analyzing vast and complex SERS datasets. By leveraging these techniques, we can extract significant information and discern subtle differences between spectra that may not be readily apparent to the naked eye. Thus, we have conducted different biomedical studies like; to detect antimicrobial resistance in bacteria, to identify cancer cell directly in blood called liquid biopsy, to characterize virus-like particles, and to discriminate the SARS-CoV-2 virus proteins in mammalian cells through machine learning.

In this talk, I will present our research group research about SERS applications in medicine in the age of artificial intelligence.

DRAFT

ID: 45

Photoconductivity and electrical transport in two-dimensional transition metal dichalcogenides

Antonia Di Bartolomeo
Department of Physics "E.R. Caianiello", University of Salerno, Salerno, Italy / 2.CNR SPIN, Salerno, Italy

The photoresponse of back-gate two-dimensional MoS_2, ReS_2 and $PtSe_2$ transistors is studied as a function of pressure and temperature. It is shown that the time resolved photocurrent behavior is dominated by slow photobolometric and slower photogating effects that are attributed to charge trapping/detrapping by shallow and deeper intragap states as well as to desorption of polar adsorbates. The photocurrent is enhanced by increasing temperature and decreasing pressure. The temperature dependence of photoconductivity can be explained by photoinduced desorption of adsorbates, such as O_2 and H_2O molecules, that enhance the n-doping level of MoS_2 and ReS_2 and suppress the p-doping level of $PtSe_2$. Such a process is facilitated at low pressure, which also suppresses the re-adsorption mechanisms, thus yielding a persistent photocurrent. The light induced desorption of adsorbates can cause a negative photoconductivity in p-type materials such as $PtSe_2$. This presentation emphasizes the key role that intrinsic defects and adsorbates have in the pressure and temperature dependent photoresponse of two-dimensional materials.

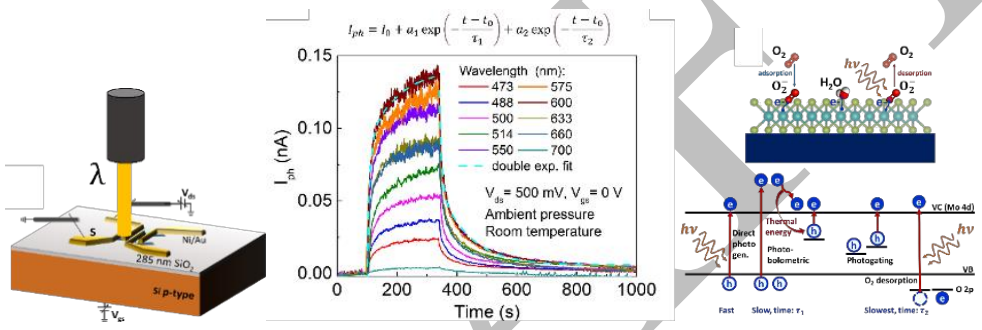

Figure: Schematic of a back-gate 2D-material based transistor. Time resolved photocurrent at different wavelengths. Adsorption/desorption of adsorbates and optical transitions in a 2D material.

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DRAFT

ID: 336

New-generation Multiplexed Point-of-Care Platforms based on Synergistic Contributions of Nanomaterials and Analytical Technologies

Emine Guler Celik*
Department of Bioengineering, Faculty of Engineering, Ege University, 35100, Bornova, Izmir, Türkiye

In-field applicability and cost-efficiency of Point-of Care diagnostics (POC) reveal their huge potential. Improvement of diagnostic accuracy and efficiency is still needed in POC platforms for replacing existing analytical methods in health screening and monitoring. With this focus, one of the trend applications is multiplexing for simultaneous detection of multiple targets. When developing multiplexed POC devices, it is critical to avoid cross-reactions as well as increase diagnostic success [1]. There are different technological designs for the multiplexing such as formation of spots/lines; separation of reaction regions such as channels/arrays; adaptation of different signal redouts by various labels. The design strategy depends on the priorities of stakeholders according to the target use. The paper material is very ideal for the preparation of different detection zones in multiplexed POC devices. On the other hand, different signal redouts can be achieved by nanomaterials due to their excellent features [2].

In this talk, recent advancements in multiplexed POC diagnostics will be highlighted and our works on paper-based diagnostics, multiplexed lateral flow assays, portable electrochemical devices for the detection of various targets including abused drugs, viruses, and different clinical biomarkers will be presented. Our findings will be discussed with an overview of the future prospects of next-generation POC diagnostic technology, prototype development and commercialization.

Acknowledgements:
This study was supported in part by the Scientific and Technological Research Council of Türkiye (Project no: 221Z083).

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DRAFT

ID: 339

Improving Efficiency and Stability of Perovskite Solar Cells by Modifications of Active Layer and Hole Transport Layer

Burak Gültekin
Ege University Solar Energy Institute, Bornova, İzmir, Türkiye

In the process of commercializing Perovskite Solar Cells (PSCs), enhancing the charge transfer processes on and between layers, as well as improving device stability, holds critical importance. Particularly in N-i-P structured devices, significant advancements have been reported through improvements and modifications within the Perovskite layer, the Perovskite/HTL interface, and the HTL layer. In this presentation, recent research covering perovskite crystal growth, surface passivation, HTM layer doping and the consequential impacts of these improvements on charge transfer dynamics, device efficiency and stability will be evaluated.

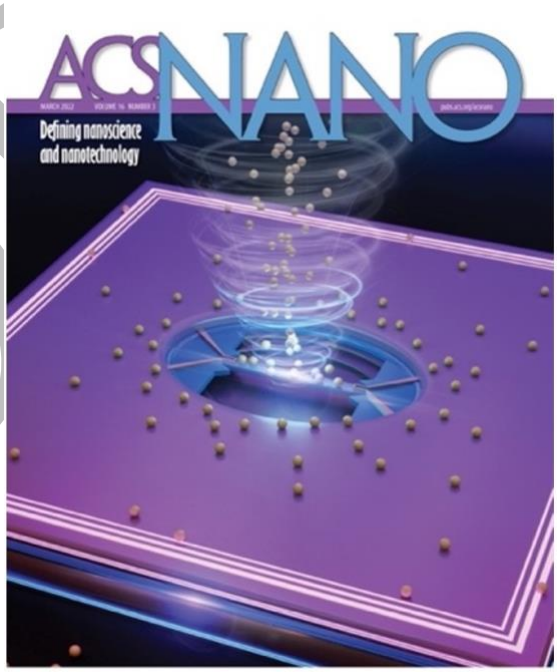
DRAFT

ID: 322

Nanomechanical Mass Spectrometry of Nanoparticles and Viruses under Atmospheric Pressure

Selim Hanay
Department of Mechanical Engineering, and UNAM, Institute of Materials Science and Nanotechnology, Bilkent University, Ankara, Türkiye

Nano-Electromechanical Systems (NEMS) have emerged as a promising technology for the mass sensing and spectrometry of nanoparticles and viruses at the single-particle level. However, a typical NEMS device has a small cross-section area, therefore it can capture only a tiny fraction of the incoming analyte particles. As a result, the limit-of-detection and throughput of NEMS mass sensors have not yet reached the levels required to analyze realistic biologic samples. Here, we overcome this problem by integrating a NEMS sensor with an on-chip polymeric ionic lens which automatically focuses the incoming analyte ions onto NEMS. The polymeric lens charges up by accumulating part of the incoming analyte ions delivered through electrospray ionization (ESI). As charge is accumulated and maintained on the polymeric lens, a significant portion of incoming analytes are focused onto an open window on the polymer layer which is aligned with an active NEMS sensor. Owing to the increased ionic flux at the NEMS location, not only the capture efficiency is increased drastically, but also the system could be operated entirely under atmospheric conditions by eliminating the need of focusing by ion optics and the vacuum conditions needed for ion optics.
We show that different nanoparticles and viruses can be characterized rapidly, and under ambient conditions [1]. We applied this technique to obtain the mass spectrum of SARS-CoV-2 in atmospheric conditions. Moreover, we have characterized another mammalian virus, BoHV-1, as a positive control experiment. The capture efficiencies obtained here are orders-of-magnitude higher than the earlier state-of-the-art NEMS systems. The results demonstrate that on-chip integration, rather than the use of bulky and expensive hardware, can be used to solve the capture efficiency problem of nanoscale sensors. With the increase in analytical throughput, the simplicity of the overall setup, and the capability to operate under ambient conditions, the technique presented here brings NEMS mass spectrometry one step closer to operation in the field and with realistic biological samples.



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ID: 331

Evolving nanoparticles aided strategies against bacterial infections

Didem Şen Karaman
Department of Biomedical Engineering, Faculty of Engineering and Architecture, İzmir Katip Çelebi University, İzmir, Türkiye

Different nanostructures with polymeric/inorganic constitutes offer advantages in reducing acute toxicity, overcoming the challenges of the conventional antibacterial therapies, antibiotic resistance and reducing costs in comparison to conventional antibiotics. Most of the studies to date have focused on inorganic NP containing silver, gold copper, zinc, titanium oxide, and cerium oxide as antibacterial agents. These materials can inherently exert antibacterial activity. These strategies enable the bacterial attack on many fronts, making it significantly more difficult for microbes to develop resistance. The physically acting NP can further be combined with chemical strategies to provide multifunctionality i.e. loading of drugs to the same nanosystems or used in combinatorial therapy, thereby increasing their effect. Among the existing NP, mesoporous silica nanoparticles (MSN) can provide multifunctionality (i.e. inherently therapeutic, drug delivery, targeted delivery, precision in dosing) due to its modular design options. In our on-going research activities we have developed different MSN based antibacterial nanostructure designs by altering the composition of nanoparticles in which antibiotic drugs are incorporated, coated with an antibacterial polymeric layer and/or antimicrobial peptides as well. Research findings on the designed MSN based nanoantibiotic aided antibacterial/antibiofilm treatments revealed that performed macromolecules accommodation on MSN boosts the antibacterial activity by reducing the required treatment dosage and improving MSN penetration through the biofilm matrix or bacterial cell interactions.

DRAFT

ID: 340

Nano based drug delivery systems in Cancer Therapy

Hülya Ayar Kayalı[1,2,3]

[1] *Izmir International Biomedicine and Genome Institute, Dokuz Eylul University, 35340 Izmir, Turkey*

[2] *Izmir Biomedicine and Genome Center, 35340 Izmir, Turkey*

[3] *Department of Chemistry, Division of Biochemistry, Faculty of Science, Dokuz Eylul University, İzmir 35390, Turkey*

Cancer, a complex and often life-threatening disease characterized by uncontrolled cell growth, holds immense significance for global health due to its widespread prevalence, substantial impact on mortality rates, and the imperative to develop effective prevention, treatment, and management strategies. Cancer treatment faces challenges like off-target effects, poor drug solubility, and limited drug combinations. Nano-based drug delivery systems offer a solution by precisely targeting tumors and sparing healthy tissue. These systems encapsulate drugs in nano carriers, increasing drug solubility and allowing combination therapy. Their extended circulation time enhances drug-cell interactions. Additionally, nano-carriers can be tailored for each patient, personalizing treatment. As a result, nano-based systems have the potential to revolutionize cancer therapy, improving effectiveness, minimizing side effects, and advancing personalized medicine. Among these, synthetic nanoparticles, exosomes and antibody-drug conjugates stand out. First of all, nanoparticles, as innovative nano drugs, have emerged as a revolutionary approach in medical science. These nanosized carriers exhibit exceptional potential to deliver therapeutic agents with pinpoint precision to targeted cells within the body. By capitalizing on their size and customizable surface properties, nanoparticles can navigate biological barriers, improve drug solubility, and offer controlled release, thereby enhancing drug efficacy while minimizing adverse effects. This cutting-edge technology has sparked considerable excitement in the medical community, offering a pathway towards more effective and personalized treatments for a wide range of diseases, including cancer, where targeted drug delivery is a game-changer in improving patient outcomes. Secondly, exosomes, nanosized vesicles secreted by cells, have emerged as a remarkable tool in the realm of nano drugs. These nanosized structures possess unique abilities to transport therapeutic cargo directly to target cells. Engineered exosomes can be loaded with specific drugs, nucleic acids, or proteins, offering a precise and efficient delivery system that bypasses many of the limitations of traditional drug administration. This innovation opens the door to personalized and targeted therapies, promising enhanced treatment outcomes while minimizing side effects, and underscores the transformative potential of exosomes as a revolutionary class of nano drugs in modern medicine. Lastly, antibody-drug conjugates (ADCs) represent a revolutionary class of nano drugs in cancer therapy. These innovative agents combine the precision of monoclonal antibodies with the potency of cytotoxic drugs. Engineered to selectively bind to cancer cells, ADCs deliver their toxic payload directly to the tumor site, minimizing damage to healthy tissues. This targeted approach enhances drug efficacy while reducing systemic side effects. With the antibody guiding its way, the ADC acts as a smart 'Trojan horse', infiltrating cancer cells and releasing its cytotoxic cargo, thus reshaping the landscape of cancer treatment by maximizing therapeutic impact and minimizing collateral damage.

DRAFT

ID: 338

Biological significance of chirality

Aşkın Kocabaş
Koç University, İstanbul, Türkiye

Biological systems typically exhibit broken chiral symmetry, with distinct left-right asymmetry. For instance, our hearts are consistently located on the left side, and our right hands are mirror images of each other. While some biological macromolecules like DNA, bacterial filagella, and cilia are intrinsically chiral, the reason behind their contribution to large-scale morphological chirality remains unknown. Additionally, it is uncertain whether this broken symmetry confers any biological or evolutionary benefits to living organisms. In this presentation, I will summarize our recent findings, which aim to address this mystery from the perspective of active matter physics. Our research indicates that chiral active systems offer specific dynamical advantages to competing populations, fostering grooving behaviors. In the context of crowded bacterial populations, chiral systems exhibit remarkably different dynamics. Moreover, we speculate that this dynamical advantage may be extrapolated to comprehend the general broken symmetry observed in various biological systems.

DRAFT

ID: 296

Topological control of light with graphene devices

Coskun Kocabas
The University of Manchester, Department of Materials, National Graphene Institute, Manchester, UK

The topological structure associated with the branchpoint singularity around an exceptional point (EP) can provide tools for controlling the propagation of light. Using graphene-based devices, we demonstrate the emergence of EPs in the electrically controlled interaction of light with a collection of organic molecules in the terahertz regime at room temperature. We show that the intensity and phase of terahertz pulses can be controlled by a gate voltage which drives the device across the EP. Our electrically tuneable system allows reconstructing the Riemann surface associated with the complex energy landscape and provides a topological control of light by tuning the loss-imbalance and frequency detuning of interacting modes. Our approach provides a platform for developing topological optoelectronics and studying the manifestations of EP physics in light-matter interactions.

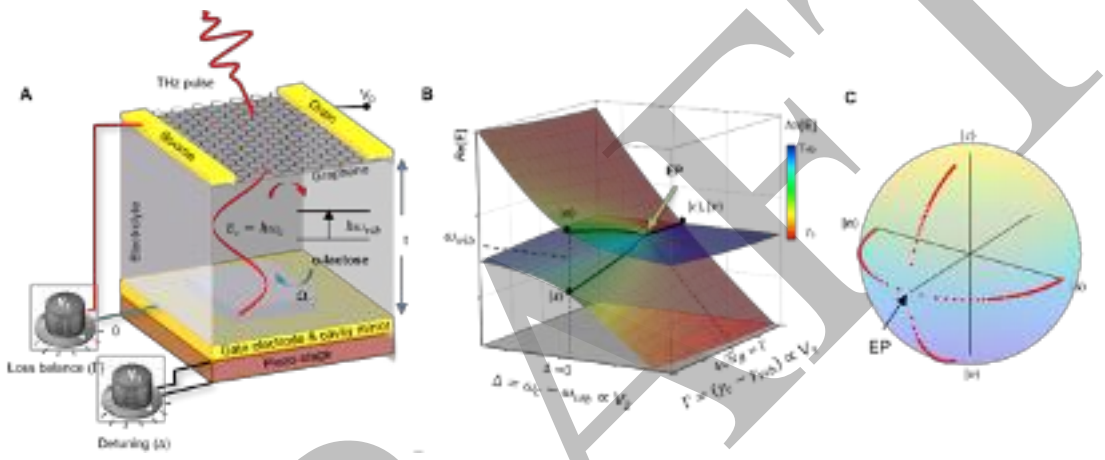

Figure: Electrically tuneable EP device. A, Schematic of the electrolyte-gated graphene transistor embedded with lactose microcrystals. B, Riemann surface obtained using numerical simulations shows the complex energy eigenvalues of the device plotted on the two-parameter voltage space defined by V_1 and V_2. C, Visualization of the evolution of the supermodes of the coupled system on a Bloch sphere as the gate voltage V_1 is varied (loss imbalance Γ is tuned).

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Keyword: *Graphene-based devices, Topological control of light*

DRAFT

ID: 28

What Can We Learn from Nanomechanical Testing: Case Studies on Nanocomposites, Thin Films, Additive Manufacturing, Advanced Alloys, and Biomaterials

Sezer Özerinç
Middle East Technical University, Ankara, Türkiye

Development of new structural materials with superior mechanical performance is among the main goals of materials science, driven by the high demand from a wide range of applications in aerospace, automotive, manufacturing, and energy sectors. Recent advances in nanomechanical measurements have provided effective tools for probing the mechanics of materials at small length scales that have not been accessible before. This capability has a number of important implications for advancing our understanding about the mechanics of materials. First of all, these nanomechanical measurements have enabled us to quantitatively analyze the strength and fracture properties of small-scale structures such as thin films and nanoparticles. Secondly, the small probe size has provided high-resolution property mapping that can differentiate the mechanical properties of different phases and morphologies in metallic alloys, composites and biomaterials. Lastly, a better understanding of the small scale mechanical behavior has given insight into the underlying reasons of mechanical behavior observed at the macroscale, suggesting novel routes for achieving superior mechanical performance through nanoengineering. This talk will give an overview of the recent advances in the application of nanomechanical measurements in materials science by giving examples from our research as well as the high-impact work in the literature.

DRAFT

ID: 58

Two-Dimensional Materials Based Supercapacitors with Enhanced Performance in Energy Storage Systems

Nihan Kosku Perkgöz*, Feridun Ay, Wonge Lisheshar Ibrahim
Electrical and Electronics Engineering Department, Eskisehir Technical University, Türkiye

Supercapacitors are energy storage devices that can store and transmit energy much faster than conventional batteries. There is an increasing number of research on these devices, which have the potential to revolutionize energy storage technology and make it more efficient, affordable and sustainable. They have become ideal devices for applications that require high power output in a short time, with their high energy density compared to capacitors, faster charging and discharging compared to batteries, and longer life. Because they last longer and can withstand more charge/discharge cycles than batteries, they are lower-cost devices in the long run. In addition, they can be used with batteries to increase the performance and extend the life of the application in which they are used, making them a promising technology for a wide range of applications from electric vehicles to renewable energy systems. Although they show great promise for use in future devices and systems, there are still challenges that need to be addressed and problems to be overcome for this technology to become widespread. Our research aims to address these issues by employing graphene MXene-based electrodes grown through chemical vapor deposition (CVD), enabling enhanced energy density, cost-effectiveness, and temperature resistance. Additionally, hybrid electrode architectures incorporating magnetic nanoparticles and graphene have potential to be explored to expand the voltage range. This study also emphasizes the use of flexible and environmentally friendly materials, aligning with sustainability goals. Overall, we aim to contribute to the development of innovative energy storage systems compatible with renewable energy integration and the objectives of the Green Deal initiative.

Keyword: *Two-dimensional materials, MXenes, Supercapacitors*

DRAFT

ID: 330

Crystal dynamics probed by THz Raman spectroscopy

Tommaso Salzillo
Department of Industrial Chemistry "Toso Montanati", University of Bologna, Viale del Risorgimento, 4 – 40136 Bologna, Italy

Different crystal structures may be conveniently identified by their Raman spectra in the region of the lattice phonon modes (THz range), where they display their own, unique features. Indeed, while the intramolecular vibrational spectrum of a compound probes its chemical identity, the lattice modes, associated to the weak dispersion forces of the inter-molecular field, probe the crystal dynamics, and are therefore sensitive even to slight structural differences.

The combination of lattice Raman spectroscopy and confocal microscopy is a valuable tool for the investigation of a system solid state, to be used for non-invasive and prompt structure recognition at the micrometric scale, the effectiveness of which is greatly enhanced by the association with accurate solid state DFT calculations. Examples of polymorph identification and characterization in both the bulk and the thin film phases of organic systems, as well as applications to the study of photochemical reactions, will be presented.

DRAFT

ID: 329

Photo-Supercapacitors: Solar Energy Conversion and Storage Devices

Nurdan Demirci Sankır
TOBB University of Economics and Technology, Ankara, Türkiye

Access to clean and sustainable energy sources is one of the most important needs of human beings. Because energy-related problems directly affect every aspect of our lives, from education to health. Global warming and other environmental problems, the effects of which we see dominantly in the current period, are largely due to the use of fossil fuels in energy production. Therefore, in line with the Paris Agreement, it is necessary to achieve zero carbon emissions to keep global warming below 2 ºC. This goal will only be possible with the use of renewable energy sources in every aspect of our lives. Undoubtedly, the sun can meet all the energy we need. With this potential, it is indisputably the most important among other renewable energy sources. The most important limitation of solar energy is that it is not always accessible. Therefore, storage systems are needed. To date, solar rechargeable battery systems and flow batteries using redox chemistry have been tried to be developed for this purpose. However, a new device comes to the fore, especially in meeting the energy needs of portable and autonomous systems. This device is called a photo-supercapacitor (PSC) and getting attention since the beginning of the 2000s. PSC, which mostly consists of a combination of dye-sensitized solar cells with supercapacitors, provides direct storage of electricity obtained from solar energy. However, in new generation energy conversion and storage devices, instead of producing and integrating two separate devices, double-acting, simpler and cost-effective solutions using electrodes that both absorb solar energy and store the generated electricity should be offered. At this point, composites of metal oxide nanoparticles prepared together with 2D materials show great potential. Due to the very long charge relaxation time of graphene oxide (GO)/zinc oxide (ZnO) nanostructure, we demonstrated the UV and day-light chargeable supercapacitors. and boosts the electrochemical properties of ZnO. GO easily captures photogenerated electrons and stores them in the large π-π network, enhancing the capacitive behavior of ZnO. This presentation reviews the recent advancements in PSC devices and dual-acting electrodes and their performance reported by our research group.

DRAFT

ID: 325

Advancing the Foundations of Atomic-Scale Device Fabrication: Insights from the Physics and Chemistry of Surfaces and Interfaces.

Steven R. Schofield
London Centre for Nanotechnology & Department of Physics and Astronomy, University College London, UK

For decades, the semiconductor industry has shown enduring and extraordinary adaptability. Yet, rapid advances in the controlled positioning of diverse dopant atom species at the atomic scale suggest an imminent revolution in semiconductor fabrication. This breakthrough technology promises new avenues for developing exceptional quantum electronic devices, at scale, and to enable new discoveries in fundamental condensed matter physics. In this talk, we will present a brief overview of this field alongside our recent progress [1-5] in demonstrating the remarkable properties of dopants like arsenic and bismuth in silicon and germanium for the creation of atomic-scale electronic devices. Our work utilises ultrahigh vacuum (UHV) scanning tunnelling microscopy, and soft x-ray angle-integrated and angle-resolved photoelectron spectroscopy (XPS, SX-ARPES). Key results we will show are the demonstration of the incorporation of arsenic into the Ge(001) surface at room temperature, and the creation and characterisation of the thinnest technological electron liquid (0.45 ± 0.04 nm) yet fabricated in silicon.

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DRAFT

ID: 312

All printed perovskite solar cells and modules for next generation energy production devices

Elias Stathatos
Nanotechnology and Advanced Materials Laboratory. Electrical and Computer Engineering Department, University of the Peloponnese, 26334 Patras, Greece.

Inkjet-printing technology is anticipated to play a major role in the future prototyping of perovskite solar cells (PSCs) to enable their ultra-low-cost and scalable manufacturing. However, inkjet challenges related to fluid dynamics need to firstly be addressed so as to allow the fabrication of high-quality printed materials and competitive photovoltaics to the established market. PSCs with earth-abundant carbon as an effective replacer for unstable hole transporting materials and expensive electrodes is a proposed structure promising better air and moisture stability. In this presentation, we will report on the latest advances of perovskites used as absorbers in carbon based perovskite solar cells and also to their modifications for long term stability and simplicity of preparation methods. Some of their outstanding properties including low cost, high stability, ambient processability and compatibility with most up scaling methods will be also discussed. Furthermore, methods for enhanced performance and stability of PSC in the presence of photonic materials such as phosphors will be also shown. Finally, the development of all-printed carbon-based hole-transport-material-free perovskite modules will be demonstrated, along with low upscaling efficiency losses and outstanding stability after 1000 h of ageing.

Acknowledgement: This research was funded by the Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "2nd Call for H.F.R.I. Research Projects" (PVLumo- project number 3730).

Keyword: *Perovskite solar cells, 3rd Generation PVs, phosphors, monolithic PV module*

DRAFT

ID: 321

Miniaturized Magnetic Levitation-Based Strategies for Advanced Biomarker Detection

H. Cumhur Tekin[1,2]

[1] *Department of Bioengineering, Izmir Institute of Technology, Izmir 35430, Türkiye*
[2] *METU MEMS Center, Ankara 06520, Türkiye*

Biomarkers are utilized in the diagnosis and monitoring of various diseases. Rapid, easy, and cost-effective detection of biomarkers is essential for effective disease management. The application of magnetic levitation technology in miniature devices has enabled the sensitive density measurements of microparticles and cells [1, 2]. In this talk, the principle of density measurements using magnetic levitation will be explained, and biomarker studies conducted with this principle will be explored. The magnetic levitation technology enables cell analysis and identification studies without labeling steps [1-3]. Furthermore, the integration of label-free holographic microscopy with magnetic levitation technology allows portable analysis [4]. The use of magnetic levitation technology in microfluidic channels facilitates the separation of cancer cells from white blood cells, enabling the isolation of circulating cancer cells in the blood. Additionally, the cells visualized in the magnetic levitation setup can be processed using deep learning algorithms to improve cell separation performance [5]. Moreover, microparticles can serve as microsensors in a magnetic levitation setup [6]. These particles selectively capture protein-based biomarkers, which are labeled with magnetic nanoparticles. Hence, their levitation heights can be altered with proteins that can be used for the determination of biomarker concentrations. Due to its cost-effectiveness and portability, magnetic levitation technology holds significant potential for the automated detection of numerous biomarkers.

Acknowledgements:
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DRAFT

ID: 314

Natural Polyelectrolytes for Biocompatible Organic Bioelectronics

Serpil Tekoğlu
Johannes Kepler University, Linz Austria

Rapid progress in technology and electronic products have brought about the environmental impact which is a major concern of people today. Therefore, the researchers have been spending tremendous efforts on sustainable materials and technologies to create eco-friendly solutions through sustainable future. The talk will address some of the issues in the related fields with a focus on biocompatible bio- and organic electronics.
In the first part, we will focus on natural-based renewable materials, so-called "green" materials as emerging materials for sustainable electronics. One of the prospects is to use biopolymers such as deoxyribonucleic acid (DNA) in bio- and organic electronics as a means to develop biodegradable and biocompatible products. By taking as advantage of natural polymer electrolyte behavior, DNA is employed as ion-solvating polymer in the emissive layer of light-emitting electrochemical cells (LECs). Further innovations through biocompatible and implantable photonic devices may offer biocompatible, bioresorbable products for healthcare monitoring, sensing, and light-activated therapies. Bearing this in mind, in the second part of the talk, DNA is proposed as secondary dopant during the synthesis of novel conductive biocomposites polypyrrole :DNA (PPy:DNA) and poly(3,4-ethylenedioxythiophene):DNA (PEDOT:DNA) for bioelectronics. These biocomposites with DNA as counter ion have been successfully tested as ion-to-electron transducer in organic electrochemical transistors (OECTs) for the first time by our group. We compare the cytotoxicity of PEDOT:PSS, PEDOT:DNA and PPy:DNA films using NIH3T3 mouse fibroblast cell line. The results show high biocompatibility to living cells while preserving the benefits of electrical conduction for future biomedical applications. The results are promising for further investigation and optimization for feasible healthcare applications.

DRAFT

ID: 323

Nanomaterials for triboelectric nanogenerators

Husnu Emrah Unalan
Department of Metallurgical and Materials Engineering, Middle East Technical University (METU), 06800, Ankara, Türkiye

Over the past two decades, there has been a rising demand for functional textiles. Notably, progress in the fields of the Internet of Things (IoT), artificial intelligence, and data science has compelled scientists and engineers to create improved functional and electronic textiles that align with consumer expectations. Nevertheless, these textiles have not fully realized their potential due to certain limitations. One significant drawback is their reliance on rechargeable batteries, hindering their practical daily use as meeting the power needs through external batteries proves to be a major obstacle. The heavy and bulky nature of conventional energy storage devices compromises user comfort. Moreover, these devices have limited capacity, necessitate frequent recharging, and pose potential risks. In contrast, triboelectric nanogenerators (TENGs) offer a promising solution, as they have the potential to serve as reliable, inexhaustible, sustainable, and economically viable power sources. TENGs are cutting-edge energy harvesting devices that convert mechanical energy from everyday movements into an abundant power source, capitalizing on the immense potential of nanomaterials.

In this presentation, I will discuss our efforts in utilizing nanomaterials for TENGs, with a focus on wearable electronics. TENG electrodes for self-powered wearable devices were constructed by using modified fabrics, consisting of thermoplastic polyurethane (TPU) film laminated with silver nanowires (Ag NWs). The true potential of fabricated TENGs was showcased through the development of a self-powered e-wristband, effectively utilized as a keyboard to control basic computer operations. Planar polymeric films, as demonstrated here, are important as proof of concept but far from what wearable electronics can offer. In order conserve fabric texture, core-shell TENG electrodes were fabricated using coaxial wet spinning. Kilometer long fibers with conducting core (using Ag NWs) and insulating shell (using TPU) were produced with promising TENG performance. The successful demonstration of weaving and sewing with fabricated core-shell fibers using different patterns culminated their integration into commercial fabrics. This achievement demonstrated the fabrication of an IoT wristband capable of wirelessly playing PACMAN on a PC.

DRAFT

ID: 14

Natural Photosynthesis and Quantum dots: Advances and Challenges

Caner Ünlü
İstanbul Technical University, İstanbul, Türkiye

Photosynthesis, one of the main life-driving natural processes, depends on two consecutive reaction systems: light reactions and dark reactions. The process of photosynthesis starts with light reactions, which begin with the absorption of light through light-harvesting biomolecular systems. However, there are some natural limitations to the absorption of light through these systems. These limitations can be overcome by creating nanoparticle-biomolecule conjugates. Semiconductor fluorescent nanocrystals, also known as quantum dots, are considered to be one of the best candidates for altering the light-harvesting capacity of photosynthetic organisms due to their unique photophysical properties, such as high fluorescence quantum yield, high photostability, narrow emission band, and wide absorption band. The size of a typical quantum dot varies between 2 nm and 10 nm, and the composition of quantum dots can consist of many different elements, including Cd, Pb, Hg, Se, Te, In, Cu, P, S, C, B, and N. Heavy metal-containing quantum dots are widely used in life science studies; however, their applications are restricted due to the toxic effects of heavy metals. On the other hand, heavy metal-free quantum dots are much more preferred in life science studies due to their low toxicity, especially in studies about photosynthesis. In this study, the synthesis and development of Cd and carbon-based quantum dots and their possible applications to increase the light-harvesting capacity of photosynthetic organisms will be discussed.

DRAFT

ID: 310

Electronic, Vibrational, and Piezoelectric Properties of Two-Dimensional Ultra-Thin Janus Materials

Mehmet Yağmurcukardeş
İzmir Institute of Technology, İzmir, Türkiye

Two-dimensional (2D) Janus materials are a new class of materials with unique physical, chemical and quantum properties. The name Janus comes from the ancient Roman god who had two faces, one looking to the future and the other to the past. This definition is used for materials with different surfaces in 2D single-layer materials, and has recently become widespread with the achievement of experimental synthesis of such materials. Prior to the synthesis of the single-layer MoSSe Janus material, two-sided structures were formed by surface functionalization in the currently known single-layer structures such as graphene. However, the experimental demonstration of 2D MoSSe revealed the existence of stable Janus-type materials, and the stability of Janus structures belonging to different material groups has been predicted in many studies. In a recently published study, we predicted with theoretical calculations that the vertical heterostructures that can be formed with these materials, inspired by the out-of-plane asymmetry of Janus materials, may show different properties depending on the layer-layer interaction. The electronic and vibrational properties of the heterostructures formed by Janus structures consisting of Germanium Oxide (GeO) and Mo-S-O atomic layers, which have out-of-plane asymmetry and have recently been brought to the literature experimentally, were shown to depend on the interacting atomic types at the interfaces. Our calculations showed that electronically the O/Ge and S/O interfaces form heterojunctions with direct and indirect type-II band alignment, respectively. On the other hand, O/O and S/Ge interfaces formed type-I band alignment with indirect band gap. Optically, different interfacial interactions exhibit distinguishable features over the absorption spectra. Raman spectrum calculations, another characterization method, have also shown that heterostructures with different interface interactions can be distinguished, especially through low-frequency phonon modes. The piezoelectric properties of GeO/MoSO heterostructures vary significantly with the interfacial interaction type. Our study is important in terms of predicting the diversity of properties that will arise if heterostructures formed with 2D materials are formed with asymmetric layers.

DRAFT

ID: 51

Scaling from Bulk to Nano: High-Resolution Device Prototyping using State-of-the-Art Electron Beam Lithography

Cenk Yanık
Sabanci University Nanotechnology Research and Application Center – SUNUM, İstanbul, Türkiye

Nanotechnology has brought about a new era of advanced nanoscale devices that are more efficient, precise, and functional than conventional bulk materials. However, the production of these devices is complex due to their small size and intricate geometries. The state-of-the-art electron beam lithography (EBL) systems offer a revolutionary solution to the challenges of the nanotechnology field.
EBL systems are highly advanced machines with exceptional resolution and accuracy, which allows for the precise creation of nanostructures. The system consists of an electron beam column and a computer-controlled interferometric stage for positioning the sample. With a focused electron beam capable of making complex patterns with a few nanometers in diameter on the sample surface, EBL is a key prototyping tool in nanofabrication applications, including micro/nanoelectronics, photonic devices, and advanced materials.
This talk will highlight SUNUM - Sabanci University Nanotechnology Research and Application Center's - exceptional nanofabrication capabilities in prototyping advanced nanoscale devices and structures using the state-of-the-art 100 kV electron beam lithography system.

Keyword: *Nanofabrication, electron beam lithography*

DRAFT

Germanene: the germanium analogue of graphene

Harold Zandvliet
Physics of Interfaces and Nanomaterials & MESA+ Institute for Nanotechnology, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

Germanene, i.e. the germanium analogue of graphene, shares many properties with graphene. In both materials the electrons in the vicinity of the Fermi level behave as massless relativistic particles. There are, however, also a few differences: (1) the spin-orbit coupling in germanene is much larger than in graphene and (2) the honeycomb lattice of germanene is not flat, but buckled. The large spin-orbit gap in germanene makes this material the ideal candidate to exhibit the quantum spin Hall effect. We show that germanene is a quantum spin Hall insulator with a gapped interior and topologically protected helical edge states. The buckling of the lattice of the honeycomb allows to tailor the quantum state of matter of germanene. By applying a perpendicular electric field the spin-orbit gap in germanene first closes and then reopens again. The reopening of the gap is accompanied by a topological phase transition of germanene from a two-dimensional topological insulator to a trivial band insulator. This electric field-induced tailoring of the quantum state of matter of germanene allows to controllably switch the topologically protected helical edge states on and off. The latter makes germanene the material of choice for the realization of a topological field-effect transistor.

DRAFT

ID: 18

Effect of Zirconium Oxide on Band Electron of Metal Elements: Doppler Broadening Spectrometer

Mahdi Ghasemifard*, Misagh Ghamari
Esfarayen University of Technology

In this study the electron structure of zirconium oxide (zirconia/ZrO_2) doped with metal ions (Pr^{3+}, Sm^{3+}, Dy^{3+}, Er^{3+}, and Eu^{2+}) synthesized by co-precipitation method were investigated. Using X-ray diffraction (XRD) the crystal structure of single and doped ZrO_2 was investigated. The results obtained from XRD show those dopants cause changes in the structure and crystal growth direction of the samples. The structure of core electrons in pure and doped zirconia was studied by Coincidence Doppler Broadening Spectrometer (CDBS). The results of CDBS show that the metal ions Pr^{3+}, Sm^{3+}, Dy^{3+}, and Er^{3+} occupy the interstitial sites of the zirconia lattice, and the metal ion Eu^{2+} replaces the Zr atom and has a significant effect on the linear momentum ratio curves.

Keyword: *Zirconia, XRD, Doppler broadening spectrometer, Core electron level*

DRAFT

ID: 25

Synthesis of High Performance rGO/Fe_3O_4/ZnSe Magnetic Nanocomposites as a Dark Catalyst Nanomaterial for Simultaneous and Fast Degradation of Dyes from Water

Not Presented

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ID: 31

A simple and rapid “turn-off” fluorescence sensor based on CdTe/ZnSe quantum dots for the on-site detection of Lead and Mercury ions in water

Not Presented

DRAFT

ID: 64

Cafestol loaded biopolymer nanoparticles: synthesis and in-vitro release studies

Özge Vardar[*1], Ayça Mehmetoğlu Al[2], Yeliz Yıldırım[3]
[1] Department of Chemistry, Faculty of Science, Ege University
[2] Department of Bioengineering, Faculty of Science, Ege University
[3] Center for Drug R&D and Pharmacokinetic Applications (ARGEFAR), Ege University

Cafestol (CFS) is one of the more than a thousand chemical compounds that make up the structure of coffee. CFS, which is known to be more present in unfiltered coffee types has antidiabetic [1], anti-inflammatory [2] and anticarcinogenic [3] properties. CFS loaded Chitosan (CS), Alginate (ALG) and Alginate-Chitosan (ALG-CS) nanoparticles with high loading efficiency were synthesized by ionic gelation method. CFS loaded biopolymer nanoparticles were characterized by Fourier transform infrared spectroscopy (FTIR), thermogravimetric analysis (TG) and surface morphology by scanning electron microscopy (SEM). In-vitro release studies of CFS loaded biopolymers were carried out in pH 7.4 and 4.6 mediums and analytical method validation studies of CFS were performed for the first time with high pressure liquid chromatography (HPLC). The CFS limit of quantification (LOQ) and detection (LOD) were 0.087 µg/ml and 0.26 µg/ml in pH 7.4 0.039 µg/ml and 0.26 µg/ml in pH 4.6 respectively. Encapsulation efficiency of the synthesized CFS loaded biopolymer nanoparticles is 53% (CFS loaded ALGNPs), 54% (CFS loaded ALG-CSNPs) and 92% (CFS loaded CSNPs). The particle sizes determined using Malvern Zeta Sizer Ultra were found to be 97±4.04 (CFS loaded CSNPs), 81±6.51(CFS loaded ALGNPs), 112±4.58(CFS loaded ALG-CSNPs). It was determined that the nanoparticles showed a varying release profile depending on the types of biopolymer and media (pH 7.4 and 4.6) between 300 and 1200 minutes. It has been concluded that CSNPs, ALGNPs and ALG-CSNPs can be used as a suitable carrier system for CFS.

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Keyword: *Cafestol, Chitosan Nanoparticles, Alginate Nanoparticles, Drug Delivery Systems*

DRAFT

ID: 65

Gadolinium Doped Graphene Quantum Dot Nanocomposite Based Diode

Aslıhan Anter[1], Zeynep Berktaş[*2], Barış Polat[3], Elif Orhan[1]
[1] Gazi University, Department of Physics, Ankara, Türkiye
[2] Gazi University, Department of Advanced Technologies, Ankara, Türkiye
[3] Medipol University, Industrial Engineering, Ankara, Türkiye

In recent years, carbon-based electronics have become an attractive technology, in particular graphene quantum dots (GQDs). The controlled modification of the electrical and opto-electronic properties of GQDs by physical-chemical processes or by synthetic methods can lead to new applications. To determine how doping carbon-based materials with Gd alters the electrical properties of the structure, Gadolinium (Gd) doped graphene quantum dots (GdNPs-PEI N-GQDs) were prepared using a hydrothermal method. The electrical properties of the diode based on GdNPs/PEI N-GQDs nanocomposites have been investigated using the current-voltage (I-V) technique and the capacitance-voltage (C-V & G/ω-V) technique at 300 K in the frequency range 0.5 kHz to 500 kHz at ± 5 V. In this study, the photoluminescence (PL) performance of GdNPs/PEI N-GQDs nanocomposites was investigated using an FS5 integrating sphere spectrofluorometer. Compared to the Gd-free PEI N-GQDs sample (7.60%), an increase in PLQY is approximately 470%. The rectification ratio (RR) was found to be 14 at a voltage of ±5 V. The rectifying behaviour of the diode changed to an ohmic behaviour after doping with Gd, compared to the Gd-free PEI N-GQDs sample ($2.8x10^4$ at ±5 V).The results can be used to gain a better understanding of the technology of carbon-based electronics.

Keyword: *Gadolinium, Graphene Quantum Dots, PEI N-Doped GQDs, diode, electrical properties*

DRAFT

Stability Investigation of $CsPbI_3$ Perovskite Quantum Dots for Solar Cells Application

Pouriya Naziri[*1], Naeimeh Sadat Peighambardoust[2], Umut Aydemir[3]

[1] Graduate School of Sciences and Engineering, Koç University, Sariyer, Istanbul-34450, Türkiye & Koç University Boron and Advanced Materials Application and Research Center (KUBAM), Sariyer, Istanbul-34450, Türkiye

[2] Koç University Boron and Advanced Materials Application and Research Center (KUBAM), Sariyer, Istanbul-34450, Türkiye

[3] Koç University Boron and Advanced Materials Application and Research Center (KUBAM), Sariyer, Istanbul-34450, Türkiye and Department of Chemistry, Koç University, Sariyer, Istanbul-34450, Türkiye

The emergence of α-$CsPbI_3$ perovskite Quantum Dots (PQDs) in the cubic phase as a novel semiconducting QD material has opened up new possibilities for fundamental research and optoelectronic device applications. These QDs exhibit unique optical and electrical properties with specifically high photoluminescence quantum yields (PLQYs), making them promising candidates for developing advanced electronic devices such as solar cells. PQDs' optical and electronic properties can be readily tuned by manipulating their size, composition, and dimensionality. This remarkable tunability enables precise control over essential characteristics such as bandgap, emission wavelength, and charge transport properties. In this study, we successfully synthesized colloidal all-inorganic perovskite $CsPbI_3$ QDs using the hot injection synthesis process. Subsequently, we conducted a comprehensive evaluation of the QDs' stability under prolonged exposure to UV light over a span of one month. We observed a partial blueshift in both the first excitonic absorption and photoluminescence (PL) peaks. Initially, the fresh quantum dots (QDs) displayed an absorption peak at 680 nm, which corresponded to their characteristic optical properties. However, after subjecting the QDs to continuous UV light exposure for a period of 35 days, we observed a slight but noticeable shift in the absorption and PL peaks, with a reduction to 679 nm. Consistent with the PL results, the band gap calculations of $CsPbI_3$ also showed a decrease over a 40-day period of storage under UV light, resulting in a spectral blue shift. Furthermore, we observed a reduction in the lifetime of $CsPbI_3$ QDs from 24 ns to 18 ns over the course of a one month period. Notably, our study initially achieved an impressive maximum quantum yield of 86% for the $CsPbI_3$ QDs, which gradually declined to 42% over a one-month duration.This reduction highlights the challenges associated with the stability and photodegradation of these QDs and underscores the need for continued research to improve their long-term performance for various optoelectronic applications.

Keyword: *CsPbI3 quantum dots, Perovskite, Hot injection, solar cells*

DRAFT

ID: 100

Preparation and Characterization of a Novel Anti-Microbial Wound Dressing

Seray Zora Tarhan*, İsmail Alper İşoğlu, Sevil Dinçer İşoğlu
Abdullah Gul University, Kayser, Türkiye

One of the main challenges in wound care and treatment is limited antibacterial properties of wound dressing materials (Sardareh et al., 2022). The traditional applications have been unable to sufficiently meet the needs of the patients suffering from the wounds. Several methods have been utilized to design wound healing products. However, among them, the electrospinning technique has attracted more attention . This technique is a simple and convenient, allowing the production of advanced electrospun membranes with a specific structure and properties that mimic the extracellular matrix (ECM) (Liu et al., 2021). Electrospun nanofibrous membranes, with their high surface area, are excellent candidates as therapeutic agent carriers to solve problems related to infection and promote wound healing (Suganya et al., 2011). Nowadays, several herbs and their active constituents have been studied as therapeutic agents due to their significant potential for the management and treatment of wounds through multiple interconnected mechanisms. Moreover, they are affordable and generally cause minimal side effects (Maver et al., 2015). Cinnamomum zeylanicum, known for its excellent antibacterial, antifungal, and anti-inflammatory activities, has been studied extensively (Bandara et al., 2012). In our study, we employed the electrospinning technique to fabricate a novel anti-microbial nanofibrous membrane inspired by the nature of Cinnamomum zeylanicum. We fabricated nanofibrous membranes using a blend of poly(lactic acid) (PLA) and natural gelatin, along with different ratios of ethanolic extract of Cinnamomum zeylanicum, as wound dressing material. The properties of the electrospun membrane were characterized utilizing ATR-FTIR, scanning electron microscopy (SEM), and water contact angle measurements. Additionally, we conducted cell viability, swelling, biodegradation, release study, and mechanical tests to evaluate the potential of the membranes for wound healing applications. The results showed that the anti-microbial nanofibrous membrane developed in this study is a promising wound dressing candidate to effectively prevent infection in the wound area.

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Keyword: *electrospinning, nanofibrous membrane, wound healing, Cinnamomum zeylanicum, antibacterial*

DRAFT

ID: 114

Introduction to new family members of carborane-thiol molecules, and their first computational adsorption study on Au nanocluster surfaces

Adem Yavuz[*1], Caner YALCIN[2], Oleg Tok[3], Jakub Visnak[3], Jan Machacek[3], Tomas Base[3], M. Fatih Danisman[4]

[1] Center for Materials Research, Integrated Research Centers, Izmir Institute of Technology, Urla İzmir 35430, Türkiye

[2] Department of Micro- and Nanotechnology, Middle East Technical University, 06800 Ankara, Türkiye

[3] Institute of Inorganic Chemistry, The Czech Academy of Sciences, 1001 Husinec-Rez, 250 68, Czech Republic

[4] Department of Chemistry, Middle East Technical University, 06800 Ankara, Türkiye

We will present a study of the adsorption mechanism of carborane-thiol molecules on Au nanocluster surfaces using density functional theory (DFT). We will investigate the adsorption behavior and dipole-dipole lateral interactions of m-carborane-9-thiol (M9), 1,1'-bis(m-carborane)-7-thiol (mm-SH), and 1,1'-bis(p-carborane)-12-thiol (pp-SH) carborane-thiol self-assembled monolayers on template-stripped Au films (TSAu) using contact angle measurements (CAs), atomic force microscopy (AFM), scanning tunneling microscopy (STM), scattering-type scanning near-field optical microscopy (s-SNOM), and X-ray photoelectron spectroscopy (XPS) techniques. Our results show that the adsorption of carborane-thiol molecules on Au nanoclusters is a complex process that is influenced by the size and shape of the nanoclusters, the surface chemistry of the nanoclusters, and the molecular structure of the carborane-thiol molecules. We believe that our study provides new insights into the adsorption mechanism of carborane-thiol molecules on Au nanoclusters and that this information could be used to design new materials with enhanced properties.

Keyword: *carborane-thiol, Au nanocluster, contact angle measurements, atomic force microscopy, template-stripped Au film*

DRAFT

Optical Properties and Characterization of Ti-Doped Zinc Oxide Thin Films

Onur Alp Aksan[*1], **Ahmet Yavuz Oral**[2]
[1] *Institute of Nanotechnology, Gebze Institute of Technology, 41400 Kocaeli, Türkiye*
[2] *Department of Materials Science and Engineering, Gebze Institute of Technology, 41400 Kocaeli, Türkiye*

The incorporation of titanium oxide into zinc oxide is essential in order to alter and enhance the surface properties. The presence of Titanium in the ZnO lattice can result in lattice distortions, strain, and defects. These structural changes can influence the material's crystallinity, grain size, and surface morphology. In this study, Ti-doped zinc oxide thin films were produced by the sol-gel method. Titanium isopropoxide was employed as a titanium source, meanwhile, zinc acetate dihydrate was used as a zinc source in the precursor solutions. For deposition and characterization, precursor solutions with four distinct molar ratios and aging times were prepared and deposited on glass substrates. Afterward, Ti-doped ZnO thin films were obtained by annealing at 550°C for 30 minutes. To examine the optical characteristics of the films, including their reflectance and transmittance, UV-visible spectroscopy was used. The effects of titanium doping on the optical characteristics of the thin films were identified between the range of 300-800nm. Furthermore, scanning electron microscopy was utilized to examine the surface morphology and microstructure of the Ti-doped ZnO thin films. The surface porosity of the films with different molar ratios was calculated using the ImageJ software from scanning electron microscope images. In conclusion, the incorporation of titanium oxide into the zinc oxide matrix has a significant influence on the surface properties of the resulting thin films. The comprehensive characterization and understanding of the surface properties of Ti-doped ZnO can contribute to their potential applications in areas such as optoelectronics, sensors, and transparent conducting electrodes.

Keyword: *Thin film, Sol-gel, Zinc Oxide, Titanium Oxide*

DRAFT

ID: 167

Zinc Oxide Nanoparticles via Green Synthesis

Hümeyra Karakaya*, **Burcu Kızılateş, İlker Erdem**
Abdullah Gül University, Kayseri, Türkiye

In recent years, metal oxide nanoparticles have been widely used in biomedical applications.
Among metal oxide nanoparticles, zinc oxide nanoparticles (ZnO NPs) have attracted great attention in the field of bioengineering with their low cost and high performance properties. The production of ZnO NPs continues for optical, as well as biomedical and industrial applications with its antibacterial and drug delivery properties[1].
There are many ways to synthesize ZnO nanoparticles, and mainly by using bottom-up approach through chemical reactions. However, severely toxic reagents, high temperatures, high pressures and long reaction times may be necessary in these methods and that may reduce the purity of the final product and limit their practical application[2]. Therefore, different approaches to optimize the production of ZnO NPs using environmentally friendly "green synthesis" technology are being explored[3]. Microorganisms (bacteria, fungi, algae) and bio-renewable resources (plants) can be used in the green synthesis of nanoparticles[4].
Plant-based extracts are gaining more attention due to their cost-effectiveness, non-toxic, sustainability, being a renewable resource and numerous advantages of phytochemicals[5]. Thyme plant has antioxidant and antimicrobial properties with its phytochemical components, and these biomolecules can react with Zn^{2+} to form zinc complex (e.g. ZnO) molecules in one step.

In this study, ZnO NPs with small particle size (16 nm, SEM data) were produced and characterized by green synthesis method using thyme plant extract. The characterization results confirmed the crystal structure and purity of ZnO NPs. It is reported in the literature that ZnO-NPs produced by green synthesis are smaller in size and nano-sized materials have a higher surface-to-volume ratio, resulting in higher surface area and more reactive particles [4]. ZnO NPs synthesized with a 5 mL of thyme extract added on 0.1 mM 50 mL of zinc sulphate heptahydrate solution was found to have high crystal quality and smaller particle size.
Easy and low cost green synthesis of ZnO NPs from thyme plant extract at room conditions has been successfully synthesized and produced ZnO NPs are promising for use in different biomedical fields.

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Keyword: *green synthesis, zinc oxide nanoparticles, thymus vulgaris, nanotechnology*

DRAFT

Optimization of Flow Conditions in a Microfluidic System for Various Viscosities of Silicone Oil Towards Synthesis of Metal Organic Framework Structures

Buse Parlak*, Selis Onel
Hacettepe University, Department of Chemical Engineering, Ankara, Türkiye

Metal organic framework (MOF) crystalline structures have gained much attention for their applications in gas storage[1], drug delivery[2], and reaction engineering[3] thanks to a large ratio of surface area-to-volume. The wide size distribution of particles with MOFs poses an obstacle to commercialization due to irregularities in quality. Microfluidic systems offer advantages, such as faster and controlled production of nanoparticles, manipulation of very small volumes of fluid, rapid heat and mass transfer, and a controlled reaction environment[4]. Synthesis of uniform nanoparticles is possible in picoreactors, formed as aqueous droplets in oil in two-phase microfluidics. The viscosity of oil, the continuous phase, and the surface tension between the dispersed and the continuous phases play a critical role in droplet formation. Using an oil phase with optimum viscosity is crucial in producing droplets, i.e. picoreactors, with the desired size and maintaining sufficient interdroplet distance to prevent droplet coalescence and clogging in the channels during synthesis[5]. The oil acts as a carrier and helps the droplets to rotate and mix along the microchannel due to shear forces between the two phases. Viscosity of the oil affects the mixing ability of the droplet, the surface pressure applied on the droplet, and, thus, the synthesis of crystals. Exposing MOF recipes that require high synthesis temperatures to high pressures in picoreactors travelling in microchannels could help to reduce synthesis temperatures. N,n-dimethylformamide (DMF) is the dominant solvent component of MOF precursor solutions used with metal salts of Zr, V, and Ti and organic ligands. We used silicone oils of 10, 100, 350, 500, and 1000 cSt viscosity to investigate its effect and optimize flow in a droplet based microfluidic system using DMF as the dispersed phase. We investigated the effects of the ratio of the flow rates of the dispersed and continuous phases Qd/Qc, capillary number Ca that influence droplet formation, diameter of droplets, and interdroplet distance. We simulated the system based on experimental data using COMSOL multiphysics software to predict the appropriate viscosity for the continuous phase and droplet sizes suitable for the precursor solution. This study is supported by TUBITAK 1001 (Project 220M002) and BIDEP 2210C program.

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Keyword: *Two-phase microfluidic system, metal-organic framework (MOF), flow optimization, viscosity, silicone oil*

DRAFT

ID: 193

Thin film electrodes based on Zn2SnO4 on In2O3:SnO2 substrates

Betül Yurttaş[*] [1], Meltem Maral[2], Arzum Erdem[2], Lütfi Özyüzer[3,4]

[1] Department of Biotechnology and Bioengineering, Izmir Institute of Technology, Urla 35430, Izmir, Türkiye

[2] Analytical Chemistry Department, Faculty of Pharmacy, Ege University, Bornova 35100, Izmir, Türkiye

[3] Department of Physics, Izmir Institute of Technology, Urla 35430, Izmir, Türkiye

[4] Teknoma Technological Materials Inc., IYTE Campus, Urla 35430, Izmir, Türkiye

This study [1] presents development of thin film electrodes with their characterization. We aimed to develop a novel thin film electrode that could be used for biosensing applications. In our study [1], the thin film electrodes (ZTO/ITO) are fabricated through magnetron sputtering which is an effective and inexpensive technique. The electrode fabrication involves the deposition of Zn_2SnO_4 (ZTO) onto In_2O_3:SnO_2 (ITO) substrates. To assess the physical, optical, and structural properties of the electrodes, surface profilometry, UV/VIS/NIR spectrophotometry, X-ray diffraction (XRD), and scanning electron microscopy (SEM) measurements were conducted. The results of these measurements revealed that the ITO thin film possesses a crystalline structure, whereas the ZTO thin film assumes an amorphous structure, and both thin films exhibit favorable surface morphology. Furthermore, the ZTO/ITO combination exhibits a higher optical transmission value compared to bare ITO. Furthermore, electrochemical characterization of the electrodes; cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) was performed. Subsequently, the surface of the ZTO/ITO electrode was modified using 3 aminopropyltriethoxysilane (APTES) in order to obtain more conductive electrode and to obtain a higher surface area on the surface of ZTO/ITO for further electrochemical biosensing studies. Consequently, the results showed that APTES modification onto the surface of the ZTO/ITO electrode results with a significant change on its electrochemical behaviour based on CV and EIS measurements.

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Keyword: *Magnetron sputtering, Electrochemical biosensor, Thin film electrode*

DRAFT

ID: 195

Structural assesment of phosphopeptide enrichment potential of the newly developed lanthanide(III) ions based magnetic affinity materials

Önder Topel[*] [1], Vahit Gök[1], Sevil Aksu[1], Ingmar Persson[2]
[1] *Department of Chemistry, Akdeniz University, Antalya, Türkiye*
[2] *Department of Molecular Sciences, SLU, Uppsala, Sweden*

It has been developed a new lanthanide(III) ion-based magnetic IMAC materials (Ln^{3+}-Mag-IMAC) consisting of core–shell–like silica-coated magnetic nanoparticles as supporting materials, chelidamic acid as a chelating agent, and Ln^{3+} ions as metal ions [1]. The potential of the developed Ln^{3+}-Mag-IMAC materials in the enrichment of phosphopeptides was modeled by phosphate adsorption studies in an aqueous solution at 25°C. The results revealed a good phosphate adsorption capacity, with a stoichiometry of 2.5, 1.2, and 1.1 moles of phosphate ions per mole of Nd^{3+}, Dy^{3+}, and Er^{3+} ions on the surface of Ln^{3+}-Mag-IMAC materials. Structural assessments using Extended X-ray Absorption Fine Structure (EXAFS) spectroscopy measurements indicated that Nd^{3+} ions on the surface of Ln^{3+}-Mag-IMAC materials exhibit a nine-coordinate structure, allowing for three possible phosphate coordination sites within the first coordination sphere; but, Dy^{3+} and Er^{3+} ions with a seven-coordinate configuration on the IMAC surface possess the ability to accommodate only two phosphate ions. The developed Ln^{3+}-Mag-IMAC materials were applied on trypsin-digested beta-casein solutions, and the captured phosphopeptides were identified by LC-MS/MS analysis.

Keyword: *magnetic nanoparticles, IMAC, phosphopeptide enrichment, phosphate adsorption, EXAFS*

DRAFT

ID: 205

Vitis Vinifera L. Comparıson of Zno Nanoparticles Synthesized by Green Synthesis Using Three Different Grapes of Zno Using Extracts

Burcu Aydoğdu[*] [1], **Nesrin Karaca Sanyürek**[2]
[1] *Munzur University, Faculty of Engineering, Departman of Machine Engineering, Tunceli, Türkiye*
[2] *Tunceli Vocational School, Munzur University, Tunceli, Türkiye*

In this study, Vitis vinifera L. cvs. Öküzgözü, Sultani, Besni varieties were used. The synthesis of zinc oxide (ZnO) nanoparticles of grape extracts was carried out using the precipitation approach. The total antioxidant capacity of grape extracts was determined, and the changes in the size and morphology of the synthesized zinc nanostructures were compared according to their antioxidant capacity. Total antioxidant capacity was determined by the CUPRAC (Copper (II) ion-reducing antioxidant capacity) method. Changes in the size and morphology of nanostructures (ZnO) were investigated by X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Energy Dissipative X-rays (EDX), Fourier Transform Infrared (FTIR) and Thermogravimetric analysis (TG-DTA). Analysis revealed that the prepared (ZnO) nanomaterial crystallized in a hexagonal wurtzite structure, and the crystallite sizes calculated using the Debye-Scherrer formula were compared.

Keyword: *Green synthesis, Nanoparticles, Vitis Vinifera L., ZnO*

DRAFT

ID: 209

Advances in Thin Film Thermoelectrics: Unlocking Performance through Surface Control

Gizem Durak Yüzüak[*1], Mehmet Çetin[2], Ercüment Yüzüak[2]

[1] Munzur University,Rare Earth Elements Application and Research Center, Tunceli, Türkiye

[2] Recep Tayyip Erdoğan University, Faculty of Engineering and Architecture, Rize, Türkiye

Thin films exhibiting exceptional thermoelectric properties are indispensable for a broad spectrum of applications, encompassing energy harvesting, solid-state cooling, and thermoelectric generators. This significance arises from the distinctive capability of thermoelectric materials to directly convert heat into electricity [1]. Enhancing the thermoelectric characteristics of thin films can be achieved through heat treatment, which imparts additional advantages to the materials. Of particular importance for investigating the structural and morphological aspects of thin films in thermoelectric applications is the regulation of annealing temperature and surface microstructure. Magnetron sputtering is a technique for making thin films by blasting a target material with ions to expel its atoms, which are then deposited on a substrate. Magnetron sputtering was used to deposit thin films of the well-known thermoelectric material BiSeTe onto Si(100) substrates for the present research. The thin films were then annealed at 250˚C for one hour in a vacuum environment with a pressure of $5x10^{-5}$ mTorr or higher. Multiple methods were employed to assess the thin films' structural characteristics, including X-ray diffraction (XRD), scanning electron microscopy (SEM), and atomic force microscopy (AFM) [2]. The resistivity and Seebeck coefficients of the thin films were electrically measured in the vicinity of room temperature. Vacuum annealing further optimized carrier concentration and mobility, resulting in increased electrical conductivity and Seebeck coefficients in the crystalline thin films. Comparison of results before and after room-temperature heat treatment revealed a nearly threefold enhancement in the power factor, a metric indicating a material's capacity to convert heat into electricity. These findings suggest that a thermoelectric energy generator incorporating a Bi-Se-Te thin film atop a rigid Si(100) substrate can significantly improve performance. The implications of this study extend to various applications, including energy conversion and thermal control, underscoring the need to regulate annealing temperature and surface microstructure of thin films to enhance their thermoelectric properties.

Acknowledgment

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Keyword: *Thermoelectric thin films, BiTe, Thermoelectric Effect, Surface Properties*

DRAFT

ID: 213

Comparison of Conventional and Green Synthesis Methods of Gold Nanoparticle Synthesis

Halit Çavuşoğlu*[1], Hüseyin Şakalak[2]

[1] Department of Physics, Faculty of Science, Selcuk University, Selcuklu, 42130, Konya, Türkiye

[2] Graduate School of Natural and Applied Sciences, Nanotechnology and Advanced Materials, Selcuk University, Selcuklu, 42130, Konya, Türkiye

Recently, numerous techniques have been explored to develop an effective approach for synthesizing metallic nanoparticles, including electrochemical, sonochemical, biochemical, photochemical, and physical processes. However, the majority of these methods rely on hazardous and toxic chemicals, leading to challenges in purifying the end product and incurring high production costs. In contrast, green nanotechnology has emerged as a dominant field by utilizing plant extracts and various biological resources, offering a promising alternative that is non-toxic, clean, and environmentally friendly compared to traditional physiochemical methods. Plant extracts for green synthesis of nanoparticles can be obtained through diverse methods, such as conventional extraction techniques and supercritical fluid extraction methods, with the latter gaining prominence due to its high efficiency and low energy costs. The green synthesis of gold nanoparticles (AuNPs) garners significant interest due to its biomedical applications. Green chemistry provides a sustainable alternative to conventional reduction methods, relying on natural substances with dual properties as both reducing and stabilizing agents for the reduction of Au(III) ions. Plant-mediated green synthesis demonstrates high cost-effectiveness and environmental friendliness in producing nanostructures with remarkable efficiency, making it preferable to physical and chemical approaches. The combination of green synthesis and curcumin to produce nanoparticles has been effective as the amount of toxic waste is highly reduced. Starting with a general introduction about nanoparticle synthesis and curcumin, the use of curcumin as a principal reducing agent and stabilizing compounds in the production of nanoparticles is developed. This study focuses on synthesizing AuNPs using curcumin obtained from supercritical extraction of turmeric and commercial curcumin. The synthesized AuNPs have been characterized using dynamic light scattering (DLS), scanning electron microscopy (SEM), and UV-Vis spectroscopy techniques to investigate their physical properties. This study also aims to compare the effects of commercial curcumin and curcumin derived from turmeric on synthesis of AuNPs based on the obtained results. The concluding section highlights the advantages of employing curcumin as a reducing and stabilizing agent in nanoparticle formation and its analytical applications.

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Keyword: *Green Synthesis, Curcumin, Gold nanoparticles*

DRAFT

Nano-hydroxyapatite Coated Multilayer Nanofiber Electrospun Composite Scaffold for Wound Dressing Application

Hayrullah Çetinkaya[*1], **Mustafa Özgür Öteyaka**[2]

[1] *Eskişehir Osmangazi University, Faculty of Engineering and Architecture, Department of Chemical Engineering, Eskişehir, Türkiye*

[2] *Eskişehir Osmangazi University, Eskişehir Vocational School, Department of Electronic and Automation, Eskişehir, Türkiye*

In orthopaedic and dental applications, wound dressing materials are used to heal the wound area. In recent years, nanofibrous structures have been considered for rapid tissue healing [1-3]. In this work, a five-layer nanofiber scaffold was produced using the electrospinning method. The first layer (L1) contains PVA/ZnO, the second layer (L2) contains PVA/Collagen/Vitamin, the third layer (L3) contains PVA/Nano-Hydroxyapatite (HA), the fourth layer (L4) was the same as L2 and the fifth layer (L5) was the same as L1. Then, the composite was coated with hydroxyapatite using the thermionic vacuum arc (TVA) method. The morphology of the resulting wound dressing was examined by field emission scanning electron microscopy (FESEM); the X-ray diffraction method (XRD) was employed to characterise the amorphous or crystalline structure; Fourier Transfer Infrared spectroscopy (FTIR) was used to examine the bond structures, and contact angle methods were performed to examine the hydrophobic/hydrophilic properties. As a result of the findings, the production of multilayer nanofiber membranes was successfully realised. The nanofibers were randomly distributed according to FESEM analysis. As a result of XRD analysis, peaks belonging to the polymer were observed, and it was determined that the structure was crystalline. Both XRD and FTIR observed that the intensity of the HA peaks increased significantly after coating. In addition, as a result of the contact angle analysis, it was determined that the material was hydrophilic.

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Keyword: *Electrospinning, Nanofiber, Scaffold, Wound dressing, Hydroxyapatite*

DRAFT

ID: 219

Photodeposition of Ag Nanoparticles on Fibrous Substrates Enabled by ALD ZnO Thin Films

Burak Sozen[*1], **Yahya Oz**[2], **Halil Akyıldız**[1]
[1] *Bursa Uludag University, Bursa, Türkiye*
[2] *Turkish Aerospace, Ankara, Türkiye*

Textile substrates offer relatively high surface area, flexibility, and low cost for catalysis, flexible/wearable electronics, and energy storage applications. By their nature, many textile materials cannot offer much for these trending applications; therefore, they require modifications. Atomic layer deposition (ALD) is one of the prominent techniques that can modify every fiber in a textile material at relatively low temperatures. In this study, organic and glass textile substrates are deposited with ZnO thin films via ALD, and the Ag nanoparticles are deposited on top of the films via the photochemical process. Metal oxide semiconductors such as ZnO can absorb the photon energy to generate radical species that can stimulate reduction and oxidation reactions. It is possible to deposit metal species on a photocatalytic material such as ZnO using the reduction route. Ag nanoparticles obtained on the fibers showed different structures depending on the metal salt used, the pH of the system, or the presence of auxiliary chemicals. The structure of the materials is investigated via SEM, EDS, and XRD analysis. Furthermore, the materials' electrical and thermal conductivity is investigated for possible composite applications.

Keyword: *photodeposition, atomic layer deposition, textiles, Ag nanoparticles*

DRAFT

Characterization and Synthesis of Vanadium Borides (VB2) and Chromium Borides (CrB2): Advancing Ternary Transition Metal Borate Coatings for Enhanced Performance

Gizem Durak Yüzüak[*1], Ercüment Yüzüak[2], Murat Tomakin[3]
[1] *Munzur University, Rare Earth Elements Application and Research Center, Tunceli, Türkiye*
[2] *Recep Tayyip Erdoğan University, The Faculty of Engineering and Architecture, Rize, Türkiye*
[3] *Recep Tayyip Erdoğan University, The Faculty of Arts and Sciences, Rize, Türkiye*

Representing a new and captivating class of materials, "borate transition metals" offer extraordinary characteristics that elicit excitement and intrigue. Their enhanced tribological, corrosion, electrical, and thermal features make them appealing for use in various applications, including coatings. The coating's chemical makeup, impurities, microstructure, flaws, and preferred crystallographic orientation all play a role in determining the coating's qualities [1]. Increasing the hardness of these formations can be achieved through viable routes such as natural structure, element addition for generating a ternary phase, superlattice structures, and manipulation of grain sizes. High melting points, hardness, resistance, superior electrical and thermal conductivity, high wear resistance, thermal shock resistance, and corrosion resistance are just some of the many reasons why vanadium borides (VB_2) and chromium borides (CrB_2) stand out among hard coatings. Through the measured addition of VB_2 to the CrB_2 system counteract the drawbacks of conventional approaches to transition metal borate synthesis and create a better coating material with improved corrosion resistance and hardness. This study is to fully characterize the properties of VB_2 and CrB_2 alloys before they become ternary. It will be ensured that ternary phases are formed by using directly proportional approaches with the results obtained and success in achieving the needed attributes without sacrificing crystal structure or purity through composition engineering.
Vanadium borides (VB_2) and chromium borides (CrB_2) were prepared by arc-melting. To obtain a homogeneous phase, sample was annealed for 2 days at 773 K. The surface structure and composition of the alloys were determined by scanning electron microscope and energy dispersive X-ray analysis. Differential scanning calorimetry measurements were carried out in the heating as well as cooling cycles. The X-ray powder diffraction technique was used in order to determine the crystal structure of the alloys. By employing a combination of SEM, EDX, DSC, and XRD techniques, a comprehensive understanding of the surface morphology, composition, thermal behavior, and crystal structure of the synthesized alloys was obtained.

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Keyword: *Super Hard Coating Materials, CrB2, VB2*

DRAFT

ID: 263

The Synthesis of Natural Biodegradable Bioaerogels from Chickpea Starch

Özge Yılmaz*, Burcu Okutucu
Ege Univercity Faculty of Science Biochemistry Department, İzmir, Türkiye

Aerogels are extremely porous materials made up of three dimensional solid network structures that are interconnected. They have possess unique properties due to their mesoporous structure, such as high porosity, low density, high specific surface area, low dielectric constant, and super low thermal conductivity. The pore size and specific surface area of aerogels can be modified, and different functional groups can be added to provide the necessary mechanical and physicochemical qualities. Aerogels can be made from different precursors, such as organic, inorganic, or hybrid materials.

Chickpea is easy to cultivate, doesn't care about soil quality, and can withstand water scarcity. In line with these advantages, this study synthesized aerogel using starch purified from chickpeas. Starch, which is naturally found in various plant sources, is ideal for use in the production of starch based products as well as a food source due to its cheapness, easy accessibility, and abundant availability. It provides a costeffective and ecofriendly way to synthesize bioaerogels. It also promotes biodegradability, making it significant.

In this study, starch was purified from chickpeas by wet and dry purification methods. Wet milling resulted in a starch yield of 28.97%, while dry milling resulted in a starch yield of 6.75%. The pectin was used as a cross linker aerogel for synthesized with the purified starch and dialyzed in $CaCl_2$ solution. The physicochemical characterization of the aerogels were tested with FTIR. The swelling capacity of aerogels were analyzed. The best swelling capacity was observed in the aerogel containing 1% starch and 0.25% pectin. The aerogels were tested for getting lactose free milk from organic and daily milk. Enzyme solutions were added to the aerogels then, these aerogels were put in tea bags. These aerogel filled tea bags were treated with daily and organic milk. At the end of 20 minutes at room temperature, the lactose content reached 0.03%, which is also found in commercial lactose free milk. As a result of this study, chickpea starch aerogels were a good alternative instead of commercial enzyme because of their less price, easy to handle, and reusability.

Keyword: *Biopolymer, Biodegradable, Starch, Chickpea, Aerogel*

DRAFT

Effect of Cannabis-Based Nanocellulose Additive Amount on Dye-Sensitized Solar Cell Efficiency

Mücella Özbay Karakuş[*1], Hidayet Çetin[2], Ali Delibaş[3], Merve Eren Yakışıklıer[2], Tolga Önen[2]

[1] *Yozgat Bozok University Faculty of Engineering and Architecture, Department of Computer Engineering, Yozgat, Türkiye*

[2] *Yozgat Bozok University, Faculty of Arts and Sciences, Department of Physics, Yozgat, Türkiye*

[3] *Yozgat Bozok University, Faculty of Arts and Sciences, Department of Chemistry, Yozgat, Türkiye*

In this study, Cannabis based nanocellulose doped quasi-solid hydrogels were produced and applicated to dye-sensitized solar cells (DSSCs). During the synthesis of quasi-solid hydrogels, different structures were obtained by adding Cannabis based nano cellulose at different ratios. Specifically, six types of gel polymer electrolytes were obtained by incorporating a liquid electrolyte into cationic poly (2 methacryloyloxyethyl trimethylammonium chloride co acrylic acid) polymer hydrogel and its derivatives with different Cannabis based nano cellulose ratios (0%, 1%, 2%, 5%, 7% and 14% by mass). The prepared gel polymer electrolytes were applied onto Pt counter electrodes and TiO_2 photoanodes sensitized with N719 dye. A standard DSSC with liquid electrolyte was also prepared, while the others were prepared with six Cannabis based nano cellulose doped quasi-solid electrolytes, thus a total of seven DSSCs with different configurations were prepared. The current-voltage (I-V) characteristics of these DSSCs were measured under a light intensity of 1000 W/m^2. Additionally, the dielectric, conductivity and electrochemical properties of the prepared nanocellulose doped quasi solid gel electrolytes were investigated using frequency-dependent analyses. The power conversion efficiencies of the DSSCs varied depending on the Cannabis based nano cellulose doping ratios of the quasi solid electrolytes. The standard DSSC with liquid electrolyte exhibited an efficiency of 9.14%, while the DSSCs prepared with the six different hydrogel electrolytes showed efficiencies ranging from 4.32% to 9.26%. Notably, the DSSC with the highest power conversion efficiency (9.26%), which has a higher efficiency level than the standard liquid electrolyte used DSSC was obtained using the Cannabis based nano cellulose doped quasi solid gel polymer electrolyte with a doping ratio of 1%. However, when the Cannabis based nano cellulose doping amount decreased or increased from 1%, the power conversion efficiency began to decline. In conclusion, the study confirms the impact of the Cannabis based nano cellulose in the structure of the quasi solid gel polymer electrolyte plays a crucial role in energy conversion efficiency. On the other hand, it is clear that when the amount of Cannabis based nano cellulose is held steady at an optimum 1% level it performs in DSSCs more effectively than the liquid electrolytes. The results obtained using Electrochemical Impedance Spectroscopy (EIS) and Cyclic Voltammetry (CV) techniques also support these outcomes.

Keyword: *Dye-sensitized solar cells, Cannabis based nano cellulose, Quasi solid gel polymer electrolyte*

DRAFT

ID: 281

Synthesis and Characterization of CsSnxPb1-xBr3 Quantum Dots for Perovskite Solar Cells

Müge Öztürk*, Tamer Yeşil, Burak Gültekin, Ceylan Zafer
Solar Energy Institute, Ege University, İzmir, Türkiye

Lead halide perovskite quantum dots (PQDs) are promising photovoltaic materials for solar cells due to their superior optoelectronic properties and easy preparation. However, lead-based perovskite materials cause environmental pollution, prompting research on non-toxic materials like Sn, Ge, and Mn cations to replace Pb cations.[1] In this study, quantum dots (QDs) were developed using tin as active layers in solar cells to reduce their toxicity. The hot injection method was utilized, with cesium oleate playing a crucial role in synthesizing uniform QDs. The resulting QDs had an ABX_3 crystal structure, specifically $CsSn_xPb_{1-x}Br_3$ (x:the mole fraction of tin). Structural and photophysical characterization techniques were employed to evaluate their properties. Small-angle X-ray scattering (SAXS) was used to determine the QDs' size in the solution phase, while high-resolution transmission electron microscopy (HR-TEM) analysis examined their structural properties and morphology. HR-TEM imaging provided detailed information on the crystal lattice, particle size, and surface characteristics, offering insights into the QDs' structural integrity and quality. UV-Vis absorption spectroscopy was employed to analyze the QDs' absorption capabilities, revealing the efficient wavelength range for solar cell applications. This investigation yielded important data on the QDs' photovoltaic performance potential, including their absorption coefficient and optical bandgap. Steady-state photoluminescence (PL) measurements were conducted to assess the QDs' light emission efficiency, providing insights into their emission properties and radiative recombination processes. Additionally, the photoluminescence quantum yield (PLQY), which measures the efficiency of light emission, was calculated to evaluate the QDs' ability to convert absorbed energy into emitted light. This characterization quantified the synthesized QDs' efficiency as active layers in solar cells. Overall, this study comprehensively investigated the synthesis of tin-incorporated QDs for efficient solar cell applications. The structural and photophysical characterization techniques, such as UV-Vis absorption spectroscopy, steady-state photoluminescence measurements, HR-TEM analysis, and PLQY calculation, improved our understanding of the optical properties, photovoltaic potential, emission efficiency, and structural characteristics of $CsSn_xPb_{1-x}Br_3$ QDs. The study's findings provide valuable insights for developing non-toxic and environmentally friendly perovskite-based solar cell technologies, ultimately enhancing solar cell efficiency.

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Keyword: *Perovskite Quantum Dots, Perovskite Solar Cells, Hot Injection, Quantum Dots, Characterization Techniques*

DRAFT

ID: 283

High-yield synthesis of antibacterial zinc oxide nanoparticles

Laylo Saidova[1], Jennet Sultanova[*1], Nilay Gunduz Akdogan[2,3], Ozan Akdogan[1,3]
[1] Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353, Istanbul, Türkiye.
[2] Faculty of Engineering, Piri Reis University, 34940, Istanbul, Türkiye.
[3] NANOTerial Technology Corporation, 34077, Istanbul, Türkiye.

Zinc oxide nanoparticles (ZnO NPs) have attracted substantial scientific interest due to their distinct properties and a wide array of applications. In this study, ZnO NPs were synthesized by a Y- junction setup, involving a reduction reaction of $ZnCl_2$ and $NaBH_4$. Following synthesis, a thorough purification process was conducted to obtain pure ZnO NPs, eliminating any residual salts and acids. The resulting ZnO NPs underwent detailed characterization utilizing advanced analytical techniques, including X-ray diffraction (XRD), and ultraviolet-visible (UV-Vis) spectroscopy. XRD analysis conclusively confirmed the crystalline Wurtzite hexagonal structure, and based on Scherer formula, it was estimated that the average crystallite size is 10.28 nm. UV-Vis spectroscopy revealed an absorbance peak at 341 nm with a band gap of 3.64 eV, indicating the presence of a quantum confinement effect. This finding aligns with previous studies conducted by Manzoor et al. (2009), which demonstrated that as the particle size decreases, an increase in bandgap occurs, leading to the manifestation of the quantum confinement effect. Additionally, antimicrobial studies were conducted to evaluate the efficacy of ZnO NPs against the gram-negative bacteria Escherichia coli (E. coli). In the research conducted by Narayanan et al. (2012), it was noted that a concentration of 0.02 g/ml of ZnO nanoparticles led to an inhibition zone of 13 mm against E. coli bacteria. Our study yielded comparable findings, where concentrations of 0.02 g/ml, 0.01 g/ml, and 0.005 g/ml resulted in inhibition zones of 15 mm, 13.3 mm, and 13 mm, respectively. Moreover, the research that was done by Liu et al. (2009) demonstrated that increasing powder concentrations and decreasing particle size enhanced the antibacterial activity of ZnO nanoparticles.

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Keyword: *Zinc oxide nanoparticles, Antibacterial activity, High-yield synthesis, Y-junction setup, antimicrobial studies*

DRAFT

ID: 297

Orientation Control over Self Assembly of Metal Tipped Colloidal Quantum Wells to Prepare Surface Enhanced Raman Spectroscopy Substrate

Zeynep Dikmen
Eskisehir Osmangazi University, Eskişehir, Türkiye

Surface Enhanced Raman Spectroscopy (SERS) as a promising analysis technique to detect characteristics and chemical structure of the samples became quite common in daily routine practices such as food safety, bioanalysis and environmental examinations, and material characterization [1, 2]. A drastic increase of the intensity of relatively weak Raman scattering by up to 10^7 times can be achieved by SERS that is based on the enhancement of the electromagnetic field by localized surface plasmons (LSPs) of metallic nanoclusters. Semiconductor nanocrystals increases manifold due to the enhancement of the local field thanks to the Raman scattering intensity of semiconductor NCs placed near metal nanoclusters [3].
In the study, we propose and demonstrate orientational control of gold-tipped colloidal quantum well (CQW) self-assembly to prepare surface-enhanced Raman spectroscopy (SERS) substrate. CdSe/CdZnS CQWs were synthesized and metal-tipped CdSe/CdZnS CQWs were prepared according to previous studies by minor revisions [4]. Face-down and vertically oriented SERS substrates were used to detect allyl thiourea, and p-nitrophenol (PNP) as model pollutant. Control over orientation of self-assembled nanoplatelets were achived via hydrophilicity/lipophilicity balance as reported in our previous report [5].

Acknowledgement:
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Keyword: *self-assembly, colloidal nanoplatelet, gold tipped nanocrystal, SERS*

DRAFT

ID: 35

Exploring the Capacitive and Piezoelectric Properties of Tunable Structured ZnO Nanomaterials

Mohamad Aleinawi*, Emre Erdem
Faculty of Engineering and Natural Sciences, Sabanci University, Istanbul 34956, Türkiye

Zinc Oxide (ZnO) holds a special stature in materials for energy research due to its attractive properties including having a wide band gap energy, and bio-safety. In this study, we present structural and spectroscopic analyses for various ZnO nano samples synthesized by different routes.
The focus of this study is directed on ZnO nanowires (NWs) synthesized by the hydrothermal route, to harness its piezoelectric properties. High aspect ratio (AR) samples were obtained, with a piezoelectric coefficient d_{33} up to 22 pC/N. Additionally, ZnO nanoparticles (NPs) obtained by the co-precipitation method are studied for usage in supercapacitor applications, and compared with NWs performance as supercapacitor electrode materials. Several samples yielded a high value of specific capacitance, providing an attractive opportunity for usage in supercapacitors applications.

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Keyword: *ZnO, Nanowires, Nanoparticles, Piezoelectric coefficient, Specific capacitance, Aspect ratio, Nanoscale*

DRAFT

ID: 125

Investigation of photophysical properties of 2D Ruddlesden–Popper perovskite / MoS2 heterostructures

Alp Yılmaz[*1], **F. Gonca Aras**[1], **Aydan Yeltik**[1,2]

[1] *TOBB University of Economics and Technology, Department of Material Science and Nanotechnology Engineering, Ankara, Türkiye*

[2] *UNAM − Institute of National Nanotechnology Research Center, Bilkent University Ankara, Türkiye*

Type-II heterostructures of two-dimensional (2D) semiconductor materials are favorable candidates for high-performance photodetector and photovoltaic applications due to the efficient charge separation resulting from proper band alignment. Theoretical studies in recent years have shown that $(C_4H_9NH_3)_2PbBr_4/MoS_2$ and $(C_4H_9NH_3)_2PbI_4/MoS_2$ stacked materials form type-II p-n heterojunctions[1,2]. 2D Ruddlesden-Popper perovskite single crystals (RPSCs) are attracting attention due to their superior properties such as high absorption coefficient and high charge carrier mobility[3]. Monolayer transition metal dichalcogenides (TMDs) such as MoS_2 have been also used in optoelectronics for many years due to their impressive charge carrier mobility, and high stability[4]. Therefore, the production of the heterostructures of RPSCs/TMDs and the investigation of their photophysical properties are of great importance for high-performance optoelectronic devices. In this study, $(C_4H_9NH_3)_2PbBr_4$/monolayer-MoS_2 and $(C_4H_9NH_3)_2PbI_4$/monolayer-MoS_2 heterostructures were produced for the first time and their photophysical properties depending on the thickness of the 2D RPSC layers were experimentally investigated in detail.

Large-area bulk 2D RPSCs were synthesized by the solution temperature-lowering method and characterized in detail. Large-area bulk 2D RPSCs were exfoliated at different thicknesses, in the range from atomic to multilayers, via the mechanical exfoliation method. Further, the large-area continuous monolayer MoS_2 film was synthesized by the chemical vapor deposition method with the glass-assisted approach for the first time and characterized by μ-Raman and μ-PL spectroscopy techniques. Herein, the PDMS stacking method was used to produce heterostructures by transferring the exfoliated 2D RPSCs onto monolayer MoS_2 film. Photophysical investigation of the heterostructures was carried out via μ-Raman and μ-PL spectroscopy. It was revealed that stronger charge separation can be achieved by reducing the thickness of the 2D RPSCs in the heterojunction region and the PL quenching of the MoS_2 film can be tuned depending on the 2D RPSC thickness. Particularly, the PL intensity of the MoS_2 film drops drastically up to 4 times with the thickness of 2D RPSCs below 100 nm. Overall, the findings in this study provide fundamental insight into the charge separation phenomenon in $(C_4H_9NH_3)_2PbBr_4/MoS_2$ and $(C_4H_9NH_3)_2PbI_4/MoS_2$ heterojunctions, which might pave the way for high-performance photodetectors and photovoltaics.

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Keyword: *2D Organometal Halide Perovskites, Transition Metal Dichalcogenides, Type-II Heterostructures, Optical Properties*

DRAFT

ID: 140

Photothermal properties of Liquid metal derived BiSn core-shell particles

Doğu Şeyda*, Orçun Dinçer, Duygu İnce, Murathan Çuğunlular, Hüsnü Emrah Ünalan, Simge Çınar Aygün

Middle East Technical University, Department of Metallurgical and Materials Engineering, Ankara, Türkiye

As dictated by the conservation of energy law, energy cannot be generated nor destroyed. Light-to-heat conversion has long been popular among scholars and the general public as a traditional yet continually developing method of energy transformation [1]. With the advancement of sophisticated nanotechnologies, a wide range of photothermal nanomaterials have been endowed with exceptional light harvesting and photothermal conversion characteristics, allowing for the exploration of novel and promising applications [1]. Among candidates, liquid metal particles have received a lot of interest for photothermal applications because of their mechanical flexibility, spherical shape, light absorption capabilities, and catalytic performance [2]. Being a metallic material, liquid metals are also capable of charge separation under light illumination [2]. It has been recently reported that undercooled liquid metal particles can be used as a template and phase distributions within a particle or shell layer can easily be customizable [3]. Liquid metal particles have a core-shell structure with metal in a naturally produced oxide skin. Natural oxides of bismuth and tin are known to be semiconductors and are being researched for use in light-triggered applications [4],[5]. In this study, by combining both the metallic core properties and the semiconductor oxide layer in one particle, we showed for the first time in literature that these liquid metal-derived BiSn particles exhibit photothermal characteristics with a novel broad-band light absorption capability and can serve as a highly efficient photo-to-heat converter material. Therefore, we suggest that BiSn liquid metal-derived particles can be used as an alternative to noble metals in light-absorbing applications. We have also showed that the absorption effectiveness of liquid metal particles can further be adjusted by modifying their composition, phase distribution, and shell thickness via oxidative heat treatments. As a proof of concept, we have also demonstrated the use of these particles as a photothermal actuator and a solar evaporation device.

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Keyword: *broadband light absorption, core-shell particles, liquid metal particles, photothermal nanomaterials, Bismuth-Tin*

DRAFT

ID: 250

Optical Polarization Characteristics of Hybrid Gratings Made of Metals and Polymer

Emirhan Taze*, Talha Erdem
Department of Electrical-Electronics Engineering, Abdullah Gül University, Kayseri 38080, Türkiye

Gratings or one-dimensional photonic crystals are periodic two-dimensional array structures that have polarization dependent transmission and reflection characteristics. (Loewen & Popov, 2018; Palmer & Loewen, 2005) Those structures are normally used as diffraction gratings, but overall transmission and reflection of the light are influenced by the orientation and composition of the grating. While effects of the geometrical properties of gratings made of metals such as aluminum are well known, effects of various material compositions leading to variations in the refractive index remain unexplored. To address this missing point, we investigate the effect of different mixtures of materials in the grating structure and how the polarization ratios of the transmitted and reflected light at different optical polarizations alter.
In our study, we utilized the Bruggeman theory (Bruggeman et al., 1935; Gaponenko, 2010) to calculate the effective refractive index of the material system made of gold, silver, and poly(dimethylsiloxane) (PDMS) at different compositions. We observed that by changing the composition, it is possible to tune the real and imaginary parts of the refractive index over the whole visible regime. Finite-difference time-domain simulations reveal that the reflection and transmission spectra exhibit composition-dependent extrema. We found out that the central wavelength and the bandwidth of these extrema vary across the visible regime depending on the material composition and geometrical parameters.
According to our simulation results, the material composition and grating period turn out to be the key factors that determine the polarization ratio and the wavelengths of extinction ratio extrema. We believe that our results will enable the use of composite materials made of solution-processed techniques such as colloidal nanoparticles. Such systems may serve as cost-effective polarization-dependent and spectrally tunable diffraction gratings and optical filters.

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Keyword: *Gratings, FDTD, Bruggeman Theory, Hybrid Materials*

DRAFT

ID: 15

One-step, cost effective and rapid fabrication of graphene films and applications on nanoelectronics

Nihan Aydemir
Gebze Technical University, Kocaeli, Türkiye

Herein we demonstrate, a cost-effective, versatile, and rapid method for graphene fabrication wherein a CO_2 laser is utilized to convert polyimide films to graphene. As opposed to the expensive and bulky lasers described in the literature, the suggested methodology utilizes a cost-effective desktop laser with ease of use. The optimization of graphene synthesis was made possible by investigating laser characteristics including laser power and scanning speed. Additionally, the Laser Draw program enabled the in-situ production of a variety of 2D patterns, producing designs. In order to demonstrate the progressive manufacturing of graphene, characterisation tests such as X-Ray Photon Spectroscopy (XPS), X-Ray Diffraction (XRD), and Scanning Electron Microscopy (SEM) measurements were carried out. Obtained graphene films were used in applications such as stretchable electronics, micro-capacitors, and electrochemical detection of ascorbic acid.

Keyword: *Graphene, Laser Induced Graphene, Super Capacitor, Stretchable Electronics, Biosensor*

DRAFT

2D-TMD Hybrid-Based Carbon Nanofibers for Simultaneous Electrochemical Detection of Ascorbic Acid, Dopamine and Uric Acid

Gamze Celik Cogal[*1], Sadık Cogal[2], Aysegul Uygun Oksuz[1], Maria Omastova[3]

[1] Suleyman Demirel University, Faculty of Arts and Science, Department of Chemistry, 32000, Isparta, Türkiye

[2] Burdur Mehmet Akif Ersoy University, Faculty of Arts and Science, Department of Chemistry, 15030, Burdur, Türkiye

[3] Polymer Institute, Slovak Academy of Sciences, Dubravska cesta 9, 84541 Bratislava, Slovakia

Graphene-like ultra-thin two-dimensional (2D) nanomaterials have attracted great interest in recent years because of their remarkable physical and chemical properties, fast electron transfers kinetics, layered structure, wide surface area, admirable surface tunability, minimal layer thickness, and excellent electrical conductivity. Transition metal dichalcogenides (TMDs), as a typical 2D nanomaterial, offer good properties for electrochemical applications, which can be controlled by tuning their layered structure [1]. Hybridizing TMDs with other materials have received great attention of the scientific community for numerous potential applications. On the other hand, electrospun nanofibers have become one of the most attractive candidates among different nanoscale materials to design and develop smart, easy and cost-effective sensing systems. Carbon nanofibers (CNFs) can be prepared via electrospinning and have unique properties including specific strength, great surface area, high electrical conductivity and good compatibility [2]. CNFs and their hybrids can be applied on various electrodes for different electrochemical applications [3].

In this work, we focused on the preparation of 2D-TMD-based CNFs for application in electrochemical sensors for determination of ascorbic acid (AA), dopamine (DA), and uric acid (UA). The rapid and certain measurements of AA, DA, and UA in biological fluids are essential for clinical diagnosis of relevant diseases and electrochemical sensing methods have been widely used to detect these compounds in biological matrices. 2D-TMD@CNF nanocomposites were successfully prepared by using an electrospinning process followed by carbonization under inert atmosphere. The surface morphology and composition of 2D-TMD@NFs and 2D-TMD@CNFs were characterized by using scanning electron microscopy (SEM) coupled with energy-dispersive X-ray spectroscopy (EDX) and transmission electron microscopy (TEM). The prepared 2D-TMD@CNFs were used to fabricate an electrochemical sensor for simultaneous detection of AA, DA and UA. To determine the electrochemical behaviours of the 2D-TMD@CNF-coated electrodes, cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) methods performed. The performance parameters of the developed sensor were obtained from the differential pulse voltammetry (DPV) measurements. It was found that 2D-TMD@CNF-based sensor exhibited wide linear detection ranges with low detection limits for AA, DA, and UA.

Keyword: *transition metal dichalcogenides, 2D-material, electrospinning, electrochemical sensor*

DRAFT

Highly Stable MXene Deposited Cu NWs Networks for Flexible Transparent Heaters

Oyku Cetin[*1], Onuralp Cakir[1], Serkan Koylan[2], Doga Doganay[1], Yaqoob Khan[1], Husnu Emrah Unalan[1]

[1] Department of Metallurgical and Materials Engineering, Middle East Technical University (METU), 06800, Ankara, Türkiye

[2] Quantum Solid State Physics (QSP), KU Leuven, Celestijnenlaan 220D, Leuven 3001, Belgium; imec, Kapeldreef 75, Leuven 3001, Belgium

Transparent conducting electrodes (TCEs) are widely utilized in diverse fields such as photovoltaics, light-emitting diodes, touch screens, smart windows, sensors, and transparent thin film heaters (TTFHs). As transparent conducting networks, copper nanowire (Cu NW) networks are highly desirable because of their high electrical conductivity and simple fabrication routes. However, poor oxidation stability of Cu NWs limits their applications by shortening the service life. This study investigated the effects of the Ti_3C_2 MXene nanosheet deposition on the oxidation stability and the optoelectronic performance of the Cu NW network. The results revealed that the deposition of MXene nanosheets increased the oxidation stability of Cu NWs from 10 days to 10 months in ambient conditions. Moreover, MXene deposition decreased the electrical resistance of bare Cu NW networks from 29 Ω/sq to 15 Ω/sq. The improved electrical conductivity without a significant decrease in the optical transmittance corresponded to an increase in the figure of merit (FoM) from 69 to 109. MXene-deposited Cu NW electrodes were utilized as flexible TTFH on polyethylene terephthalate (PET) substrates. The stabilities of the fabricated flexible heaters were observed for one week period under the 3 V of bias voltage to examine their long-term stability. The Joule heating performance of these TTFHS showed outstanding stability for the one-week period and was utilized as human thermotherapy patches and defrosting electrodes.

Keyword: *Copper Nanowires, Transparent Conductors, Ti3C2 MXene, Oxidation Stability, Transparent Thin Film Heaters*

DRAFT

ID: 87

Effect of Production Process Conditions on the Properties of Hexagonal Boron Nitride Nanoplates in Liquid-Phase Exfoliation by Sonication

Lutfullah Mucahit Dogdu*, Sule Yaba, Abdullah Uysal, Solen Kinayyigit
Nanocatalysis and Clean Energy Technologies Laboratory, Institute of Nanotechnology, Gebze Technical University, 41400 Gebze, Kocaeli, Türkiye

The major challenge in the world is to fulfill the high global energy demand and decrease pollution with environmentally-friendly, renewable, and efficient energy storage and conversion devices. In recent years, two dimensional (2D) nanomaterials have emerged as new class of materials that may overcome the challenges in new generation electronic devices [1]. Among this type of materials, hexagonal boron nitride (h-BN) received special attention especially due to its unique properties such as thermal insulation, high Young's modulus and mechanical strength, and chemical inertness, which are features needed for electrochemical energy storage devices [2].

Hexagonal boron nitride (h-BN), also called white graphene due to its structural resemblance to graphene, is composed of alternating nitrogen and boron atoms covalently bonded to one another and the layers are held together by van der Waals interactions [3]. There are many methods available for the production of h-BN nanoplates (h-BNNs) [2]. Among various techniques, liquid phase exfoliation (LPE) by sonication stands as a simple, economical and thus widely used method for the production of h-BNNs [4]. This is a promising route as it is easy to scale-up and single- or few-layered h-BNNs may be achieved with manipulation of the process conditions such as the change of organic solvents, sonication power and exfoliation time [5].

In this study, LPE process conditions were investigated in depth in order to understand their effects on the properties of the h-BN nanoplates produced. Few-layer h-BNNs were prepared in organic solvents, namely, dimethylformamide (DMF), isopropyl alcohol (IPA), N-methylpyrrolidone (NMP) and 1-Cyclohexyl-2-pyrrolidone (CHP). To our best knowledge, this is the first study presenting CHP as an emulsion solvent in this method. In addition, various sonication power (360W-900W) and time were examined. h-BNNs in powder form was obtained by applyingcentrifugation, filtration and drying steps to the mixture obtained at the end of sonication. Size, shape, thickness and the surface area of the exfoliated h-BNNs were investigated by various characterization techniques such as AFM, SEM, XRD, and FTIR. Our future studies will be towards the use of h-BNNs with optimized properties as composite materials for solid-state electrolytes that can be used in flexible batteries.

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Keyword: *2D Nanomaterials, Liquid Phase Exfoliation, Sonication, Hexagonal Boron Nitride*

DRAFT

ID: 90

Graphene/SOI based Passive Matrix 2D-Photodetector Array

Alper Yanılmaz*[1], Özhan Ünverdi[2], Cem Çelebi[1]

[1] *Quantum Device Laboratory, Department of Physics, Izmir Institute of Technology, Izmir, 35430, Türkiye*

[2] *Faculty of Engineering, Department of Electrical and Electronic Engineering, Yasar University, Izmir, 35100, Türkiye*

Self-powered two dimensional (2D) passive matrix photodiode array (PDA) based on the integration of conventional semiconductors and 2D materials is thought to attract great of interest in the area of image sensing due to energy-efficiency and its ease of fabrication. Specifically, monolithic integration of graphene (G) and silicon (Si) based optoelectronic devices is that they provide exceptional device performances. However, one of the great challenge between spatially separated functional G/Si pixels in an array defined on a single substrate is the crosstalk. To the best of our experience, this problem can be eliminated using silicon-on-insulator (SOI) substrate. Here, we fabricated a novel 4 × 4 pixel 2D PDA based individual G and n-type silicon (n-Si) electrodes on a SOI substrate investigated its optoelectronic device performances. The G/n-Si pixel design is based on lithographically defined individual monolayer G electrodes and vertically located arrayed n-Si on SOI. Each pixel in the 2D array revealed rectifying Schottky character and similar device performances under self-powered mode in terms of an I_{light}/I_{dark} ratio up to 10^4, a responsivity of ~0.08 A/W, a specific detectivity of ~10^{10} Jones, and a response speed of ~1.3 μs at 660 nm wavelength. The optical crosstalk was extremely low between neighboring pixels and also it could be greatly minimized up to ~0.09% (-61 dB) per array. Additionally, the homogeneity of the G film transferred on n-Si were examined by Raman mapping and correlated with the pixel sensitivity under illumination. We believe that this work paves the way for various potential for incorporating G and SOI technology into the next generation image sensors based on passive matrix arrays operating at self-powered mode.

Keyword: *Graphene, Optoelectronic Devices, 2D Photodiode Array, Passive Matrix Element, Silicon-on-Insulator*

DRAFT

ID: 94

Very Large-Scale Integration of Graphene Terahertz Modulator

Yury Malevich[*1,2], **Gokhan Bakan**[3], **Said Ergoktas**[1,2], **Coskun Kocabas**[1,2,4]

[1] *Department of Materials, University of Manchester, Manchester, M13 9PL, United Kingdom*

[2] *National Graphene Institute, University of Manchester, Manchester, M13 9PL, United Kingdom*

[3] *National Physical Laboratory, Hampton Road, Teddington, TW11 0LW, England, United Kingdom*

[4] *Henry Royce Institute for Advanced Materials, University of Manchester, Manchester, M13 9PL, United Kingdom*

The ability to integrate millions of functional devices onto a single chip is a preeminent achieving of the modern technology. Active switching of individual pixels in large arrays has enabled flat panel displays, high resolution cameras and other imaging devices. Similar scaling capabilities for terahertz (THz) optical devices, however, has been hindered by the lack of an efficient THz material and integration scheme. Here, by merging graphene-based THz devices and the thin-film transistor (TFT) technology, we developed mega-scale spatial light modulator arrays with subwavelength pixels. We demonstrate electronically programmable patterns of intensity and phase of THz light over a large area with unprecedented levels of uniformity and reproducibility that enable large-scale fabrication. To show the promises of these devices, we demonstrate a THz imaging system using spatially programmable THz masks and only a single THz detector. These results provide realistic pathways to structure THz waves for potential applications in non-invasive THz imaging and next generation THz communications.

Keyword: *THz imaging, spatial light modulator, graphene, electrolyte gating, single-pixel imaging*

DRAFT

ID: 97

Self-powered Graphene/4H-SiC ultraviolet photodetector with low level light detection

Ala Jehad[*1], Cem Celebi[1], Ozhan Unverdi[2]
[1] *Izmir Institute of Technology, İzmir, Türkiye*
[2] *Yasar University, İzmir, Türkiye*

A rapid response speed, self-powered graphene/silicon carbide (G/n-4H-SiC) ultraviolet (UV) photodetector with a p-i-n like-structure of an active area of 25 mm^2 has been fabricated and investigated. Chemical vapor deposition (CVD) grown bilayer graphene was transferred on the top of an epilayer of n^-/n^+ 4H-SiC as a transparent conductive electrode. The photodetector's optoelectronic characteristics exhibited low dark current (I_d) of ~ 0.58 nA, and spectral voltage responsivity (R) of ~ 0.75 V/W at 300 nm wavelength UV light. Under low level UV light of 300 nm (~ 12 nW), the photodetector revealed a leakage current (I_L) and a photogenerated response voltage (V) of ~ 1.1 nA and ~10 mV, respectively. The photodetector Time-dependent voltage response measurements displayed a rapid response speed with rise and decay times of ~ 74 ns and ~ 581 ns, respectively under 280 nm wavelength. The experimental results indicate that the photodetector based on G/4H-SiC developed in this study is capable of directly detecting low-intensity UV radiation without requiring complex external circuitry, such as a transimpedance amplifier.

Keyword: *UV Photodetector, Spectral voltage response, p-i-n structure, CVD graphene*

DRAFT

Development of Graphene/PAN/PPy Nanofiber Based Biosensors for the Detection of Cow's Milk Allergen α-Casein

Nesli Yagmurcukardes[*1], Atike Ince Yardimci[2], Yaser Acikbas[1], Pınar Kara[3], Ozgur Tarhan[4]

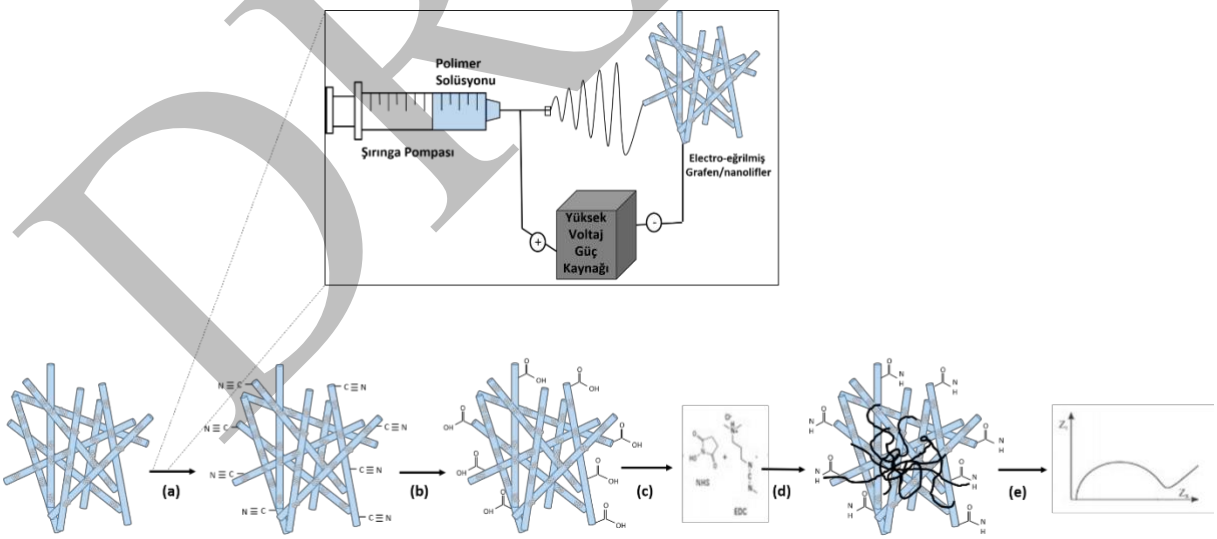
[1] *Usak University, Department of Materials Science and Nanotechnology Engineering, Usak, 64200, Türkiye*

[2] *Usak University, Technology Transfer Office, Usak, 64200, Türkiye*

[3] *Faculty of Pharmacy, Department of Analytical Chemistry, Ege University, 35100 Izmir, Bornova, Türkiye*

[4] *Usak University, Department of Food Engineering, Usak, 64200, Türkiye*

Milk and dairy milk products are among the most consumed foods in our country and in the world. Due to the proteins it contains, especially cow's milk can trigger allergen reactions in children and some adults and cause serious health problems. When processed into products such as milk, cheese and yogurt, the processes that it is exposed to heat, enzymes, fermentation play a critical role in reducing and/or eliminating the allergenicity of the relevant proteins. This study is focused to develop a safe, sensitive and low detection limit graphene/PAN/PPy based biosensor for the determination of α-CN milk protein, one of the most common food allergens, in dairy products, pasteurized milk and cheese. Graphene/PAN/PPy nanofibers are synthesized by electrospinning method and the morphological properties of these nanofibers are optimized by using scanning electron microscopy (SEM) images. The structural properties of Graphene/PAN/PPy are determined by thermogravimetric and mechanical characterization methods, and anti-CN antibodies are immobilized using carbodiimide chemistry on prepared Graphene/PAN/PPy, which has been created in order to ensure α-CN selectivity and to transform special interactions into observable signals. In order to achieve maximum performance in biosensor applications, the antibody concentration is optimized on Graphene/PAN/PPy electrodes, and electrochemical measurements of the Graphene/PAN/PPy nanobiosensor will be carried by impedance spectrometry (EIS) methods. The results obtained from this developed nano-biosensor will be compared with the results of the conventional ELISA method by using the same concentration of α-CN detection and this will be revealed that the detection limit and range obtained were developed with the targeted biosensor. In order to test the selectivity of the prepared Graphene/PAN/PPy biosensor prototype for the detection of α-CN in milk and cheese products, it is aimed to use the same biosensor in testing the negative control containing β-lg.



Keyword: *graphene, biosensors, food allergens*

DRAFT

ID: 128

Topological engineering of terahertz light using electrically tunable exceptional point singularities

M. Said Ergoktas[*1], **Sina Soleymani**[2], **Nurbek Kakenov**[3], **Kaiyuan Wang**[1], **Thomas Smith**[4], **Gokhan Bakan**[1], **Sinan Balci**[5], **Alessandro Principi**[4], **Kostya Novoselov**[4], **Sahin K. Ozdemir**[6], **Coskun Kocabas**[1]

[1] *Department of Materials and National Graphene Institute, University of Manchester, Manchester, M13 9PL, UK.*

[2] *Department of Engineering Science and Mechanics, Pennsylvania State University, University Park, PA 16802 USA.*

[3] *Department of Physics, Bilkent University, Ankara, Türkiye.*

[4] *Department of Physics and Astronomy, University of Manchester, Manchester, M13 9PL, UK.*

[5] *Department of Photonics, Izmir Institute of Technology, Izmir, Türkiye.*

[6] *Department of Engineering Science and Mechanics, Pennsylvania State University, University Park, PA 16802 USA. Materials Research Institute, Pennsylvania State University, University Park, PA 16802, USA.*

The topological structure associated with the branch point singularity around an exceptional point (EP) can provide tools for controlling the propagation of light. Through use of graphene-based devices, we demonstrate the emergence of EPs in an electrically controlled interaction between light and a collection of organic molecules in the terahertz regime at room temperature. We show that the intensity and phase of terahertz pulses can be controlled by a gate voltage, which drives the device across the EP. Our electrically tunable system allows reconstruction of the Riemann surface associated with the complex energy landscape and provides topological control of light by tuning the loss imbalance and frequency detuning of interacting modes. Our approach provides a platform for developing topological optoelectronics and studying the manifestations of EP physics in light–matter interactions.

Keyword: *graphene, exceptional point*

DRAFT

ID: 137

Elastic Piezoelectric Nanogenerator Design

Çiğdem Yener*[1], Fatma Betül Köker[1], Levent Paralı[2], Cumhur Gökhan Ünlü[1]

[1] *Pamukkale University, Faculty of Technology, Department of Biomedical Engineering, 20070, Denizli, Türkiye*

[2] *Celal Bayar University, Electronics and Automation Departments, 45140, Manisa, Türkiye*

In recent years, rapid advancements in wireless sensors and wearable electronic devices have increased the demand for high-power density and long-lasting power sources [1]. Systems that can generate sustainable electrical energy by harvesting mechanical energy from vibrations, human movements, and the human body provide battery-free solutions. Particularly in the field of biomedicine, the development of energy harvesting mechanisms from body movements for self-powered implantable or wearable devices has become a focal point of interest [2]. Piezoelectric materials, which enable to convert mechanical energy into electrical energy, form the basis of such self-powered systems. Furthermore, thanks to the advantages provided by nanotechnology, the production of these materials in nano size and their incorporation with nanomaterials have enabled the development of piezoelectric nanogenerator (PENG) structures with improved performance characteristics [3]. In our study, we have designed an elastic piezoelectric nanogenerator that can be used pacemakers applications in biomedical field. Polyvinylidene fluoride (PVDF), the best piezoelectric polymer, was used as the polymer matrix in the structure. To enhance the performance of the nanogenerator, barium titanate ($BaTiO_3$) nanoparticles with high piezoelectric properties and reduced graphene oxide (rGO) nanomaterials were incorporated into the polymer and supported by conductive polymers to create a nanocomposite structure. The fabricated nanocomposite structure was obtained in the form of nanofibers through the electrospinning method, which simultaneously provided mechanical stretching and electrical polarization. Electrical and piezoelectric measurement characterizations were conducted on the resulting structure with varying levels of rGO doping to make comparisons. Based on the optimal results, the ultimate goal is to create an implantable structure that can generate energy using both internal and external body movements.

***** This work is supported by Pamukkale University- Scientific Research Projects Coordinatorship (BAP) (2022FEBE005).

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Keyword: *piezoelectric nanogenerator, graphene, nanofiber, elasticity, nanoparticle*

DRAFT

ID: 145

Graphene/ZnO nanorod hybride devices for CO sensing

Hidayet Çetin[*1], **Merve Eren Yakışıklıer**[2]
[1] *Yozgat Bozok University, Art and Science Faculty, Department of Physics, Yozgat, Türkiye*
[2] *Yozgat Bozok University, Sorgun Vocational School, Yozgat, Türkiye*

Graphene is two-dimensional material, and when it uses as a gas sensor material, the whole part of graphene interacts with upcoming gas molecules. This paves the way for producing very sensitive gas sensors with graphene. However, graphene-hybrid structures have recently attracted attention due to the need for more functional materials. In the work, ZnO nanorods were vertically grown using hydrothermal methods on graphene/SiO_2 substrates. ZnO nanorods of various diameters and densities were fabricated vertically on graphene, and the effect of ZnO nanorod diameter and density on electrical characteristics of graphene field effect transistors was investigated. The electrical responses of the fabricated graphene/ZnO nanorod hybrid sensors for carbon monoxide gas were measured at 25, 12, 6, and 3 ppm CO gas concentrations at room temperature, 50, and 100 ºC sensor temperatures. It was observed that the ZnO nanorod/graphene hybrid structure gave more stable and distinguishable sensor responses. It was also found that all ZnO/graphene hybrid sensors exhibited more efficient characteristics when the sensor temperature was increased.

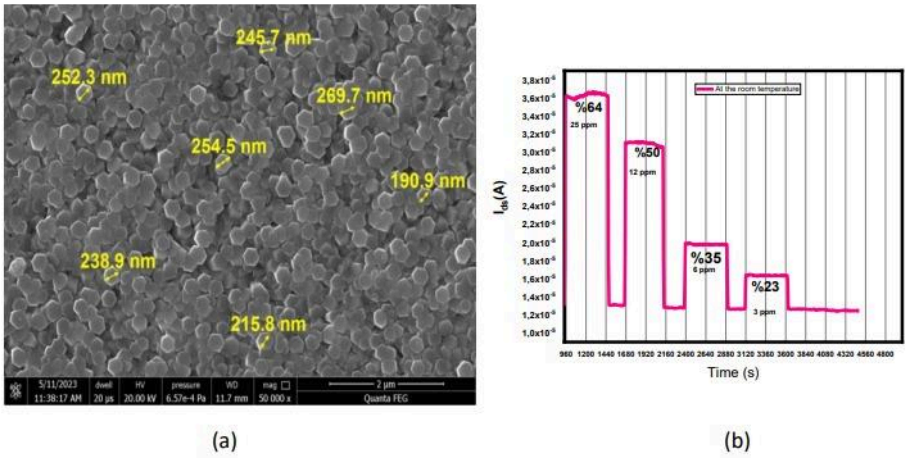

Fig 1. (a) The SEM image of ZnO nanorods vertically grown on graphene channel of the GFET sensor. b) CO gas response of ZnO nanorod/graphene hybrid structure at room temperature.

Keyword: *Graphene, ZnO nanorod, CO gas sensing*

DRAFT

ID: 169

Reversible Ionic Liquids Intercalation for Electrically Controlled Thermal Radiation from Graphene Devices

Xiaoxiao Yu*, **Gokhan Bakan, Hengyi Guo, M. Said Ergoktas, Pietro Steiner, Coskun Kocabas**
The University of Manchester, Manchester, United Kingdom

Using graphene as a tuneable optical material enables a series of optical devices such as switchable radar absorbers, variable infrared emissivity surface or visible electrochromic devices. These devices rely on controlling the charge density on graphene with electrostatic gating or intercalation. In this paper we studied effect of ionic liquid intercalation on the long-term performance of optoelectronic devices operating within broad infrared wavelength range. Our spectroscopic and thermal characterisation results reveal the key limiting factors for the intercalation process and the performance of the infrared devices, such as the electrolyte ion-size asymmetry and charge distribution scheme, and the effects of oxygen. Our results provide insight for the limiting mechanism for graphene applications in infrared thermal management and tuneable heat signature control.

Keyword: *graphene, ionic liquid, electro-optical effect, infrared device, thermal radiation*

DRAFT

ID: 170

From Metal Diborides to 2D Borophene

Özden Güneş Yıldız[*1], **Umut Aydemir**[2]
[1] *Graduate School of Sciences and Engineering, Koç University, Sariyer, Istanbul-34450, Türkiye*
[2] *Koç University Boron and Advanced Materials Application and Research Center (KUBAM), Sariyer, Istanbul-34450, Türkiye*

AlB_2-type metal diborides exhibit hexagonal crystal structures, composed of cationic metal sheets comprised with honeycomb boron layers [1]. Borophene, the monolayer Boron sheets, represents the lightest elemental material and the latest addition to the 2D Xene family. With its remarkable electronic, superconductive, elastic, thermal, mechanical, and transport properties, borophene holds immense promise for advanced technological applications, encompassing energy storage, gas sensing, and catalysis [2]. This study aims to achieve a reproducible synthesis of few-layer boron nanosheets (BNSs) through a novel approach that combines ultrasound-assisted exfoliation and the utilization of cation exchange resins in their hydrogen form to eliminate metal cations from metal diborides [3]. By leveraging pre- and post-ultrasonic shear forces, we successfully created larger reaction interfaces between the cationic groups of the resin and MB_2 (M stands for a metal atom), effectively separating the boron layers and generating individual hydrogenated borophene layers by breaking van der Waals bonds.
Comprehensive optical, morphological, and surface analyses were performed utilizing SEM, TEM, AFM, XPS, and UV-vis techniques. XPS analysis revealed the presence of B-H bonds instead of M-B bonds in the hydrogenated BNS. Our findings report the successful synthesis of a few-layer BNS measuring 2.5 nm in thickness, exhibiting an optical bandgap of 2.5 eV. The correlation between the resulting borophene motifs and the structural characteristics of the initial MB_2 enables the enhancement of material properties by controlling morphological and structural attributes. Moreover, the observed 2.5 eV optical bandgap underscores the potential of borophene as a promising material for optical semiconductor devices, with the added possibility of further augmentation through tunability via metal atom decorations. This research represents a significant advancement in understanding the synthesis and properties of BNS, providing a foundational basis for future explorations and applications across diverse scientific and technological fields.

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Keyword: *Borophene, 2D Materials, Metal diborides, ultrasound-assisted exfoliation, Hydrogenation*

DRAFT

Control of Dielectric Properties in Single-Layer WS2 via Defect Density Engineering

Hasret Ağırcan[*1], Domenica Convertino[2], Antonio Rossi[2], Leonardo Martini[2], Simona Pace[2], Neeraj Mishra[2], Kathrin Küster[3], Ulrich Starke[3], Guldem Kartal Şireli[4], Stiven Forti[2], Camilla Coletti[5]

[1] Department of Metallurgical & Materials Engineering Istanbul Technical University, 34469 Maslak, Istanbul, Türkiye./Center for Nanotechnology Innovation @NEST, Istituto Italiano di Tecnologia, Piazza San Silvestro 12, I-56127 Pisa, Italy.

[2] Center for Nanotechnology Innovation @NEST, Istituto Italiano di Tecnologia, Piazza San Silvestro 12, I-56127 Pisa, Italy.

[3] Max Plank Institut für Festkörperforschung, Heisenbergstr. 1, 70569 Stuttgart (DE)

[4] Department of Metallurgical & Materials Engineering Istanbul Technical University

[5] Center for Nanotechnology Innovation @NEST, Istituto Italiano di Tecnologia, Piazza San Silvestro 12, I-56127 Pisa, Italy. /Graphene Labs, Istituto Italiano di Tecnologia, Via Morego 30, 16163 Genova, Italy

Although tungsten disulfide (WS_2) possesses attractive optical and electronic properties[1], the intrinsic defects of various nature, concentration, and distribution can strongly affect the crystal's electronic and optical characteristics[2][3]. This study focuses on the control of dielectric properties of WS_2 via defects density engineering. Particularly, we investigate the defects in atomically thin WS_2, grown via liquid phase chemical vapor deposition (LiP-CVD)[4]. By tuning the growth parameters we were able to obtain WS_2 in different shapes and defects distribution, that were characterized by using optical spectroscopy, photoelectron spectroscopy, and Kelvin probe force microscopy. Our findings reveal the chemical nature of defects in WS_2 and their significant impact on the crystal's optical properties (Fig. 1). By gaining a deeper understanding of the microscopic nature of defects in WS_2, this research provides a crucial contribution towards developing a defect-controlled technology to control the dielectric environment in 2D crystals.

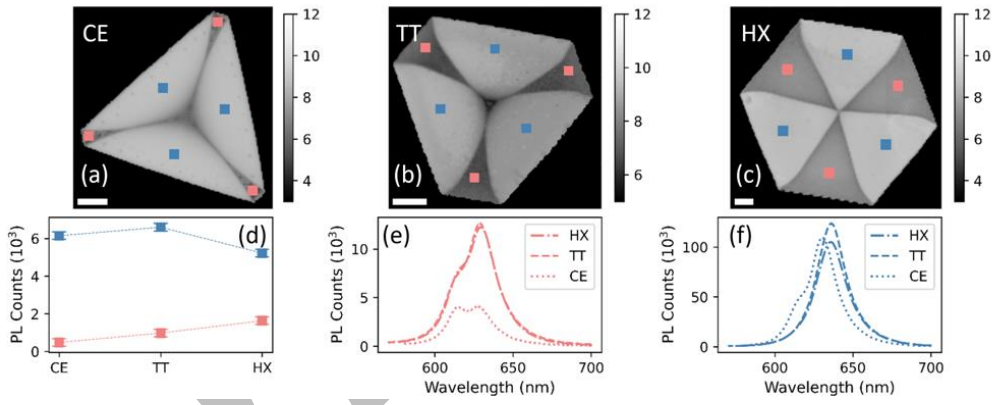

Figure 1: 2D PL intensity maps of cut-edged (CE) (a), truncated (TT) (b), hexagonal (HX) (c) monolayer WS2. (d) PL intensity for dark (red) and bright (blue) regions for the three different shapes. (e-f) PL spectra for dark and bright regions respectively, for the three structures. Scalebar 15 µm.

Acknowledgments

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Keyword: *2D Materials, Monolayer WS2, defect engineering*

DRAFT

ID: 228

Eye Tracking Applications Based on Graphene-Quantum Dot Photodetectors

Emre Ozan Polat
Kadir Has University, İstanbul, Türkiye

Image sensors hold a pivotal role in society due to their ability to capture vast amounts of information. Traditionally, image sensors are opaque due to light absorption in both the pixels and the read-out electronics that are stacked on top of each other. Making image sensors visibly transparent would have a far-reaching impact in numerous areas such as human-computer interfaces, smart displays, and both augmented and virtual reality. In this work, we present the development and analysis of the first semi-transparent image sensor and its applicability as an eye-tracking device.

In order to provide an image sensor that is semi-transparent and exhibits high responsivity for the visible and SWIR range,[1] we use graphene/quantum-dot (GQD) pixels. Graphene, a two-dimensional crystal of carbon atoms,[2] provides both very high room-temperature electronic mobility(>100.000cm^2/Vs),[3] as well as transparency due to its atomic thickness.[4] Previous work has shown that graphene-based photodetectors can be applied in many application areas such as imaging[5] and data communications, and offer advantages such as of flexibility,CMOS integration, broadband sensing, and photo response speed. Sensitizing graphene with quantum dots transforms it into a photoconductive system with high responsivity reaching up to 10^7 $A.W^{-1}$ while maintaining speeds of 1ms and demonstrating with combined sensitivity to both visible and SWIR wavelengths.

Due to the high mobility of the graphene, the devices exhibit built-in photoconductive gain. As a result, the photosignals do not need amplification close to the detector. Instead, the signals can be transported to the edge of the array, allowing for the use of a non-local readout system placed away from the image sensor

The device consists of an 8x8 array of semi-transparent photodetectors and electrodes disposed deposited on a fully transparent substrate. Each pixel of the array has a size of 60 x 140 μm and an optical transparency of 85-95%. Pixels have a high sensitivity, with more than 90% of them showing a noise equivalent irradiance < 10-4 W/m^2 for wavelengths of 637 nm. As the semi-transparent photodetectors have a large amount of built-in gain, the opaque read-out electronics can be placed far away from the detector array to ensure maximum transparency and fill factor. Indeed, the operation and appearance of transparent image sensors present a fundamental shift in how we think about cameras and imaging, as these devices can be concealed in plain sight.

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Keyword: *Graphene, Quantum Dot, Photodetector, Eye Tracker, Transparent*

DRAFT

Production with convenient way of graphene derived from lignite and investigation of mechanical properties for polymer applications

Semih Doğan*, **Kuray Dericiler, Burcu Saner Okan**
Sabancı University, Istanbul, Turkiye

Lignite also known as brown coal, is a type of carbonaceous material that drops on the lower end of the coal spectrum in terms of low carbon content, high moisture content, combustion efficiency and energy density. On the other hand, lignite is commonly available and accessible in many countries, making it a more readily available and low-cost effective energy source compared to higher-grade coal and specialized carbon materials [1]. This advantage can provide it economically feasible to convert to high-quality carbon materials [2]. The direct conversion of lignite to graphene is a complicated and challenging process. Although lignite can be a potential carbon source, the transformation into graphene contains several critical steps. For this purpose, the findings from this study explained the surface methodology of lignite through impregnation and carbonization process. Firstly, raw lignite was treated with nitric acid solution to introduce nitro groups to into the lignite structure. Then, catalytic impregnation of lignite with iron chloride was carried out in order to enhance the interaction between the iron and the lignite and the deposition of iron species onto the lignite surface. The last step of this process, the carbonization process under high temperature and argon atmosphere led to the decomposition of organic compounds present in lignite and the formation of solid carbonaceous material (Figure 1). The carbonaceous material formed through carbonization consisted of carbon-rich compounds derived from the impregnated lignite. In order to analyze and identify the presence of graphene derivatived from lignite with material characterization techniques, it was utilized by FT-IR, XRD, Raman Spectroscopy, XPS, TGA and SEM. Particularly, this preparation methodology with the analysis results provided powerful evidence and a comprehensive explanation of the successful conversion of graphene from lignite. Moreover, to investigate the impact of the degree of crystallinity of a polymer on the mechanical properties of lignite and lignite-based graphene reinforced into the polymer matrix composites were prepared at 0.5 %wt. Besides, L-Graphene enhanced the overall tensile modulus and flexural modulus as a conventional filler at 0.5 %wt loading ratio. Finally, sustainable and cost-effective graphene production in this study holds potential benefits such as enhanced mechanical and electrical properties, energy storage and conversion.

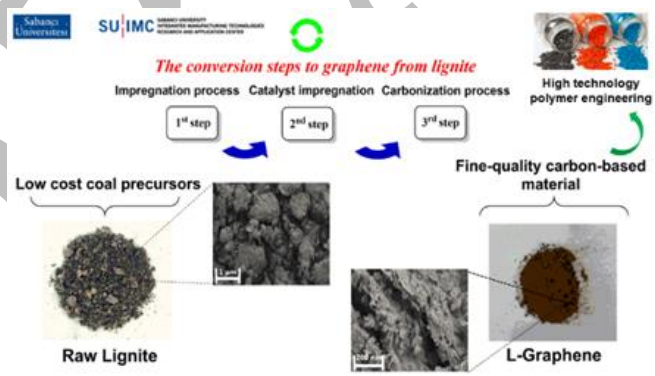

Figure 1. Summary of the experimental design.

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Keyword: *Lignite, Lignite-based graphene, the production techniques of graphene de-rivatives from carbon sources, polymer application, nanomaterial characterization techniques*

DRAFT

ID: 282

Development of Carbon-Based Resin Composite

Tarık Can Turkoglu[*1], **Goknur Cambaz Buke**[2]

[1] *Micro and Nanotechnology, Graduate School of Engineering and Science, TOBB University of Economics and Technology, Ankara, Türkiye.*

[2] *Department of Materials Science and Nanotechnology Engineering, TOBB University of Economics and Technology, Ankara, Türkiye.*

The study aims to develop an easy and repeatable process for producing carbon-based resin composites with high mechanical strength, electrical conductivity, and thermal conductivity by supplying carbon micro and nanostructures in powder form. The primary application area of the produced composites has been determined as the "vacuum pump pallet," which has an extensive usage area in the industry. The blades are made of composite material to prevent friction due to contact between the vacuum pump pallet and the body due to centrifugal force and to distribute the heat homogeneously.

The works carried out in this context can be listed as follows;

1- Obtaining graphite powder-based resin composite structure
In the experiments, Type-1, Type-2, Type-3, and Type-4 graphite powders were commercially supplied from four different companies in different sizes and purity, and the resin was mixed mechanically in different ratios (in the range of 1-80%). Density, electrical conductivity, shore hardness, tensile strength, and thermal heat distribution measurements of the composites produced due to the mixing process were made. The performances of composite plates with densities ranging from 1.044 to 1.76 g/cm3 in the vacuum pump were tested.
2- Obtaining graphene-based resin composite structure
In the experiments, Type-1 and Type-2 graphene powders, which were commercially supplied in different sizes and purity from four different companies, and the resin were mixed mechanically at different rates (in the range of 1-25%). Density, electrical conductivity, shore hardness, tensile strength, and thermal heat distribution measurements of the composites produced due to the mixing process were made. The performances of composite plates with densities ranging from 1.044 to 1.56 g/cm3 in the vacuum pump were tested.
3- Performance-based physical and chemical characterization of graphite and graphene-based resin composites
The morphology of composite materials between carbon structures and resin was investigated using OM, TEM, XRD, Raman spectroscopy, and SEM.
As a result, the behavior of micro- and nano-sized powders in the resin was examined, and the density, electrical conductivity, shore hardness, tensile strength, and thermal heat distribution measurements of the produced composites were made.

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Keyword: *Carbon, Resin, Composite, Graphite, Graphene*

DRAFT

The Fabrication of Na-Doped MoS2 Thin Films

Ali Altuntepe*, Serkan Erkan, Mehmet Ali Olğar, Güldöne Toplu, Recep Zan
Nanotechnology Application and Research Center, Niğde Ömer Halisdemir University, Niğde, Türkiye

The MoS_2 films stand out among the TMDs material group due to their superior properties. Doping is essential to enhance the electrical properties of 2D materials[1]. The doping is a process of intentionally introducing impurities into a material to modify its electrical or optical properties [2]. There are lots of doping methods for 2D materials but these are commonly classified as direct and post treatment doping [3]. For 2D-MoS_2 films, post-treatment doping can be performed by introducing dopant atoms through a variety of methods such as ion implantation, CVD, or solution-based techniques [4]. Post-treatment doping can be used to achieve controlled doping of MoS_2 films and to modify their electrical and optical properties [5]. In the present study, post-treatment doping using NaOH solution was utilized and a two-step approach have been employed to obtain Na-doped MoS_2. The MoS_2 films were grown by magnetron sputtering using single target MoS_2 (95% purity) and then obtained film was doped by CVD. The influence of NaOH molarity, which is adjusted through deionized water and annealing time on the structural properties of the MoS_2 films has been investigated through X-ray Diffraction, Raman, X-ray Photoelectron and Ellipsometer Spectroscopies. The measurement revealed that increasing the NaOH molarity resulted in the loss of homogeneity in the MoS_2 films and necessitating the use of 0.2 M NaOH for the fabrication of Na doped MoS_2 thin films with high homogeneity for both film and doping. In addition, annealing time played a critical role for the fabrication of Na doped MoS_2, as longer annealing times resulted in the destruction of the MoS_2 film homogeneity. Consequently, an annealing time of 5 minutes was found to be the optimum value to obtain Na doped MoS_2 thin films. Overall, this study demonstrates the successful growth of high quality and homogeneous 2.2% Na doped MoS_2 films with promising potential for various applications.

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Keyword: *Doping, chalcogen, MoS2, thin film, Na-doping*

DRAFT

ID: 288

Boron-Doped Graphene and Sodium-Doped MoS2: A Promising Combination for Enhanced Solar Cells

Recep Zan*, **Ali Altuntepe, Serkan Erkan, Güldöne Toplu, Mehmet Ali Olğar**
Nanotechnology Application and Research Center, Niğde Ömer Halisdemir University, Niğde, Türkiye

Two-dimensional (2D) materials such as carbon nanotubes (CNT), molybdenum disulfide (MoS_2), tungsten disulfide (WS_2) have many superior properties [1]. The interest to nano materials increased with graphene exfoliation by Novoselov et al [2]. Graphene is one of the most popular 2D materials due to its high transmittance, high electric and thermal conductivity and high mechanical strength [2]. Transition metal dichalcogenides (TMDs) share certain properties with graphene, but have the unique property of having a direct band gap when reduced to a single layer [3]. However, graphene has a limited use in optoelectronics because of its high sheet resistance. In addition, MoS_2 requires enhanced optoelectronic properties to be used in optoelectronic applications. To overcome these handicaps, doping methods have been carried out in the literature [4]. In this study, boron-doped graphene and Na-doped MoS_2 thin films were used to fabricate a new solar cell structure and evaluating its power conversion efficiency. Boron-doped single layer graphene was synthesized using CVD and Na-doped MoS_2 was grown by both PVD and CVD approaches. The cell structure included Na-doped MoS_2 as an n-type layer and boron doped graphene as a p-type layer. Diborane (B_2H_6) was used as boron source for the boron doped single layer graphene growth and NaOH was used to obtain Na-doped MoS_2 films. The complete solar cell structure from back to front consists of Ag as a back contact, a Na-doped MoS_2 layer, a single layer boron doped graphene, an ITO layer as transparent conductive oxide and an Ag as a front contact. Then, the cell performance was evaluated using a solar simulator under 1.5 AM illumination. In thıs study, the cell conversion efficiency was found to be 2.1%. This solar cell in question consists of 2D materials and thus presents a very thin structure. We suggest that the efficiency can further be improved by optimizing the growth of the layer and cell structure.

The authors gratefully acknowledge funding from Niğde Ömer Halisdemir University Scientific Projects Unit under a project number of FMT 2021/4-ÖNAP.

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Keyword: *graphene, doping, chalcogen, MoS2, solar cell*

DRAFT

ID: 316

Synthesis and characterization of AuNP/SWCNT hybrid materials as a photothermal therapy agent and determination of temperature changes by laser application

Gökhan Dikmen
Eskisehir Osmangazi University, Central Research Laboratory Application and Research Center (ARUM), Eskisehir, 26040, Türkiye

Photothermal therapy (PTT) is considered as new cancer treatment that has several advantages over traditional therapies because of its high selectivity, non-invasiveness, negligible drug resistance, and minimal side effects. In order to kill cancer cells, photothermal agents absorb light energy and generate heat [1, 2]. In this study, AuNP/SWCNTs were synthesized as PTT agent. The resulting material was characterized using XRD, Raman and TEM. Then, the 808 nm and 1watt laser was applied for 10, 20, 30 and 60 seconds to view the temperature distribution with a thermal camera and the variation of the temperature with time was examined. It was observed that the average diameter of the synthesized SWCNTs was measured as 10 nm and the average particle size of AuNPs attached to their surfaces were measured as 20 nm, and it was observed that the temperature increased to 30°C after the laser application for 20 seconds and reached 55 °C after 30 seconds. As a result, AuNP/SWCNTs can be used as PTT agents because they reach 55°C in a short time like 30 seconds.

Acknowledge:
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Keyword: *SWCNT, AgNP, Photothermal Therapy*

DRAFT

ID: 298

The Physicochemical Surface Properties and Langmuir-Blodgett Deposition of Single Perovskite Nanosheets Structured Nanofilms on ITO-PET Substrates

Özge Sağlam*[1], Begümnur Küçükcan[2], Bensu Günay[2], Fatma Pinar Gordesli-Duatepe[3]

[1] Department of Mechanical Engineering, İzmir University of Economics, Sakarya Cad., İzmir, Türkiye

[2] Division of Bioengineering, Graduate School, İzmir University of Economics, Sakarya Cad., İzmir, Türkiye

[3] Department of Genetics and Bioengineering, İzmir University of Economics, Sakarya Cad., İzmir, Türkiye

$Ca_2NaNb_4O_{13}^-$ single two-dimensional (2D) perovskite nanosheets were synthesized via a chemical delamination process of n=4 Dion-Jacobson type $KCa_2NaNb_4O_{13}$ layered materials. Herein we report the first deposition of the nanosheets onto conductive, transparent, and flexible indium tin oxide-polyethylene terephthalate (ITO-PET) substrates using the Langmuir-Blodgett (LB) technique [1]. The study revealed the significant potential of perovskite nanosheets in flexible and transparent electronic applications, making them promising candidates for the next generation of energy/data storage devices that rely on well-organized low-dimensional nanostructures. To examine the physicochemical interactions between the nanofilms consisting of $Ca_2NaNb_4O_{13}^-$ perovskite nanosheets and Si and ITO-PET substrates, the polar and apolar surface tension components of the nanofilms and substrates were quantified, along with the work of adhesion of nanofilms to the substrate surfaces. It was determined that dispersive interactions affected the adhesion of the nanofilm to the substrates in the air. Moreover, the nanofilm exhibited stronger adhesion to the Si surface compared to the ITO-PET surface in the air. On the other hand, in water where polar interactions were dominant, the nanofilm adhered more strongly to the ITO-PET surface than to the Si surface. Additionally, bacterial adhesion to the nanofilm surface was weaker than the surfaces of bare substrates, indicating a lower potential for biofouling. The results obtained from this study will contribute to a better understanding of the physicochemical interactions between nanofilms composed of $Ca_2NaNb_4O_{13}^-$ 2D nanosheets and other materials, as well as the development of devices and nanocoatings for diverse applications.

This work was supported by The Scientific and Technological Research Council of Turkey (TÜBİTAK; Grant number 218M517).

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Keyword: *2D Materials, Perovskite nanosheets, Langmuir-Blodgett technique, Surface tension, Work of adhesion*

DRAFT

ID: 29

Enabling Nanowire Devices using Markerless Overlay with the NanoFrazor

Vasilis Theofylaktopoulos*, Jana Chaaban , Eliott Clerc
Heidelberg Instruments Nano, Zürich, Switzerland

The NanoFrazor technology provides a fabrication platform for nanostructures of arbitrary shapes on a wide range of substrate materials. It uses thermal scanning probe lithography (tSPL) and direct laser sublimation. Thermal nanolithography is achieved through an ultrasharp heated tip. This is combined with in-situ real-time reading of written structures. The writing depth is actively controlled in a closed-loop system. Applications range from nanoelectronics, photonics, spintronics to nano-bio arrays.
Many nanowire devices require the fabrication of electrodes. Using the NanoFrazor, precise placement can be achieved without the requirement of markers. This is done by locating the nanowires, first with the integrated optical microscope and then scanning the target using the tSPL tip. The same tip is used to pattern the electrodes on a thermal resist and prepare the sample for lift-off. In this talk, we will present the workflow of contacting InAs nanowires, 70nm in diameter. The goal is to achieve electrode gap sizes of 100nm-400nm. Finally, additional applications in nanofabrication will be presented.

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Keyword: *nanowire, nanofabrication, thermal scanning probe lithography, tSPL*

DRAFT

ID: 77

Graphene Quantum Dot based Tubular micromotors as fluorescence sensor for Fe3+

Gozde Yurdabak Karaca
Suleyman Demirel University, Isparta Health Services Vocational School, Medical Services and Techniques, Isparta, Türkiye

Micromotors are miniaturized devices that convert energy from various sources into mechanical motion at the microscale[1]. They have gained significant attention in recent years due to their potential applications in fields such as biomedicine, environmental remediation, sensing and microscale robotics[2,3]. Magnetic micromotors are a type of micromotor that utilize magnetic fields for their propulsion and motion[4]. Magnetic micromotors offer several advantages over other types of micromotors. Firstly, they can be remotely controlled and propelled in various fluids and complex environments without the need for direct physical contact or tethering. This enables them to navigate through biological fluids, such as blood or mucus, or manipulate objects in microfluidic systems with high precision. Additionally, magnetic micromotors can be functionalized with different coatings or surface modifications to enable specific functionalities, such as drug delivery[4,5], cargo transport, or sensing capabilities.

This study aims to explore the synthesis and characterization of graphene quantum dot-based magnetic tubular micromotors and investigate their detection performance as metal sensor. The magnetic tubular micromotors were fabricated by electrochemical deposition of graphene quantum dots (GQD) and nickel (Ni) layers on polycarbonate membrane. In this study, we propose a novel approach for the detection of iron(III) ions (Fe^{3+}) using graphene quantum dot-based tubular micromotors as fluorescence sensors. The fluorescence sensing mechanism is based on the specific interaction between Fe^{3+} ions and the GQDs. Fe^{3+} ions exhibit high affinity towards the surface functional groups, leading to quenching of the fluorescence emission of GQDs. The concentration of Fe^{3+} ions can be quantitatively determined by monitoring the fluorescence intensity changes of the GQDs on the micromotors. Furthermore, we investigated the selectivity of the sensor by testing its response to other metal ions commonly found in environmental and biological samples. The results showed good selectivity towards Fe^{3+} ions, with minimal interference from other metal ions, including Hg^{2+}, Sn^{2+}, and Zn^{2+}.

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Keyword: *Graphene Quantum Dot, Nanotube, Micromotor, metal detection*

DRAFT

ID: 101

Integration of monolithic fabrication methods for enhanced testing of silicon nanowires

Sina Zare Pakzad , Basit Ali , Semih Berk Coban* , Mehrdad Karimzadehkhouei , B. Erdem Alaca
Koc University, İstanbul, Türkiye

The pursuit of advancing techniques for the fabrication and electromechanical characterization of nanostructures, including nanowires (NWs) and nanotubes, has garnered increasing attention (Nasr Esfahani, 2019). However, these endeavors encounter several challenges. Precise measurement of forces and displacements, accurate inspection of sample cross-sections, considering surface quality and defects, and monitoring experiments in real-time are essential requirements for achieving well-defined electromechanical characterization (Chen, 2017). Despite conducting numerous tests to examine the mechanical properties of silicon (Si) at room temperature, there are still a series of significant unresolved issues (Elhebeary, 2020). The limited understanding of size-dependent brittle-to-ductile transition (BDT) temperatures can be attributed to the difficulties associated with conducting experimental protocols under various loading conditions and at elevated temperatures (Elhebeary, 2020). Increasing evidence suggests that Si nanostructures exhibit ductile behavior at significantly lower temperatures when their size is reduced (Cheng, 2019). Recent studies have demonstrated the potential of micromechanical system platforms for conducting more complicated experiments on various sample types (Elhebeary, 2020).
By leveraging advancements in microfabricated flexural testing platforms and monolithic fabrication method, a novel design has been developed for conducting pure bending experiments on Si NWs. The fabrication process begins on a silicon-on-insulator wafer, involving initial patterning using AZ MIR 701 photoresist and a Heidelberg laser writer. Subsequent steps include development using AZ 726 MIF photoresist and deep reactive ion etching resulting in the creation of scallops for releasing the Si NW. Within this process, the micro-stretcher is co-fabricated with Si NWs. The testing platform consists of groups of beams serving as frames or supports. It is finally released through hydrofluoric vapor etching, achieving the desired configuration of the NW and MEMS. The objective of this work is to fabricate the micro-stretcher and Si NWs through a single fabrication process, enabling the transfer of motion to create tensile motion in the flexural stretcher while simultaneously inducing bending deformation in Si NWs. To achieve this, a commercial micro-mechanical testing machine has been employed. The results will provide insight into studying the failure mechanisms of Si NWs at different temperatures, leading to a better understanding of size-dependent BDT temperatures in Si NWs.

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Keyword: *Microelectromechanical Systems, Nanowires, Silicon, Bending Test, Microfabrication*

DRAFT

ID: 102

Microfabricated flexural design for multifaceted MEMS testing

Sina Zare Pakzad, Basit Ali*, Semih Berk Coban, Mehrdad Karimzadehkhouei, B. Erdem Alaca
Koc University, İstanbul, Türkiye

The global demand for connectivity and the rise of digital technologies, including the Internet of Things (IoT), are intricately linked to the miniaturization of sensors made possible by microelectromechanical systems (MEMS). Concurrently, the field of nanomechanics is experiencing significant advancements through the utilization of MEMS technology and integrated microscale testing devices (Karimzadehkhouei, 2023). These devices enable intricate characterization schemes that go beyond traditional stress-strain analysis, encompassing fracture, fatigue (Jimenez, 2023; Lapouge, 2017). Moreover, they offer real-time inspection capabilities within electron microscopes, enhancing the understanding of mechanical properties at the nanoscale. While dynamic monitoring and analysis of microstructural evolution during in-situ testing provide significant advantages (Emon, 2021), the limitations associated with conducting such tests within confined chambers, primarily restricted to vacuum conditions, have prompted researchers to explore alternative methods. To address these limitations, various approaches have been developed, including microfabricated flexural stages, modified micromanipulators to enable complex loading conditions. In the present study, a comprehensive methodology is proposed for the design, fabrication, testing, and modeling of a MEMS stage integrated into a commercial testing device. The initial focus is on developing a sophisticated head component that enables the integration of micromanipulator tips to facilitate in-plane loading conditions within a commercially available micro-mechanical testing machine. A detailed calibration process is conducted using analytical and experimental methods to ensure precise force and deflection measurements. Statistical analysis is performed by subjecting a released MEMS structure on a silicon-on-insulator (SOI) substrate, to repeated tests, validating the accuracy and reliability of the approach. Subsequently, a new MEMS head stage is designed and fabricated using a novel monolithic fabrication method with reduced process complexity, which is extended to SOI substrates (Nasr Esfahani, 2022). The initial patterning stage involves the use of AZ MIR 701 photoresist and a Heidelberg laser writer to define the desired pattern. Subsequent development is carried out using AZ 726 MIF photoresist and deep reactive ion etching. Finally, hydrofluoric vapor etching is employed to release the desired structure. The developed approach can be further expanded to conduct multiple testing endeavors on numerous samples within a single chip, utilizing automated methods to alleviate manipulation challenges.

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Keyword: *Microelectromechanical Systems (MEMS), Microfabrication, Manipulators, Small-scale testing, Automation*

DRAFT

ID: 133

Combined Pressure and Temperature Sensing Using A Multiscale MEMS/NEMS Force Sensor

Levent Demirkazık[*1], Masoud Jedari Ghourichaei[1], Mehrdad Karimzadehkhouei[1,2], B. Erdem Alaca[1,2,3]

[1] Dept. of Mechanical Engineering, Koç University, Istanbul 34450, Türkiye
[2] n2STAR-Koç University Nanofabrication and Nanocharacterization Center for Scientific and Technological Advanced Research, Koç University, Istanbul 34450, Türkiye
[3] Surface Science and Technology Center (KUYTAM), Koç University, Istanbul 34450, Türkiye

Piezoresistive sensing in MEMS technologies is widely used due to its stability and high-resolution measurements. It is commonly used in sensors for force, pressure, strain gauges, and accelerometers. Piezoresistive transduction has an advantage over capacitive transduction in creating small-sized sensors using silicon NW piezoresistors. These devices can have critical dimensions reduced from micrometers to nanometers, providing sensitivity and immunity to parasitic capacitances and inductances during quasi-static DC measurements.

The developed MEMS sensor comprises three main components: an interaction platform (proof mass), Si NWs for sensing the movement of the platform, and the springs to add rigidity to prevent the platform from moving out of the plane. The chips are made using 4-inch silicon-on-insulator (SOI) wafers with P-type doping, a 2±0.5 μm device layer, a 2 μm±5% buried oxide (BOX) layer, and a 500±10 μm handle layer. The fabrication process includes deep Si etching for the proof mass, springs, and NWs, ion implantation for NWs and pads, and metallization for pad connections. Hydrofluoric (HF) etch of the BOX layer releases the proof mass, and photolithography encapsulates metallization paths with photoresist.

A pipette tip with a tip diameter of 500 μm connected to pneumatic tubing is attached to a micropositioner and positioned vertically above the chip to measure the effect of pressure and temperature drop due to gas expansion. The tubing is connected to a nitrogen cylinder, and the pressure levels are monitored using a manometer. The pressure is applied for four cycles for 5 seconds each with the help of a valve. The touchpads linked to the NWs are subjected to a 300 mV potential difference, and current readouts are recorded. The pressure causes an initial current spike with a mean of 0.3%, and the overall current levels drop due to a temperature decrease of 0.45%. For Si NWs with a doping level of 10^17, this decrease corresponds to a 1ºC decrease in temperature. The fabricated MEMS force sensor is versatile in out-of-plane conditions, as shown by the measurable change in current for applied pressures on the movable platforms.

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Keyword: *MEMS, Silicon Nanowire, Piezoresistive, Force Sensor, Pressure Sensor*

DRAFT

ID: 134

Analytical design of high-g accelerometer utilizing piezoresistive nanowire/MEMS integration

Mehdi Bostan Shirin[*1], **Basit Ali**[1], **Mehrdad Karimzadehkhouei**[1,2], **B. Erdem Alaca**[1,2,3]
[1] *Department of Mechanical Engineering, Koç University, Sariyer, Istanbul 34450, Türkiye*
[2] *n2STAR-Koç University Nanofabrication and Nanocharacterization Center for Scientific and Technological Advanced Research, Koç University, Sariyer, Istanbul 34450, Türkiye*
[3] *Koç University Surface Technologies Research Center (KUYTAM), Koç University, Sariyer, Istanbul 34450, Türkiye*

Nowadays, accelerometers have found widespread use in many devices such as mobile phones, navigation systems, and defense industries. Depending on the application, these accelerometers can be categorized into two main types: high-g and low-g. Thanks to MEMS, miniaturized accelerometers have been developed and commercialized. The accelerometers' measurements basis can be capacitive, resonant, piezoresistive, piezoelectric, optical, or thermal. Among them, piezoresistive has received more attention for high-g accelerometers due to their ability to have high natural frequencies. Numerous studies have been conducted on the design and manufacturing methods of these accelerometers so far. Recently, there has been significant research into the design and development of high-g accelerometers, with a focus on improving their performance, reliability, and sensitivity [1, 2]. One of the promising ways to do it, is utilizing piezoresistive Si nanowire (NW). This has two significant effects. First, by positioning the NW in a stress-concentrated area, a higher sensitivity is attained. Second, miniaturization results in greater resonance frequencies, a property that applications are increasingly looking for [3].
In this study, a simple high-g accelerometer with piezoresistive NW is modeled. This model provides a systematic analysis of the effecting parameters in the performance of the accelerometer and elucidate the potential performance improvements utilizing the NWs. After general introduction of the structure, the sensitivity, resonant frequency, and figure of merit (FOM) are derived with respect of the design parameters. Based on the formulation, it is demonstrated that FOM of the accelerometer can be enhanced through utilizing high gage factor piezoresistive materials or by down-scaling the size of NWs. Accordingly, a guideline is introduced to facilitate the design of the initial geometry that helps the designers to establish an initial configuration for the structure which can decrease the computational cost of finite element (FEM) optimization. Finally, a sample accelerometer is designed and the results are verified by FEM analysis. The main importance of the proposed structure lies in its simplicity. Besides, the aforementioned accelerometer has high natural frequency and frequency bandwidth that is comparable to those presented in the literature.

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Keyword: *High-g accelerometer, Nanowire, MEMS, Piezoresistive*

DRAFT

Mix-and-Match Lithography of Silicon Nanowire-based Transistors

Taner Altınmakas[*1], Mert Özden[1], Sina Zare Pakzad[1], Ivo W. Rangelow[2,3], Mehrdad Karimzadehkhouei[1,4], B. Erdem Alaca[1,4,5]

[1] Department of Mechanical Engineering, Koç University, Sariyer, Istanbul 34450, Türkiye
[2] Ins. of Precision Measurement and Sensor Technology, Ilmenau Uni. of Tech., Ilmenau, 98693, Germany
[3] nano analytik GmbH, Ehrenberg Str. 3, 98693-Ilmenau, Germany
[4] n2STAR-Koç University Nanofabrication and Nanocharacterization Center for Scientific and Technological Advanced Research, Koç University, Sariyer, Istanbul 34450, Türkiye
[5] Koç University Surface Technologies Research Center (KUYTAM), Koç University, Sariyer, Istanbul 34450, Türkiye

In recent years, integration of semiconductor nanowires (NWs) into micro and nanoelectromechanical systems (MEMS/NEMS) has received essential attention due to their transduction abilities in nano-newton range [Nasr Esfahani and Alaca, 2019]. Semiconductor industry's interest in single-dimensional structures has also grown due to size reduction and improved sensitivity [Nasr Esfahani et al., 2018]. Field-Emission Scanning Probe Lithography (FE-SPL) is an easy prototyping method for the fabrication of NWs in a cost-efficient and high-yield way. FE-SPL performs a significant advancement in NEMS research as it allows to create features with sub-10 nm critical dimensions by low-energy electrons with a thermally-actuated self-sensing cantilevers in ambient conditions (at room temperature and without vacuum) [Rangelow, 2016]. FE-SPL enables to utilize imaging and patterning in cycles with the same cantilever being capable of closed-loop lithography, providing enhanced flexibility, increased speed, and improved ease of use [Kaestner and Rangelow, 2020b].
In this study, Si nanowire-based transistors with nearby electrodes will be fabricated on a p-typed highly doped silicon-on-insulator (SOI) substrate by using mix-and-match method, which contains both micro and nanoscale fabrication. The SOI substrate consists of a 12-nm thick Si layer and a 25-nm thick buried oxide (BOX) layer. In the first stage of mix-and-match fabrication, gate electrodes and surrounding architectures of the NW transistor are fabricated by using conventional photolithography and reactive ion etching (RIE). Isolation of the device and out-of-device area are also obtained with this step. Having a 4×4 device array and coating 10 nm thick AZ-Barli II, the SOI substrates are prepared for FE-SPL. Thanks to the imaging feature of FE-SPL, nanoscale features are aligned with gate electrodes which allow co-fabrication of micro and nanoscale. Utilizing cryogenic RIE after creating positive tone patterns with FE-SPL, Si NW-based transistors will be fabricated. Finally, the behavior of transistors will be characterized.

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Keyword: *Scanning Probe Lithography, Cryogenic Etching, Mix-and-Match Lithography, Micro and nanofabrication, Transistors*

DRAFT

ID: 173

Analysis of the Orientation-Dependent Characteristics of Silicon Nanowires

Mehrdad Karimzadehkhouei
Department of Mechanical Engineering, Koç University, Istanbul 34450, Türkiye; n2STAR-Koç University Nanofabrication and Nanocharacterization Center for Scientific and Technological Advanced Research, Koç University, Istanbul, 34450, Türkiye

The miniaturization of electromechanical sensors brings significant advantages such as higher resonance frequencies, lower power requirements, increased speed, improved sensitivity, and a higher signal-to-noise ratio. Cost reduction is also achieved through wafer-level production. By incorporating nanowires (NWs), these benefits can be fully exploited (Karimzadehkhouei, 2023). Miniaturization enables sensors to respond rapidly to changes in acceleration due to higher resonance frequencies and lower power requirements. Wafer-level production reduces manufacturing costs by fabricating multiple sensors on a single wafer. NWs offer unique properties, including high aspect ratios, improved mechanical properties, and enhanced electrical characteristics, enhancing sensor performance in terms of sensitivity, selectivity, and signal-to-noise ratio. The combination of miniaturization and NW integration enables unprecedented levels of performance and efficiency in electromechanical sensors, impacting various industries and domains. The characterization of Si NWs, which are highly desired because of their superior electrical properties, size and scalability, and high surface-to-volume ratio, involves analyzing their orientation-dependent properties through different techniques. Additionally, annealing processes play a significant role in controlling the orientation and the brittle-to-ductile transition temperature, further enhancing the understanding and potential applications.
In this study, Si NWs are fabricated by the following fabrication process flow: a) nanopatterning employing Heidelberg laser writer (DWL 66+): this high-precision tool allows for precise control over the placement and dimensions of the nanostructures, b) developing the photoresist, and c) etching employing deep reactive ion etching equipment (Sentech SI 500C): this equipment offers excellent etching control and selectivity, ensuring the formation of well-defined and uniform NWs. Subsequently, the characterization of Si NWs is conducted using FemtoTools equipment (FT-MTA03), with a particular emphasis on exploring their behavior under testing temperatures ranging from room temperature to elevated conditions exceeding 450ºC. The investigation also takes into account the influence of two crystal orientations, <110> and <100>, on the mechanical properties of these NWs. By comprehensively analyzing the effects of crystal orientation, this research contributes valuable insights into understanding the unique properties and performance of NWs, paving the way for their enhanced utilization in diverse applications.

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Keyword: *Silicon Nanowires, Orientation-dependent Mechanical Properties, Brittle-to-ductile Transition Temperature*

DRAFT

ID: 187

Silicon Nanowire-Based M/NEMS Platform: Out-of-Plane Physical Stimulation Sensing

Masoud Jedari Ghourichaei[*1], Mehrdad Karimzadehkhoui[1,2], Levent Demirkazik[1], B. Erdem Alaca[1,2,3]

[1] Dept. of Mechanical Engineering, Koç University, Istanbul 34450, Türkiye

[2] n2STAR-Koç University Nanofabrication and Nanocharacterization Center for Scientific and Technological Advanced Research, Koç University, Istanbul 34450, Türkiye

[3] Surface Science and Technology Center (KUYTAM), Koç University, Istanbul 34450, Türkiye

Microelectromechanical systems (MEMS) and nanoelectromechanical systems (NEMS) have emerged as essential components in various industries, including automotive, aerospace, etc. These devices integrate mechanical and electrical components at the micro and nano scales. Piezoresistive sensing is a key mechanism in M/NEMS devices, known for its versatility and high sensitivity. Nanowires (NWs) are one-dimensional nanostructures with diameters less than 1μm. Their small size and high surface-to-volume ratio make them ideal for NEMS devices due to their unique electromechanical properties. Single crystal Si is a preferred material for NW fabrication due to its strong piezoresistive effect and high gage factor, allowing the development of sensitive and miniaturized sensors [1]. The small size of piezoresistive NWs enables high spatial resolution in sensor fabrication, making them suitable for nanoscale force and biological sensing applications. [2]. The current design uses piezoresistive Si NWs, noted for their potential in sensing applications.

A M/NEMS force sensor has been developed for out-of-plane or in-plane applications, utilizing a silicon-on-insulator wafer. The shuttle, which serves as a proof mass, was released through a hydrofluoric vapor etch process and is hanged using 8 springs at 4 corners of the square shuttle enabling the shuttle to move both in-plane and out-of-plane. 8 NWs have been attached to the periphery of the shuttle. The movement of the shuttle causes a change in the resistance of the NWs, and the signal can be monitored using a readout circuitry.

The fabricated device has been tested for its out-of-plane resonance frequency. Utilizing a piezo actuator for out-of-plane actuation, the first resonant frequency of the sensor is determined using a laser Doppler vibrometer (Polytec MSA 600). The results indicate that the resonance frequency of the shuttle is 12.32 MHz, with a quality factor of 720 when measured in air. The findings agree with the COMSOL simulations. The high resonance frequency observed in this device offers several advantages, including enhanced responsiveness, improved linearity, and reduced noise. These characteristics make the force sensor a promising candidate for various applications requiring high performance and precision.

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Keyword: *MEMS, NEMS, Si Nanowire, Resonance Frequency, Physical Sensor*

DRAFT

ID: 222

Machine Learning-Driven Atomistic Analysis of Mechanical Behavior in Silicon Nanowires

Sina Zare Pakzad[*1], Mohammad Nasr Esfahani[2], Demircan Canadinc[1], B. Erdem Alaca[1]
[1] Koc University, İstanbul, Türkiye
[2] University of York, York, United Kingdom

Silicon nanowires (Si NWs) exhibit exceptional properties, making them highly versatile for applications in sensing, energy conversion, and communication (Karimzadehkhoueie, 2023). However, understanding the size-dependent mechanical behavior of Si NWs has proven challenging due to inconsistencies in previous studies (Nasr Esfahani, 2019). Recent atomistic simulations employing the molecular dynamics (MD) method have shed light on the influence of size and surface effects on Si NWs. One notable finding is that the formation of a native oxide layer significantly reduces both the modulus of elasticity and ultimate strength, by up to 40% and 30%, respectively (Zare Pakzad, 2023). Additionally, the generation of substantial tensile intrinsic stresses, reaching up to 1.2 GPa (Nasr Esfahani, 2022)., has been observed. These insights emphasize the crucial role of the surface and provide a basis for investigating the size effect in Si NWs. To address the complexities associated with size-dependent elasticity, several analytical models have been developed. Among these, the modified core-shell (M-CS) model stands out for its ability to incorporate size and surface effects, offering a gradual transition from the free surface to the bulk crystal of NWs. By employing the M-CS model, this study aims to establish a comprehensive connection between different geometric scales. To achieve this, the research combines computational, experimental, and analytical approaches. A large-scale atomistic simulation using the MD method will be conducted, simulating up to 2500 Si NWs. Various critical dimension parameters, temperature conditions, interatomic potential types, and testing methodologies will be carefully considered. The resulting dataset will be utilized to train and validate machine learning (ML) algorithms, enabling predictions of size-dependent trends on a separate test dataset (Catal, 2022). The study will analyze relevant MD studies from the literature, focusing on specified parameters, to establish a connection between size-dependent trends and previous observations. By integrating these approaches, the aim is to develop a robust ML tool capable of providing reliable predictions regarding the elasticity of Si NWs with varying dimensions. This project not only addresses the long-standing challenge of reconciling various approaches at the 10-nm scale but also enhances our understanding of the mechanical properties of Si NWs.

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Keyword: *Nanoelectromechanical Systems, Silicon Nanowires, Molecular Dynamics, Modified Core-Shell, Machine Learning*

DRAFT

ID: 166

Modeling of the Lateral Breakdown in GaN HEMTs on Si with step-graded AlGaN buffer

Gokhan Atmaca*, Jeong-Jin Kim, Ho-Young Cha
Hongik University, Seoul, South Korea

In this work, we present an accurate TCAD modeling of the lateral breakdown in GaN High Electron Mobility Transistors (HEMTs) on Si substrate with step-graded AlGaN buffer. Several studies reported that the inversion channel at the AlN/Si interface plays an important role on the breakdown behavior of GaN based HEMTs on Si for high-power electronics applications [1,2]. At high drain voltages, the breakdown is initiated by carrier injection from an inversion channel formed between the epitaxial buffer layers and the p-Si substrate [1,2]. It can be assumed the carrier injection from the inversion channel layer is one of the main reasons behind the breakdown for GaN based HEMTs on Si is still far from theoretical expectations [1]. TCAD modeling can confirm the existed explanations and provide better insights about breakdown behavior regarding the role of the inversion channel at the AlN/Si interface. At first, two different HEMT structures with different step-graded AlGaN buffer layers are considered for off-state buffer leakage measurements. In the Structure A, the step-graded AlGaN buffer stack is consisted of 300 nm $Al_{0.24}Ga_{0.76}N$, 340 nm $Al_{0.45}Ga_{0.55}N$ and 330 nm $Al_{0.75}Ga_{0.25}N$ layers, while it is consisted of 610 nm $Al_{0.24}Ga_{0.76}N$, 400 nm $Al_{0.45}Ga_{0.55}N$ and 300 nm $Al_{0.75}Ga_{0.25}N$ layers in the Structure B. Measured off-state buffer breakdown voltages are obtained as 763 and 970 V for the Structure A and B, respectively. The calculated breakdown voltages via a TCAD modeling including deep donor states in step-graded buffer layers and electron injection from the inversion channel are consistent with measurement results, which are 755 and 929 V for the Structure A and B, respectively. Using the accurate TCAD modeling, we also investigated the relation between the buffer breakdown voltage and different thicknesses of the step-graded AlGaN layers. Moreover, it is proposed the insertion of a p-AlGaN layer between the undoped GaN buffer and step-graded AlGaN buffer structure to suppress the effect of the electron injection from the inversion channel on the breakdown voltage. TCAD modeling shows that suppresion of the electron injection from the inversion channel can enhance the breakdown voltage. Demonstrated TCAD modeling in this study can be used in buffer structure optimization in GaN-based HEMTs on Si.

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Keyword: *TCAD modeling, GaN HEMTs, electron injection, buffer breakdown*

DRAFT

Synthesis and Characterization of Niobium Titanium Nitride (NbTiN) Superconducting Thin Film for Superconducting Circuit Applications

Mehmet Kahraman*, İsmet Kaya
Sabanci University, İstanbul, Türkiye

Superconducting thin films play a crucial role in various technological applications, ranging from quantum computing to superconducting electronics. Among these materials, NbTiN has recently emerged as a promising candidate due to its excellent superconducting properties and its compatibility with the existing nanofabrication techniques.

Here we present our recent results of synthesis of NbTiN thin films by sputtering, and their electrical and strucal characterization. We optimized the sputtering parameters to achieve high-quality NbTiN thin films with high critical temperature. The deposition parameters, such as substrate temperature, sputtering power, and total gas pressure and nitrogen partial pressure were systematically varied and their effect on the film morphology and superconducting properties were examined using a design of experiment (DOE) software. The crystallographic parameters of the films and the grain sizes were determined X-ray diffraction (XRD) and atomic force microscopy (AFM) and techniques.

Furthermore, the superconducting properties of the NbTiN films were evaluated by resistivity measurements, critical temperature (Tc) determination, and critical current density (Jc) analysis using a dilution refrigerator down to the base temperature of 10 mK. The influence of the sputtering parameters on the superconducting transition temperature and critical current density were analyzed to understand the relationship between the film growth conditions and superconducting properties of the films. Our findings demonstrate that the deposition parameters strongly affect the quality and the properties of NbTiN. By optimizing the sputtering process, we were able to achieve NbTiN films with enhanced superconducting properties, namely high Tc and Jc values.

This study contributes to the ongoing efforts in advancing superconducting thin film technology and its application in various fields. The optimized growth parameters and comprehensive material characterization presented here will facilitate the fabrication of high-quality NbTiN thin films and pave the way for the development of advanced superconducting devices for future technologies.

Keyword: *Superconductivity, Type 2 superconductors, Niobium Titanium Nitrite (NbTiN), Superconducting thin film*

DRAFT

ID: 246

Investigation of memristive behavior of BST thin film with TiO_2 interlayers depending on substrate temperature.

Özlem Akın*[1], Hasan Efeoğlu[2]
[1] *Atatürk University, Nanoscience and Nanoenginerring Department, Erzurum, Türkiye*
[2] *Atatürk Universiy, Electric Electronic Engineering Department and Nanoscience and Nanoenginering Department, Erzurum, Türkiye*

In 1971 Leon Chua realized that the binary relationship between magnetic flux and charge was not taken into account. In his study on this, he invented the fourt devices in electronics and called as a memristor, as a result of the mathematical data obtained from the relationship between flux and charge [1]. Although many studies were carried out until 2008, it was announced that the results supporting Leon Chua's memristor structure were obtained in the study carried out by the team in the HP laboratory in 2008, and after that date, scientists started to work on the memristor [2].
BST is a material with ferroelectric properties. The compound $Ba1-xSrxTiO_3$ is a material that combines the ferroelectric properties of $BaTiO_3$ and the mechanical stability of $SrTiO_3$. The ferroelectric property of this material can be changed by changing the Ba/Sr ratio [3], so this material finds a wide range of applications from simple capacitors to ferroelectric non-volatile memories [3]. Taking advantage of this feature, a tunnel layer that can be adjusted between paraelectric and ferroelectric by mechanical stress is selected and the effect of ferroelectric property of the material on resistance switching is examined. In addition to its ferroelectric property, BST has many features that make it preferred in studies.
Although BST film has been studied in terms of magnetic properties and dielectric properties in the literature, its memristive properties have not been studied much. In the literature, oxygen vacancies in the structure of thin polycrystalline BST films are shown as the reason for the resistance deterioration in the structure [4]. Based on this, in this study, the memristive behavior of the BST thin film was investigated. Within the scope of this study, the BST film was grown by magnetic sputtering method, which has not been used before, in the memristor fabrication of BST, which is less used and naturally a deficit in the literature, $Ba0.5Sr0.5TiO_3$ composition. In the literature, sol-gel chemistry and PLD methods are generally used in the memristor fabrication of BST. The determined composition of the BST film was grown with different substrate temperatures and TiO_2 as an interlayer, and the memristive behavior of this structure was investigated. In addition, since we know that the temperature has an effect on the memristive behavior and switching, these samples were annealed at different temperatures and the behavior of these structures depending on the annealing temperature was investigated.
As a result, it has been observed that structures grown at different substrate temperatures exhibit different memristive behavior depending on the annealing temperature.

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Keyword: *memristor, BST thin film, sputter*

DRAFT

Theoretical estimation of thermal conductivity for the carbon-based nanocomposites: Nan model

Tuba Evgin
Dokuz Eylul University, Engineering Faculty, Mechanical Engineering Department, Tinaztepe Campus, 35397, Buca, Izmir, Türkiye

The theoretical prediction of the thermal conductivity for the polymer nanocomposites is very significant to new materials design and optimization of them (Chen et al. 2016). Numerous theoretical and empirical models have been recommended to estimate the thermal conductivity coefficient of polymer composites. However, the theoretical predicting of thermal conductivity of the polymer nanocomposites is a significant research topic. Because each theoretical thermal conductivity models have its own limits, and it cannot achieve every aspect of the matter. Most theoretical thermal conductivity models depend on assumptions for simplicity and do not consider the presence of interfacial thermal resistance. The thermal conductivity of nanocomposites is significantly altered by the interface thermal resistance (Nan et al. 2004). Therefore, Nan et al. (1997) derived a model including this resistance to predict the thermal conductivity of nanocomposites.
In this study, experimental thermal conductivities of HDPE/MWCNTs (Evgin et al. 2016) and HDPE/GnPs (Evgin et al. 2020) nanocomposites could be fitted by using the model of Nan et al. (1997). This model considers the size and the orientation of the filler as well as the thermal boundary resistance between the matrix and filler. The diameter of MWCNTs (d = 12 nm for M12 and d = 58 nm for M58) and thickness of GnPs (t=75 nm for G1, t=75 nm for G2 and t=6.5 nm for G3) are known. The results obtained by Nan model are found to be a good agreement with the experimental data for the HDPE-based nanocomposites. The carbon-based nanofillers broken during the production process. This mechanical effect on the length of MWCNTs and lateral size of GnPs during the process has been rarely demonstrated in the literature. Data given by the supplier shown that M12 has longer size than M58 and G1 has the same lateral size as G2. However, after the process, M58 shows a length 25% higher than M12 and G3 exhibits a lateral size %60 higher than G1. It can be concluded that MWCNTs with small diameter and GnPs with higher thickness are less resistant to mechanical stresses. The highest reduction in lateral size is observed in G2, it still shows the highest lateral size.

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Keyword: *theoretical and empirical models, Nan model, thermal conductivity, polymer composites*

DRAFT

Theoretical insight on the high catalytic activity of bimetallic Pt–Cu nanoparticles for the electrocatalysis of hydrogen evolution reactions

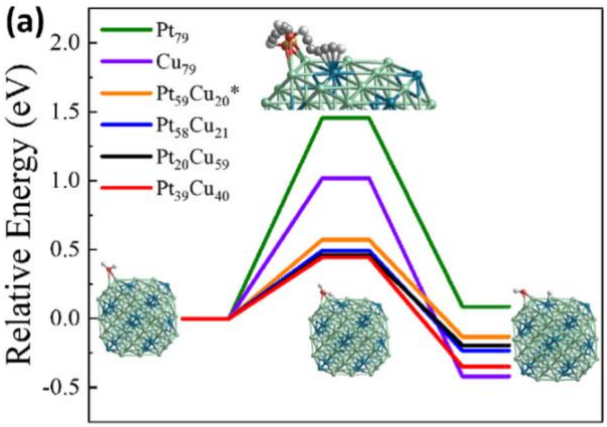
İlker Demiroğlu*[1], Doğan Kaya[2], İlknur Baldan Işık[2], Hasan Hüseyin Işık[2], Selda Kılıç Çetin[2], Cem Sevik[1], Ahmet Ekicibil[2], Faruk Karadağ[2]

[1] Eskisehir Technical University, Eskişehir, Türkiye

[2] Cukurova University, Adana, Türkiye

Due to high demand for clean energy sources such as wind, solar, tidal, geothermal, etc., electrocatalysis has become the most efficient method to mitigate the world's high energy demand by generating sustainable, renewable, green, and pollution-free energy. Consequently, the electrocatalysis of the water-splitting process provides high-purity hydrogen and oxygen gas production, which is an effective method not only for generating electricity but also reducing the greenhouse effect. Although hydrogen gas production is a well-known process, it is essential to develop environmental-friendly and low-cost technology for large-scale production.

Platinum group metals attract high scientific interest due to their wide range of applications from fuel cells to dental alloys due to their high catalytic activities. Among Platinum group metals, commercially available Pt nanoparticles provide enhanced catalytic activities in catalytic converters of automobiles and fuel cells due to their low operating temperatures, high energy conversion and low environmental pollution. Nowadays, most common challenges in Pt-catalysis are high cost, mining difficulties and limited Pt resources. Therefore one of the future direction in Pt-catalysis is alloying these catalytic active metals with cheaper and more abundant metals without losing important catalytic activities. Here, one advantage could be also sometimes improved catalytic activity due to the sinergistic effects according to the chosen metal. Thus, In this study, we investigated the effect of Cu ratio on structural properties and HER activities of PtCu bimetallic nanoparticles. First-principle DFT calculations confirms the stabilities of Pt_1Cu_3, Pt_1Cu_1 and Pt_3Cu_1 crystal formations as ordered alloy structures. The nudged elastic band method calculations and the d-band model verify the higher catalytic activity of PtCu NPs compared to pure nanoparticles, and point out the relevance of a synergistic effect of Pt and Cu atoms upon water dissociation. The relationship between catalytic activity and structural characteristics of PtCu alloys is strongly correlated. According to theoretical calculations, Cu and Pt sites significantly influence the adsorption of H_2O and H, respectively, for splitting water molecules. While the $Pt_{59}Cu_{20}$ cluster has the highest H_2O adsorption energy at the (100) atop site of Cu atoms, H adsorption occurs at the (111) site of Pt atoms.



Keyword: *bimetallic nanoparticles, Hydrogen evolution reaction*

DRAFT

ID: 254

Advanced SEM Metrology and CAD Layout-based Automation for SEM Image Acquisition

Sven Bauerdick[*1], Klemens Reuther[1], Nezih Ünal[1], Muhammed Bekin[2]
[1] GenISys GmbH, Taufkirchen, Germany
[2] GenISys AS, İzmir, Türkiye

Today's nanofabrication processes based on optical, electron beam and laser beam lithography require significant SEM (scanning electron microscope) investigation for continuous improvement and monitoring. Micro and nanometer scale high fidelity structures can only be achieved with careful process calibration/ modeling and inspection of critical parts of a test pattern or device.
While lithography steps are conducted with highly sophisticated instrumentation in R&D prototyping and small batch production, conventional analytical SEMs still are used to measure the resulting structures. However, SEM based metrology and process monitoring are manual, highly tedious, and time consuming to perform. Also, it is highly dependent on the knowledge and competence of the operator, it causes problems in repeatability. Nowadays R&D institutions, multi-user facilities, and specialized small-batch manufacturing companies call for easy, automated, and reliable measurements. On the other hand, fully automated CD-SEMs (critical dimension scanning electron microscopes) optimized for high volume IC manufacturing industry are more costly and do not provide the required flexibility. However, there is a demand for analyzing large numbers of SEM images, for example in resist calibration, large area/ array structures or prototype batches. Here SEM metrology capabilities need to catch up with the progress in applications and fabrication processes. We will present a software-based solution that provides advanced metrology for SEM images as well as CAD layout-based automated SEM image acquisition on an ordinary analytical SEM. The automated feature detection and metrology is based on proven algorithm optimized for SEM systems. The metrology is based on large number of measurements (measuring every scan line) and intelligent averaging which improves resolution and stability. Key features will be introduced, such as support for 1D and 2D complex shapes, measuring arrays of similar features, batch processing of large image sets and employing contours and layouts for lithography applications. This will be illustrated by various application examples. Moreover, we will explain a new functionality which employs interfacing to SEM tools for remote control and image acquisition. This allows for layout-based SEM image scans to be acquired and then be measured automatically with the pre-defined metrology in an integrated workflow.

Keyword: *Scanning Electron Microscope, SEM Metrology, SEM Automation, SEM Inspection*

DRAFT

ID: 265

Lithography Simulation and application oriented OPC

Dmitri Titko*, **Qing Tan, Nezih Ünal**
GenISys GmbH, Taufkirchen, Germany

Lithography simulation has been a focal point during the last 20 years. It became a key enabler of Moore's law in CMOS-IC manufacturing. Simulation supports the optimization of lithographic process and enables the resolution enhancement technologies (RET) for technology node going below the wavelength of the exposure tool (< 300nm node for i-line stepper, < 200nm node for DUV stepper). At the same time optical proximity effects become significant and require OPC - one of the key technologies enabling higher resolution. Moving to mature technology nodes mask optimization evolves from simple "manual" OPC techniques to more advanced Rule based OPC and with increasing complexity to Model based OPC.
The OPC techniques for CMOS have become standard in production for more than 20 years with well-established tools and processes. Those standard solutions fall short for special applications such as photonic IC, quantum devices, compound semiconductor devices, or flat panel display. Those applications require special layouts using non-Manhattan curvilinear design, complex materials and processes, and special exposure tools such as laser systems or large area projection systems.
This paper demonstrates a software-based solution combining lithography simulation with Rule and Model-Based corrections. With Rule Based correction being very fast in computational speed often becomes too complex to setup and calibrate for technology nodes below 130nm. Model Based correction using full imaging Kernel being robust in application with changing designs – is able to overcome this limit but requires more computational time. This paper highlights a hybrid approach to combine the speed of Rule OPC and the robustness of Model OPC. Simulation with specialized software functionality is used for optimizing the Rule OPC and combining it with the Model OPC where required. Examples for CMOS and special applications like photonic IC will be presented.

Keyword: *Lithography simulation, Optical proximity correction, Rule based OPC, Model based OPC, Photonic IC*

DRAFT

ID: 252

Redox-Active Porous Organic Polymers as Cathode Materials For Zinc-Ion Batteries

Onur Buyukcakir
Izmir Institute of Technology, Department of Chemistry, Izmir, Türkiye

Zinc(Zn) based energy storage systems are inexpensive, environmentally friendly, and compatible with aqueous electrolytes.[1] However, one of the critical challenges preventing the Zn-ion batteries (ZIBs) from being widely used, especially in grid-scale energy storage, is the lack of cathode materials that provide high capacity and rate performance. Although several organic cathodes have been reported for use in aqueous rechargeable ZIBs in recent years, obtaining electrochemically active organic compounds with rich redox-active centers that can reversibly store Zn^{2+} ions is highly challenging.[2] Therefore, it is still of interest to design new organic compounds and polymeric structures as active electrode materials for next-generation ZIBs to provide high electrochemical performance without losing long-cycle life, sustainability, and affordable cost. This presentation will present the use of conjugated quinone-based redox-active organic polymers as cathodes. The electrochemical performances of these polymers as cathode materials will be presented in detail. The proposed zinc-ion storage mechanism supported by theoretical calculations and in/ex-situ measurements will be exhibited.

Acknowledgments: O.B. acknowledges financial support from the Scientific and Technological Research Council of Turkey (TUBITAK) under Project No.220Z024.

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Keyword: *polymeric frameworks; porous organic polymers; energy storage; zinc-ion batteries*

DRAFT

Effective CO_2 Adsorption Process by Silica Xerogel/Biochar Composites

Lubaba Salah*, Gulcihan Guzel Kaya, Huseyin Deveci
Konya Technical University, Chemical Engineering, Konya, Türkiye

CO_2 emission, one of the main sources of greenhouse effect, is a serious environmental problem. According to Intergovernmental Panel on Climate Change, CO_2 concentration will reach up to 570 ppmv leading an increase in global temperature and sea level [1]. To decrease CO_2 emission, many CO_2 capture technologies have been developed. CO_2 adsorption by adsorption process is commonly applied using potential solid adsorbents which require low cost, high adsorption capacity, easy regeneration, high stability and fast kinetic [2, 3]. In this work, silica xerogel/biochar composites were synthesized by sol-gel method. Crystallographic and structural characterizations of the composites were carried out by X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR) analyses. Field emission scanning electron microscopy (FESEM) analyses revealed silica xerogel particle growth on the biochar surface. CO_2 adsorption measurements were performed on a volumetric sorption analyzer at 25 °C. Effect of biochar content (1, 2 and 3 wt%) on the CO_2 adsorption capacity of the silica xerogel/biochar composites was investigated and an increase in the adsorption capacity was observed with increasing biochar content. In the presence of 3 wt% biochar, the CO_2 adsorption capacity of the composite was determined as about 0.90 mmol g^{-1}. After five repeated CO_2 adsorption-desorption experiments, no significant change in the CO2 adsorption capacity of the composite including 3 wt% biochar was observed. The promising results showed that silica xerogel/biochar composites had enhanced CO_2 adsorption capacity which can be improved by utilization of more biochar content.

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Keyword: *Silica xerogel, Biochar, CO2 adsorption process*

DRAFT

ID: 160

Development of Antibacterial Coatings as a Potential Strategy to Reduce Transference Risk in Clinical Settings

Aatif Ijaz[1], Ghazaleh Azizi Saadatlou[* 2], A. Levent Demirel[3], Safacan Kolemen[3]

[1] Center for Functional and Surface Functionalized Glass, Alexander Dubcek University of Trencin, Trencin, Slovakia & Department of Chemistry, Koc University, Istanbul, Türkiye

[2] Materials Science and Engineering Graduate Program, Koc University, Istanbul, Türkiye

[3] Department of Chemistry, Koc University, Istanbul, Türkiye

Healthcare-associated infections caused by the transmission of bacteria and viruses from frequently used objects in clinical settings present a continuous health hazard. Pathogenic microbes can survive on metallic and plastic surfaces for several days. This project aims to develop durable, antibacterial coatings through a low-cost and environment-friendly approach for steel and copper alloys employed in knobs and door handles. The nanocomposite coatings are developed in a matrix of Styrene-Butadiene-Styrene (SBS) to prevent the adhesion of pathogens to the metallic substrates. The matrix contains polydopamine (PD)-capped silica particles that are integrated with silver nanoparticles (AgNPs). PD photothermally enhances the antibacterial activity of SBS coatings due to its inherent antibacterial ability and the local increase in temperature under near-infrared (NIR) irradiation. The antibacterial efficacy of composite coatings is further enhanced due to the synergistic effect of AgNPs.

The photothermal activity of the PD-coated/AgNPs integrated silica particles was tested by dispersing them into the water and irradiating them with 808 laser light. The results have shown that the temperature increases by 15°C in 10 minutes upon exposure to NIR light. The antibacterial activity was tested against gram-positive Staphylococcus aureus bacterial species with the contact killing method according to the modified JIS Z 2801 standard. The results showed that the colonies formation unit value was 70.3×10^6 CFU/ml for the uncoated copper substrate. The copper substrate was coated with films containing 1, 3, 5, and 10 wt.% of the particles, and the colonies formation unit dropped by 87.6%, 88.6%, 89.0%, and 90.0%, respectively.

Keyword: *Nanocomposite coating, Antibacterial, Photothermal Activity*

DRAFT

ID: 212

Importance of the Dispersibility of Carbon Nanotubes in Organic Resins in terms of Mechanical and Electrochemical Properties

Seçil Sevim Ünlütürk*, Necati Güdümcüoğlu
Kansai Altan Boya Sanayi ve Ticaret A.Ş, İzmir, Türkiye

Carbon nanotubes (CNTs) are mostly used beyond all the carbonic materials due to their unique properties like flexibility, chemical stability, etc[1, 2]. The electrical conductivity, which is achieved by CNTs makes them very attractive, especially in the automotive industry. On the other hand, the dispersibility of CNTs in common vehicles is very challenging. That is the reason why it becomes difficult to use CNTs in various applications[3]. In this study, the incorporation of two different CNTs into acrylic resin was investigated in terms of electrical resistivity and mechanical properties. For this purpose, electrochemical impedance spectroscopy (EIS) and Dynamic Mechanic Analysis (DMA) techniques were applied. Since the dispersibility of CNTs is critical for the enhancement of all the properties, Hansen Dispersibility Parameters (HDP) were studied for both resin and two different CNT types. The results showed that better dispersion decreases the electrical resistivity of the coatings. Agglomeration resulting from the incompatible CNT-resin mixture was also proved by optical microscopy. According to the results, we aimed to improve the electrical and mechanical properties of the organic systems used in the automotive industry by choosing the optimum CNT type and amount.

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Keyword: *Carbon Nanotubes, Organic Coatings, Hansen Dispersibility Parameters*

DRAFT

Solvent-Driven Anisotropic Spongy Actuators

Esma Mutluturk[*1], Bilge Baytekin[2], Gokcen Birlik Demirel[1]

[1] Department of Chemistry, Polatlı Faculty of Arts and Sciences, Ankara Hacı Bayram Veli University, Ankara, Türkiye

[2] Department of Chemistry, Bilkent University, Ankara 06800, Türkiye; UNAM – National Nanotechnology Research Center, Bilkent University, Ankara, 06800, Türkiye

Up to now, robots made up of rigid materials have been employed in most robotic applications[1]. However, rigid-bodied robots are restricted to discrete motion. Hence, they have only limited adaptability. The critical challenges for designing robots with agility and adaptability are achieving continuum motion with a fast response time, simple (re)fabrication of the robot, variable material stiffness, and lightweight. Using soft materials offer solutions to several of these issues at once. Soft material actuators can display continuum motion through different actuation mechanisms[2]. Herein; we show solvent-driven PDMS spongy actuators. Porosity difference in the anisotropic bilayers of PDMS sponges is used to create the anisotropy required in a bending actuator. The asymmetrical spongy polymers are manufactured through table sugar templates and actuated by solvent absorption/desorption. These actuators are produced in one step using a single material and weigh about half a bulk robot. The straightforward design of these new actuators contributes a new perspective for manufacturing soft robots.

Keyword: *anisotropic swelling, polydimethylsiloxane, PDMS sponge, solvent actuation*

DRAFT

ID: 46

Fabrication and SERS application of the Thermoresponsive Polymer Brush-Decorated 3-D Plasmonic Gold Nanorod Arrays for Single-Molecule Detection

Kübra Ozkan Hukum*, Tuncer Caykara, Gökhan Demirel
Gazi University, Faculty of Science, Department of Chemistry, Ankara, Türkiye

Plasmonic-based molecular sensing has garnered significant interest not only for fundamental scientific research but also for real-life applications. For plasmonic sensing, the generation of tunable hot-spots where the electromagnetic field is maximized plays a crucial role. Considering recent advancements in polymer science and engineering, densely packed polymer brush-decorated solid supports are opening up new frontiers in the field of surface-enhanced Raman scattering (SERS) due to their unique structures and functionalities. Therefore, in this study, a stimulus-responsive SERS platform was designed by combining plasmonic particles and poly(DEGMA) modified 3-D ordered/vertically aligned gold nanorod (AuNR) arrays surfaces. Temperature- responsive poly(DEGMA) brushes were synthesized via the interface-mediated RAFT polymerization method. 3-D AuNR arrays were produced using the oblique angle physical vapor deposition method. The formation and mapping of hot-spots were analyzed using a confocal Raman microscope. High-density hot-spot formations on the platforms were achieved by reducing the distance between the plasmonic particles and the underlying array of AuNR via phase transition of temperature-responsive polymer brushes. When the poly(DEGMA) modified 3-D AuNR arrays were combined with plasmonic colloidal particles, a remarkable synergy increase in SERS signals was observed. In conclusion, it was clearly demonstrated that temperature-responsive polymer brushes combined with plasmonic materials have the potential to produce effective plasmonic detection platforms.

Keyword: *polymer brushes, interface-mediated RAFT polymerization, SERS, hot-spot engineering, molecular detection*

DRAFT

ID: 277

Producing Ultra-Thick Patterns via Maskless Grayscale Lithography

Muhammed Bekin[*1], **Dominique Collé**[2]
[1] *GenISys AS, İzmir, Türkiye*
[2] *Heidelberg Instruments Mikrotechnik GmbH, Germany*

A crucial technique for producing structured surfaces in photoresist, particularly for micro-optic applications, is maskless grayscale lithography. It exposes a layer of positive resist with low contrast by using spatially controlled light intensity. A DWL 66+ from Heidelberg Instruments makes it simple to expose a digital design with height or gray value data that corresponds to a certain target depth in the photoresist. The resulting topography is heavily impacted by lateral development, geometry-dependent proximity effects, and a non-linear resist dosage dependence. It is quite difficult to get the right balance of these elements for grayscale lithography.

Processes for thicknesses up to 60 µm are well known. In the area of micro-fabrication, the ability to create taller structures is of tremendous importance. It has been compared between two experimental and one commercial resist to reach and surpass the 100 µm symbolic height. We doubled and quadrupled the coating cycles at relatively low velocity following a validation experiment in a single coated layer of an experimental DNQ-based photoresist and rapidly received encouraging results. The triple-coated film revealed some type of delamination at the deepest part of the layer, towards the surface of the substrate, even though it allowed for the fabrication of structures 100 µm high. The development of N2 bubbles is indicated by the delamination, which is a drawback of DNQ-based photoresists that release nitrogen when exposed to light. For thicknesses above 80 µm, experiments using a commercially available resist from Microresist Technology appear to exhibit comparable results. Recent tests trying a different supplier's second experimental resist produced some encouraging findings: structures slightly higher than 100 µm without an obvious nitrogen flaw defect have been produced. Another benefit is that compared to the prior test, the overall dose needed to reach this depth was substantially lower.

We will present a grayscale solution for ultra-thick photoresist layer for maskless grayscale lithography. Also, without the requirement for iteration, a good match to the target can be obtained by using lithography simulation software. When the laser exposure and development are modeled, the resist contrast curve is taken into account, and the dose assigned to each pixel is adjusted based on the strength of proximity effects from its surrounds. We will present maskless and easy way to make grayscale lithography with DWL 66+ from Heidelberg Instruments.

Keyword: *Direct Writing Lithograpy, Lithography, Micro-optic, Maskless*

DRAFT

ID: 21

Determination of BRCA1 a potential biomarker in the treatment of breast cancer.

Seymanur Kurt[*1], Derya Bal Altuntaş[2], Sema Aslan[3], Murat Yolcu[4], Zuhal Yolcu[4]

[1] Recep Tayyip Erdogan University, Department of Advanced Technologies, 53100, Rize, Türkiye

[2] Recep Tayyip Erdogan University,Department of Bioengineering, Faculty of Engineering and Architecture, 53100, Rize, Türkiye

[3] Department of Chemistry, Faculty of Science, Muğla Sıtkı Koçman University, 48050, Muğla, Türkiye

[4] Department of Chemistry, Faculty of Science, Giresun University, Giresun, Türkiye

BRCA1 is considerably addressed for the clinical diagnosis of miscellaneous tumor types. In this study, an electrochemical immunosensor for the determination of the BRCA1 biomarker was presented. Disposable pencil graphite electrodes (PGE) has been modified with Au nanoparticle (Au NP) and nanostructure dispersed chitosan (Cs) matrix. Therefore, the electrochemical interaction between the antibody-electrode surface was facilitated. Under optimal conditions, the immunosensor exhibited high sensitivity toward BRCA1 biomarker in the low concentration range 0.05–20 ng mL^{-1}, with the detection limit of 4.14 ng mL^{-1} and relative standard deviation 3.59 (n=5). It has a great potential in the clinical screening of divergent cancer biomarkers.Finally, PGE/ 2D materyal / (CS+Np) /anti-BRCA-1/BSA /BRCA-1 was utilized for the BRCA1 detection.

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Keyword: *BRCA1, Nanoparticle, Immunosensor,*

DRAFT

SPION Trapping Under Liquid Flow Through the Microfluidic Channel by Magnetophoresis

Selin Su Karakol[*1], Bahar Gungordu[1], Nilay Gunduz Akdogan[2,3], Ozan Akdogan[1,3]
[1] Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353, Istanbul, Türkiye.
[2] Faculty of Engineering, Piri Reis University, 34940, Istanbul, Türkiye.
[3] NANOTerial Technology Corporation, 34077, Istanbul, Türkiye.

In the past few years, there has been a growing scientific interest in developing biosensors for detecting various diseases, measuring blood constituents, and various other biomedical applications. These diagnostic kits have attracted significant attention in the scientific community. Despite numerous advancements in this specific domain, the attainment of expeditious outcomes and user-friendly functionality still needs to be achieved. The field of science has witnessed persistent progress, leading to the possibility of developing a magnetic gradient patch (MGP) that exhibits the potential of capturing nanoparticles and bio-entities. The utilization of MGPs has made significant contributions towards the advancement of biosensor technology, enabling the detection and identification of various biological entities.

The present study is centred on the evaluation of the trapping efficacy of superparamagnetic iron oxide nanoparticles (SPIONs) under a liquid flow. Fe_3O_4 nanoparticles were synthesized and their size was determined to be 7 nm through XRD analyses. Furthermore, the observation that the particles exhibit a Standard Deviation of 1.3 nm and a Mean diameter of 7.6 nm as determined through TEM analysis, provides evidence for the superparamagnetic nature of the particles. The present investigation pertains to the implementation of superparamagnetic Fe_3O_4 nanoparticles (SPION), in the combination of a microfluidic channel and a magnetic gradient patch composed of polymer-based polydimethylsiloxane (PDMS).

The biosensor that has been developed exhibits potential in the detection and identification of diverse ailments. Furthermore, timely detection allows individuals to access expedited medical interventions for various illnesses. The analysis will focus on the retention values of particles to be transported through a microfluidic channel, facilitated by a peristaltic pump device. Finally, due to their high efficiency and accuracy, there is a need to develop microfluidic channel integrated systems to reduce the time spent on analysis and to reduce the high cost of materials used to meet the ever-increasing drug demand for disposable test kits.

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Keyword: *Biosensors, SPIONs, Nanoparticles, Magnetophoresis, Microfluidic channels*

DRAFT

Polymer Brush Coated Monodisperse Magnetic Nanoparticles Prepared via RAFT Polymerization for DNA Isolation

Kübra Özkan Hüküm* [1], **Tugba Tezcan**[2], **Ezgi Salmanlı**[3,4], **Uğur Tamer**[2,3]

[1] *Gazi University, Faculty of Science, Department of Chemistry, Ankara, Türkiye*

[2] *Gazi University, Faculty of Pharmacy, Department of Analytical Chemistry, Ankara, Türkiye*

[3] *METU MEMS Research and Application Center, Ankara, Türkiye*

[4] *Virology Department, Faculty of Veterinary Medicine, Ankara University, Ankara, Türkiye*

Magnetic nanoparticles (MNP) have attracted great attention in nanoscience and nanotechnology fields in recent years due to their unique and novel physicochemical properties based on their particle size and morphology. Thanks to their controllability using external magnetic force, MNPs modified with organic molecules are widely used in various fields such as biotechnology (DNA extraction, protein separation, gene targeting, etc.), biomedical (magnetic resonance imaging, etc.) and environmental (removal of heavy metal ions, etc.) applications. Surface polymerization is one of the most popular methods used for coating nanomaterials to achieve desired surface properties. Among these methods, reversible addition-fragmentation chain transfer (RAFT) polymerization, which is a controlled free radical polymerization technique, is an effective method used for functionalizing materials. It offers superior advantages, such as narrow molecular weight distribution and desired grafting density. In this study, firstly, monodisperse MNPs were synthesized and then activated using TEOS and APTS. Next, an amine-terminated MNP RAFT agent was attached to facilitate the growth of polymer chains on the MNP surface. Afterwards, poly(vinylbenzyl trimethylammonium chloride) brushes were synthesized onto MNP surface via the interface-mediated RAFT polymerization technique for DNA isolation process. The modified MNPs were characterized by FTIR, DLS and zeta potential analyses. Adsorption and desorption studies of DNA were performed on the developed MNPs. The good efficiency of both adsorption and desorption were obtained. The proposed MNPs can be good candidate for purification and isolation process of DNA.

Keyword: *Magnetic nanoparticles, interface-mediated RAFT polymerization, DNA isolation*

DRAFT

ID: 68

Aqueous Phase Biofunctionalization of Melt Electrowritten Polyester based Scaffolds

Büşra Köksal*, Ümit Hakan Yıldız
Department of Chemistry, Izmir Institute of Technology, İzmir, Türkiye

Current developments in biofabrication techniques give the possibility to design novel biopolymer-based materials with high biocompatibility, functionality, and tunable porosity [1–3]. Biofabrication with Melt electrowriting (MEW) is one of the additive manufacturing methods applied in tissue engineering applications using polymer melts and an electric field stabilizing a polymer jet to localize in a pre-determined shape over a collector close to the nozzle. PCL is a milestone in MEW with semicrystalline and biodegradable properties [4], yet needs further modifications to increase hydrophilicity for cell attachment and proliferation. We developed novel Poly (ε-caprolactone) -unsaturated polyester (PCL-PE) biocomposite scaffolds by one-step modification of electrowritten scaffolds with gelatin and NCO-Gel (modified gelatin) in the aqueous phase for tissue engineering applications. The scaffolds were fabricated by two ways as applying potential or potential free writing. It is observed that unsaturated triple bonds (C≡C) of PE polymer have accumulated on the scaffold surface due to phase separation induced by applied potential. The phase segregation between PCL and PE in electrowritten scaffold was proved by atomic force microscopy (AFM). The scaffolds modified with gelatin or NCO-Gel polymer to increase biocompatibility have been studied to confirm the promising potential of NCO-gel in various bio-printing modalities. The previous studies on NCO-Gel hydrogels showed that the hydrogel has excellent biocompatibility and stiffness raised due to hydrogen bonding pairs by 2-isocyanatoethyl methacrylate group on NCO-Gel [5]. X-ray photoelectron spectroscopy (XPS) demonstrated the biofunctionalization of the scaffold through representing of C-N bond formation at 400 eV corresponding to N1s binding energy. Chemical mapping of the scaffold and XPS spectra shows almost 100% biofunctionalization of the PCL-PE scaffold. Together with increased cell viability, biocomposite scaffold has great potential in further tissue engineering applications.

Acknowledgments
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Keyword: *biocomposite scaffold, melt electrowriting, Poly (ε-caprolactone), Gelatin, tissue engineering*

DRAFT

Graphene Oxide Functionalization Strategies for Nanobiosensing Applications

Marina Serin*[1], Ezgi Kivrak[1], Pinar Kara[2]

[1] Graduate School of Natural and Applied Sciences, Department of Biomedical Technologies, Ege University, Izmir, Türkiye

[2] Faculty of Pharmacy, Department of Analytical Chemistry, Ege University, Izmir, Türkiye

With the studies carried out in recent years, a prompt development of nanotechnology and a better understanding of nanoparticles' structures and properties have enabled their use in different areas of biotechnology, including bioimaging, drug delivery systems, targeted therapeutic and biosensors for diagnosis and monitoring of diseases (Rihn 2017). Graphene oxide (GO) is a two-dimensional (2D) carbon nanomaterial with a single layer structure of honeycomb weave known for its unique properties, such as high electron transfer rate, high electrical conductivity, high thermal stability, water solubility, large specific surface area (2630 m^2/g), exceptional elasticity and rigidity (Aliyev et al. 2019). Due to these properties GO is an emerging nanomaterial for the development of novel biological sensing platforms. In our present study, we investigated and compared different strategies for GO functionalization and its capability to bind biomolecules and thus feasibility to be used in nanobiosensing. Three different procedures were used for GO functionalization, those were treating with 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide/N-hydroxysuccinimide (EDC/NHS) (Tertiş et al. 2015), chloroacetic acid (Imani et al. 2015) and 3-glycidoxypropyltrimethoxysilane (GPTS) (Hu et al. 2014), respectively. Functionalized nanoparticles were deposited onto pencil graphite electrodes (PGE) from the solution in H_2O. After the surface nanomodification, electrodes were used for binding biomolecules (dsDNA) in solution with different concentrations. dsDNA molecules were covalently attached to the sensor surface via coupling between the carboxylic groups or silane structures on the nanoparticles' surfaces and the amino groups of dsDNA. Using GO nanoparticles allowed us to increase the sensitivity of the proposed nanobiosensor as proof-of-concept. The measurements were performed with differential pulse voltammetry (DPV). Functionalized GO nanoparticles have enhanced the performance of the electrochemical nanosensors by providing high surface area, thus rapid electron transfer. GO-based nanobiosensors designed in this study showed high correlation and sensitivity in binding of biomolecules and, in addition, high precision and repeatability. In future we are planning to carry out studies aimed at application of these nanobiosensor systems in combination with certain bioreceptors (i.e. antibodies, aptamers) for detection of variable biomarkers in real biological samples for further possible development of point-of-care diagnostic tools.

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Keyword: *Graphene oxide, Nanobiosensor, Differential pulse voltammetry*

DRAFT

ID: 83

A Novel Antibacterial Polymeric Wound Dressing Membranes for Wound Healing Applications

Adile Yürük*, Sevil Dinçer İşoğlu, İsmail Alper İşoğlu
Abdullah Gül University, Faculty of Life Science, Department of Bioengineering, Kayseri, Türkiye

Millions of people have suffered from acute and chronic skin wounds, such as injury, burns and diabetic ulcers. These wounds may cause acute or chronic pain, infection, loss of tissue function, prolonged hospitalization, huge financial burden, social stress, anxiety, increased morbidity, and mortality. Every year, healthcare systems worldwide spend at least $25 billion on the treatment of wound-related complications worldwide. Traditional wound treatment strategies cannot meet the clinical requirements for wound healing; hence, there is a huge need for a modern wound treatment approach. In this study, we developed a novel biocompatible and biodegradable polymeric wound dressing membrane with antibacterial activity against gram-negative and gram-positive bacteria. The electrospinning technique was utilized to fabricate wound dressing membranes from a blend of polycaprolactone, a synthetic polymer and gelatin, a natural polymer. The antibacterial Viburnum Opulus plant extract was encapsulated in the electrospun membranes as a ratio of 25, 35, and 50%, (w/v). The membranes were then characterized chemically, morphologically, physically, and mechanically. All electrospun membranes showed uniform, bead-free fiber structures with diameters of 500-1200 nm in Scanning Electron Microscope (SEM) images. Moreover, they exhibited that great antibacterial activity as demonstrated by the formation of inhibition zones of 14 mm to 36 mm against gram-negative and gram-positive bacteria. Importantly, the antibacterial plant extract did not exhibit any toxic effect on cell viability tests conducted on the human fibroblast cell line. Therefore, antibacterial plant extract containing electrospun membrane shows great potential for modern wound healing applications.

Keyword: *wound dressing, electrospinning, antibacterial, plant extract*

DRAFT

ID: 98

Melt Electrowriting of PCL-Ti_3C_2 Scaffold for Enhanced Vascularization in Full-Thickness Skin Regeneration

Mahdiyeh Zahrabi*, Ferdows Afghah, Bahattin Koç
Sabancı University Nanotechnology Research and Application Center (SUNUM), Sabancı University, İstanbul, Türkiye

Full-thickness skin regeneration continues to be a major challenge that requires innovative approaches to overcome the limitations of conventional strategies. A promising technique, melt electrowriting (MEW), has the potential for developing structured networks with micro-scale fiber sizes that resemble the extracellular matrix (ECM). This study contributes to improving the vascularization for full-thickness skin regeneration. In our approach, a biodegradable and biocompatible aliphatic linear polyester, Poly(-caprolactone) (PCL), is printed using the MEW technique to construct a scaffold which is improved by Ti_3C_2 coating, a two-dimensional (2D) material, as in 3D PCL-MXene scaffold.
In addition to biodegradability and biocompatibility, PCL has several beneficial properties, including desirable mechanical properties, making it an optimal material for skin tissue engineering. Besides, the addition of Ti_3C_2 as a biocompatible and biodegradable material offers a few significant properties, including high conductivity, hydrophilicity, and antibacterial activity. These characteristics have a significant potential to improve the PCL scaffold's functionality and biocompatibility and create the ideal conditions for skin tissue regeneration. A 3D-printed PCL-Ti_3C_2 scaffold contributes to vascularization, allowing high oxygen and nutrition permeability, increasing the possibility of regenerating a thick skin substitute, and supporting the survival of living tissue. Through characterizations such as SEM-EDS, zeta potential, UV-Vis analysis, and confocal microscopy, we have supported our claims.
Herein, this study presents the potential of melt electrowriting of PCL-Ti_3C_2 scaffold to fabricate 3D structures that mimic the ECM, aiming to enhance vascularization. The beneficial properties of PCL and the Ti_3C_2 coating offer improved performance and biocompatibility, ultimately contributing to the possibility of full-thickness skin regeneration.

Aknowledgment
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Keyword: *Full-thickness skin regeneration, Melt electrowriting (MEW), PCL-Ti3C2 composite*

DRAFT

Super Penetrating Conjugated Polymer Nanodots for Biomaging Applications

Soner Karabacak*[1], Başak Çoban[2], Ahu Arslan Yıldız[2], Ümit Hakan Yıldız[1]
[1] Department of Chemistry, İzmir Institute of Technology, İzmir, Türkiye
[2] Department of Bioengineering, İzmir Institute of Technology, İzmir, Türkiye

To date, semiconducting polymers, are utilized in life science for ion, biomolecules, and nucleic acids sensing [1-2]. Recently it appeared that semiconducting polymers emitting at visible and NIR (Near Infrared) regions are also of utmost importance for bioimaging cells, tissues, and organs [3-4]. Especially, NIR probes stand out with excellent properties which have minimal interference absorption, low biological autofluorescence, and high tissue penetration for biological applications. In NIR probes, semiconducting polymers were used to form "Pdots (Polymer nanoparticles)" by miniemulsion and precipitation techniques. So, they exhibit superior emissive and colloidal properties with a sub-50 nm size. The size of Pdots is one of the most critical parameters since the size of Pdots determines where the accumulation occurs in a biological cell [5]. For example, size of 50 nm Pdots are prone to accumulate in the cytoplasm whereas sub-20 nm size Pdots can penetrate to the crowded cellular compartments, mitochondria as well as microtubules around the nucleus. Here, the NIR emissive cationic Pdots were prepared from non-ionic donor-acceptor-donor based conjugated polymer and cationic surfactant CTAB by sonication-assisted emulsification. The cationic Pdots have an average hydrodynamic radius of ~12 nm with +56.5 mV (±9.5) surface charge which provides high colloidal stability. The maximum absorbance and emission wavelengths of the NIR emissive Pdot was found as 650 nm, and 861 nm, respectively. The NIR emissive Pdot showed high potential in cancer cell imaging which stains nuclei of SH-SY5Y, HELA, and MDA-MB-231 selectively. Thanks to their high surface charge and colloidal properties, NIR emissive Pdots can be localized intracellularly. In addition, the penetration behavior of Pdots was also investigated by creating tumoroid spheroid tissues (SH-SY5Y, MCF-7). This analysis confirmed the extensive penetration of Pdot in the tumoroid spheroid model as compared to DAPI. In the imaging analyses, DAPI intensively penetrated the spheroid's outer wall but weakened in the middle of the spheroid. Similarly, in the imaging analyses for Pdot, the intensity of Pdot increased as it progressed toward the center of the spheroid, in contrast to DAPI. These findings assure that Pdots have extraordinary penetration capability to tumoroid and spheroid barriers.

Acknowledgments
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Keyword: *Near Infrared Emissive Conjugated Polymer, Polymer Nanoparticles, Tumoroid Imaging, Biosensor*

DRAFT

Real-Time Monitoring of Interactions Between Gramicidin-D Channel Protein and Different Biomimetic Lipid Membrane Models

Şebnem Seherler*, Fatma Neşe Kök, Abdulhalim Kılıç
Molecular Biology, Genetics and Biotechnology Programme, İstanbul Technical University, İstanbul, Türkiye

Understanding the fundamentals of cellular mechanisms such as signaling and trafficking, as well as the development of effective medical systems like diagnostics and drug screening, requires thorough investigation of cell-cell, biomolecule, and surface interactions. However, direct investigation of complex biological membranes with various compositions is challenging. To overcome this limitation, biomimetic lipid membrane platforms can be utilized, which incorporate major components of cellular membranes such as proteins and phospholipids. These platforms simplify the investigation of cellular membranes. One powerful technique for studying biomimetic membrane structures and their interactions with nanoparticles, drugs, proteins, and cells in real-time and without the need for labeling is Quartz Crystal Microbalance with Dissipation (QCM-D). QCM-D enables the characterization of structural changes in biomimetic lipid membrane models by monitoring frequency (i.e., mass deposition) and dissipation (i.e., viscoelasticity/rigidity) signals, respectively. In these biomimetic membrane systems, model proteins such as readily characterized channel proteins are introduced into the lipid bilayer to investigate membrane-protein interactions. An example of a model complex biological ion channel is Gramicidin-D, a 15-amino acid peptide antibiotic that forms a dimer with a size matching the hydrophobic portion of the lipid bilayer.
In this study, different biomimetic lipid membrane models were created using two types of liposomes: one composed of a neutral phospholipid molecule, 1,2-Dioleoyl-sn-glycero-3-phosphocholine (DOPC), and the other containing a negatively charged phospholipid, 1,2-dioleoyl-sn-glycero-3-phospho-L-serine (DOPS) in a ratio of 92:8. These liposomes were produced through the thin-lipid film hydration and extrusion method. Subsequently, the liposomes were deposited onto the solid supports, i.e., gold or silica sensor surfaces to construct different model lipid membranes. Depending on the interaction between the solid support and liposomes, either an intact liposome monolayer or a supported lipid bilayer was formed on the surface. These biomimetic lipid membranes were then exposed to varying concentrations of Gramicidin-D ranging from 2 µg/mL to 20 µg/mL to investigate the effect of charge (DOPC or DOPC:DOPS) on the interaction between the model membranes and Gramicidin-D.

Keyword: *Biomimetic Lipid Membranes, Supported Lipid Bilayers, Phosphatidyl Serine, Gramicidin-D, QCM-D*

DRAFT

ID: 184

MagLev-Based Cell Sorting for Analyzing Neuronal Differentiation

Rumeysa Bilginer Kartal*, **Ahu Arslan Yıldız**
Izmir Institute of Technology, Department of Bioengineering, İzmir, Türkiye

Magnetic Levitation (MagLev) is a versatile and powerful technique for sorting objects based on their density differences. This study focuses on the sorting of SH-SY5Y cells for neuronal differentiation using the MagLev technique. The differentiation process involves the use of retinoic acid (RA) and brain-derived neurotrophic factor (BDNF). Neuronal marker expression of un/differentiated cells was investigated by β-III tubulin and NeuN for evidence of differentiation. The MagLev results demonstrated a gradual change in the density of differentiated SH-SY5Y cells, while the density of undifferentiated cells remained stable. These findings highlight that cell density is a potent indicator for detecting neuronal differentiation. Overall, this study shows that MagLev methodology enables rapid, label-free, and easy sorting for analyzing cell differentiation at a single-cell level.

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Keyword: *Magnetic levitation, density-based cell sorting, SH-SY5Y, neuronal differentiation, retinoic acid*

DRAFT

ID: 189

Characterization and Utilization of a Glucuronoxylan-Based Bio-ink for 3D Bioprinting

Özüm Yildirim*, **Ahu Arslan-Yildiz**
Department of Bioengineering, Izmir Institute of Technology (IZTECH), 35430 Izmir, Türkiye

Bioprinting is an emerging technique that enables the fabrication of three-dimensional (3D) structures in designed shapes and features. A key component of bioprinting is the bio-ink, which significantly affects the successful fabrication of 3D bioprinted constructs. To meet the requirements of current bioprinting techniques, the ideal bio-inks should possess characteristics such as biocompatibility, viscosity, printability under low pressure, stability in cell culture, and proper gelation mechanism (Özmen et al., 2023). Hydrocolloids exhibit these desirable features and resemble the properties of native extracellular matrix (ECM) structures (Guzelgulgen et al., 2021), making them suitable bio-ink for 3D bioprinting. In this study, a novel bio-ink based on glucuronoxylan was developed and evaluated for its printability in 3D bioprinting applications. The bio-ink was characterized using FTIR and mechanical analysis, while bioprinting parameters were optimized by assessing uniformity, pore factor, and shape fidelity. The resulting bioprinted structures exhibited high mechanical strength, favorable protein adsorption behavior, and exceptional water-holding capacity, surpassing that of other hydrogels commonly used in soft tissue engineering. Furthermore, long-term culture of NIH-3T3 fibroblast cells within the bio-ink demonstrated excellent cell viability and compatibility (Yildirim and Arslan-Yildiz, 2022). These findings indicate that the glucuronoxylan-based bio-ink is a promising and biocompatible material for future bioprinting studies.

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Keyword: *Glucuronoxylan, Quince seed hydrocolloid, Bio-ink, 3D bioprinting*

DRAFT

Construction of a Nanoplasmonic Biosensor Platform

Elif Deniz Çalı[*1], Yaşar Yurtsever[1], Ayşe Nur Gürler[1], Zeynep Şahin[1], Abdulhalim Kılıç[2]
[1] Molecular Biology and Genetics Department, Istanbul Technical University, Istanbul, Türkiye
[2] Molecular Biology, Genetics and Biotechnology Programme, Istanbul Technical University, Istanbul, Türkiye

There is a requirement to construct cost-effective, easy-to-use, fast, and reliable platforms for point-of-care (POC) devices. Gold nanoparticles (AuNP) are good candidates for POC devices as they possess localized surface plasmon resonance (LSPR) properties or in short nanoplasmonics. Further, they can be functionalized with various biomolecular recognition components (DNA probes, aptamers, antibodies, etc.,) and widely utilized in biosensor systems to enhance sensitivity and enable real-time monitoring and label-free detection. The aim of this study is to develop a portable, easy-to-use, and cheap nanoplasmonic biosensor framework allowing quantitative and multiplexed detection using a spectrophotometer. To achieve this, negatively charged gold nanoparticles were immobilized on a multi-well plate, which is pre-coated with polyethyleneimine (PEI), which is a positively charged polymer. The sensor system is optimized by different parameters such as buffering system, PEI & nanoparticle concentrations, PEI & AuNP incubation times, and AuNP size. The platform was validated using sucrose and glycerol as test samples, and the responses were monitored by observing the shifts in wavelength peaks. The results demonstrated distinct behavior depending on the buffering system (MilliQ water, PBS, and citrate buffer) used to suspend AuNPs. The behavior was also found to be dependent on the size and concentration of the nanoparticles. In conclusion, the study successfully developed an experimental platform that allows for obtaining different responses for different solutions and the ability to distinguish between different concentrations of the same solution.

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Keyword: *nanoplasmonic, biosensor platform, biosensor, point-of-care devices*

DRAFT

Silk Fibroin-Based Porous Cardiac Patches and Their Potential for Energy Harvesting

Yiğithan Tufan[*1], Hayriye Öztatlı[2], Doga Doganay[1], Arda Buyuksungur[3], Melih Ogeday Cicek[1], İpek Tuğçe Döş[1], Çağla Berberoğlu[1], Husnu Emrah Unalan[1], Bora Garipcan[2], Batur Ercan[1,4,5]

[1] Department of Metallurgical and Materials Engineering, Middle East Technical University, Çankaya, Ankara, Türkiye

[2] Institute of Biomedical Engineering, Boğaziçi University, İstanbul, Türkiye

[3] Department of Basic Medical Sciences, Faculty of Dentistry, Ankara University, Ankara, Türkiye

[4] Biomedical Engineering Program, Middle East Technical University, Çankaya, Ankara, Türkiye

[5] BIOMATEN, Center of Excellence in Biomaterials and Tissue Engineering, Middle East Technical University, Çankaya, Ankara, Türkiye

As an alternative approach to treating heart failure, regenerative therapies can utilize induced pluripotent stem cells (iPSCs) to repair damaged cardiac tissue. Using iPSCs offers advantages such as reducing the risk of immune rejection and eliminating the need for immunosuppressive drugs [1]. However, creating an optimal environment for the growth and cardiomyogenic differentiation of iPSCs relies on scaffold-based cardiac patches that mimic cardiac muscle tissue [2].

Silk fibroin (SF) is a biocompatible protein that could be regenerated to design porous scaffolds having tunable properties, making it an ideal candidate for scaffold-based cardiac patches. The pore size, porosity, and pore interconnectivity of SF scaffolds are crucial properties to be optimized for cardiac tissue regeneration. A comprehensive study that examines the combined and interrelated effects of these properties and the β-sheet content on the mechanical, biological, and degradation properties of SF scaffolds is currently lacking in the literature. Moreover, incorporating CNFs into SF scaffolds can address the lack of electrical conductivity of SF-based scaffolds.

Triboelectric nanogenerators (TENGs) show promise in converting mechanical energy into electrical energy [3]. The pulsatile nature of the heart provides a potential source of mechanical energy that TENGs can harness as electrical energy. Existing literature on TENG systems designed for harvesting energy from cardiac motion mainly focuses on closed systems, often enclosed in bioinert cases [4]. None of these systems had TENG electrodes that simultaneously support the growth of iPSCs and promote cardiomyogenic differentiation.

In this proof-of-concept study, porous SF and SF/CNF scaffolds were fabricated and characterized to investigate the interconnected effects of pore size, porosity, pore interconnectivity, and β-sheet content on their mechanical, degradation, and biological properties. iPSCs were used to assess the scaffolds' biological performance in vitro. Electrical properties of the scaffolds before and after the incorporation of CNFs were characterized. It was also shown that the SF and SF/CNF scaffolds could be utilized as counter electrodes in a TENG system, showing their energy harvesting potential from the simulated cardiac motion. This study can potentially be the first step in developing multifunctional cardiac patches designed to repair cardiac tissue and simultaneously harvest energy from the natural cardiac motion.

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Keyword: *Silk fibroin, Cardiac patch, Stem cell, Triboelectric nanogenerator*

DRAFT

Using atomic force microscopy in different liquid media as a tool to quantify adhesive biopolymers and their effect on the rigidity of bacterial cells

Gamze Nur Aspar[1], Fatma Pınar Gördesli Duatepe[*2]

[1] Izmir University of Economics, Graduate School, Bioengineering Graduate Program, 35330 Izmir, Türkiye

[2] Izmir University of Economics, Faculty of Engineering, Department of Genetics and Bioengineering, 35330 Izmir, Türkiye

Real time imaging in physiological media is unique to atomic force microscopy (AFM), allowing researchers to monitor cell surface dynamics with unprecedented resolution[1]. AFM is not only an imaging tool, but also a tool that can directly measure the interaction forces between its probe and the sample surface, generating approach and retraction force-distance (FD) curves from which nanomechanical surface properties and adhesion capacities of bacterial cells can be determined[1-3]. In this study, AFM was used to determine the nanoscale adhesion energies of Bacillus subtilis cells grown for 2.5, 4.5 and 6.5 hours under water and a buffer solution (containing 2mM $MgSO_4$ and 0.1mM $CaCl_2$). The adhesion energies were calculated from the recorded retraction FD curves by evaluating the area under the curve using Trapezoidal rule[2]. Differences in adhesion energies measured in water and buffer solution can provide information on the amounts of adhesive components, such as wall teichoic acids (WTAs), associated with the cell wall of B. subtilis as a function of growth time. Our results showed that the adhesion of B. subtilis was mostly mediated by WTAs and that the highest amount of WTAs associated with cells grown for 4.5 hours showed the highest mean and median adhesion energy in water (439.5 aJ and 290.2 aJ, respectively) and the highest percentage decrease (83 %) in adhesion energy in buffer solution. Following the initial physical interaction between the AFM probe and the cell surface, a nonlinear compression reflecting cell wall elasticities was observed in the approach FD curves of B. subtilis cells. For each bacterium studied, this regime (indentation-force data) was fitted by the classic Hertz model to determine the Young's modulus[3]. As expected, cells became more rigid in buffer solution and the highest cell surface rigidity was observed for cells grown for 4.5 hours. Since WTAs increase membrane stability and rigidity by forming cationic bridges with divalent cations[4], this finding also suggests that the production of WTAs is growth time dependent, with the highest amount of WTAs was found in B. subtilis grown for 4.5 hours.

Acknowledgement

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Keyword: *Nanobiotechnology, Atomic force microscopy, Adhesion energy, Hertz model, Cellular elasticity*

DRAFT

Development of an Advanced LSPR-Based Biosensor Chip for Rapid Detection of Border Disease Virus

Abdullah Alakbarov[*1], Şebnem Kılıç[1,2], Nazlı Hilal Altun[2], Hümeyra Taşkent-Sezgin[2], Volga Bulmuş[2], Abdullah Alakbarov[2]

[1] Biotechnology Master Program, Izmir Institute of Technology, Urla, İzmir, 35430, Türkiye
[2] Department of Bioengineering, Izmir Institute of Technology, Urla, İzmir, 35430, Türkiye

The Border disease virus (BDV) belongs to the genus Pestivirus in the family Flaviviridae, and is responsible for causing fetal deathly infection, leading to annual occurrences of affected farms. Border disease virus infection is important in countries because the BDV is transmissible from sheep to cattle, cattle to cattle, and cattle to sheep. Various methods are employed for the identification of ruminant pestiviruses, pestivirus antigens, and pestivirus antibodies. These techniques include virus isolation, ELISA (enzyme-linked immunosorbent assay), AGID (agarose gel immunodiffusion), SNT (serum neutralization), IHC (immunohistochemistry), in situ hybridization, and RT-PCR (reverse transcriptase polymerase chain reaction). Despite being widely regarded as the most reliable method, virus isolation is characterized by its complexity, lengthy duration, and high cost. Consequently, antigen and antibody detection techniques are regularly used to identify pestivirus infections within individual animals and at the hard level. Nevertheless, these techniques lack the ability to consistently distinguish between Bovine Viral Diarrhea Virus (BVDV) and Border Disease Virus (BDV) infections, and their diagnostic sensitivities and specificities are suboptimal. In contrast to BVDV, there is currently a lack of available antibodies that can be reliably used for the detection of BDV through immunohistochemistry (IHC). Hence, it is imperative to employ diverse methodologies for the purpose of detection.

Optical biosensors are widely recognized as one of the most commonly employed biosensors. Plasmonic biosensors are a type of label-free optical biosensors eliminating the need for additional labeling steps and therefore being considered advantageous over the other types. Among plasmonic biosensors, the Localized Surface Plasmon Resonance (LSPR)-based biosensors offer several advantages for various applications, including increased reliability and accuracy because of elimination of bulk effects, Moreover, LSPR-based detection is particularly suitable for the fabrication of small tools, making it valuable for portable biosensor applications. LSPR-based biosensors have the potential to enable the detection of diseases, including Border disease, for which effective and early detection methods are currently lacking. The present study aims to develop an LSPR-based-biosensor chip for the purpose of detecting BDV-DNA as an antigen. The biosensor chip is comprised of a gold nanorods (GNRs) patterned glass surface having microchannels with four inlets and four outlets.The GNRs were coated with BDV-specific single-strand DNA sequences for the biorecognition of BDV. Experimental results demonstrated the promising capability of the biosensor chip in detecting the target antigen, BDV-DNA, within the range between 10 pM and 100 pM.

Keyword: *Border disease virus, BDV Detection, Localized surface plasmon resonance, LSPR, Plasmonic sensor*

DRAFT

Silicon microtechnology based electrochemical biosensors

Vuslat Juska*, Alan O'riordan
Tyndall National Institute, University College Cork, Ireland

We aim to demonstrate several routes for the successful fabrication of silicon-based electrodes and multiplexed chips. We have established several flows based on photolithography, deposition, and etching to fabricate devices with varying sizes and dimensions[1-4]. Each design of devices was studied with morphological characterization techniques such as scanning electron microscopy (SEM), and then electrochemical methods. Following this, we have developed electrochemical sensing systems; chemical and biological.
One of the important aspects of using such small-scaled devices is the electrochemical reproducibility of the ultramicro surfaces, which clearly affects the analytical performance of the developed devices. Therefore, we investigated the effect of several cleaning protocols on the electrochemical characteristics of the ultramicro multiplexed device, which has a 1 μm-width and 45 μm-length[5]. We have developed and optimized the most efficient cleaning protocol for these devices and we assessed the surface morphology of the gold surface before/after cleaning via atomic force microscope (AFM). These devices are also compatible with SD card connections for future further miniaturization of the overall system with electronics attachment.
(I) Fabricated devices were used for the miniaturization of the hydrogen bubble template to explore the scaling-down limits of in situ template. By doing so, we have generated Cu and Au foam micro interfaces for sensing applications with excellent performance.
(II) Then, we focused on the on-chip assaying protocol development aiming for a universal platform of immunosensing and our central motivation was the development of an anti-biofouling coating, which will be biocompatible, easy-to-apply, and rapid for surface preparation.
We have shown the use of the anti-biofouling surfaces with undiluted serum samples. Importantly, we studied the benchmarking process of the assays we studied such as cortisol and haptoglobin. In order to establish a set of experiments, we collected milk samples from unhealthy cows on certain days and we studied the samples with ELISA. Following this, we measured the samples with the developed multiplexed device for the response comparison. The existence of such a successful biocompatible hydrogel-based interface with anti-biofouling and multiplexing capability may find its way to many more applications due to its broad applicability and biocompatible nature.

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Keyword: *microfabrication, biosensors, antifouling, multiplexed sensing*

DRAFT

ID: 22

Quantification of Adrenaline Levels during Cardiopulmonary Resuscitation in Patients

Ersin Yılmaz[*1], Mehmet Altuntaş[2], Derya Bal Altuntaş[3], Sema Aslan[4], Ercan Nalbant[5]

[1] Department of Statistics, Muğla Sıtkı Koçman University, Muğla, Türkiye

[2] Recep Tayyip Erdogan University, Faculty of Medicine, Department of Emergency Medicine, Rize, Türkiye

[3] Recep Tayyip Erdogan University, Faculty of Engineering and Architecture, Department of Bioengineering, Rize, Türkiye

[4] Department of Chemistry, Faculty of Science, Muğla Sıtkı Koçman University, Muğla, Türkiye

[5] Department of Emergency Medicine, Rize State Hospital, Rize, Türkiye

There is still no unity in the role of the administration dose and spontaneous use of exogenous adrenaline (AD) applied in cardiopulmonary resuscitation (CPR). This goal is to develop an electrode in exogenous blood cells in patients undergoing CPR.In this study, Core Shell Quantum Dots ZnS/CdSe Screen-printed electrode (CSQD ZnS/CdSe/SPE) was employed to measure modified AD by electrochemical method. Blood samples taken from 20 patients who underwent CPR in the emergency department were taken into tubes with EDTA, centrifuged, and the measurement process was started after they were kept at +4 ºC for 1 hour. The electrochemical behavior of AD on the modified electrode surface was investigated by differential pulse voltammetry (DPV), cyclic voltammetry (CV) and, electrochemical impedance spectroscopy (EIS) techniques. Under optimum conditions, the linear working range of the developed modified electrode was determined as 0.001-3 μM with DPV and 0.001-300 μM with EIS. The best detection limits (LOD) for this concentration range were found to be 2.79121E -08 μM according to the DPV method.

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Keyword: *Adrenaline, Cardiopulmonary resuscitation*

DRAFT

ID: 36

Development of Polymer/Lipid Based Janus Structures for Combined Therapy Applications

Burcu Ökmen Altaş*, Gökçe Dicle Kalaycıoğlu, Nihal Aydoğan
Hacettepe Üniversitesi, Kimya Mühendisliği Bölümü, Çankaya, Ankara, Türkiye

Structures developed as drug delivery systems are classified according to their distinctive features such as size, geometry, surface load, and production technique [1]. In addition to these features, delivery systems developed for combined therapy in recent years play an important role in overcoming multi-drug resistance, maximizing the therapeutic effect, minimizing drug-drug interactions, and reducing side effects [2]. Considering these functional properties, the most appropriate delivery system can be selected for the treatment of targeted diseases, and thus the effectiveness of the treatment can be increased. Studies have emphasized that traditional delivery systems are not efficient enough to simultaneously encapsulate and release multiple drugs with different physicochemical properties [1,2]. For this purpose, our study presents multifunctional, anisotropic, polymer/lipid micro/nanostructures that can simultaneously encapsulate drugs with different solubility into their specialized compartments and offer sequential release with independent release kinetics, unlike existing delivery systems. In our study, we worked with two model molecules such as methylene blue (hydrophilic agent) and resveratrol (hydrophobic agent). According to the results, it was observed that there was no significant difference in the release profiles of drug molecules between their single or double-charged formulations. These customizable structures can also be prepared in different sizes by changing the ratio of the two compartments with different physical and chemical properties and other production conditions for different applications.

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Keyword: *combined therapy, micro/nanohybrid structures, controlled release, drug delivery systems*

DRAFT

Dual-targeted and biocompatible nanoparticles loaded with esculetin and curcumin cause the death of pancreatic cancer cells

Ayse Nur Nurdogan[*1], **Rabia Sak**[2], **Gamze Ergin Kızılcay**[3], **Fatemeh Bahadori**[4], **Ayse Karatug Kacar**[1]

[1] *Istanbul University, Faculty of Science, Department of Biology, Istanbul, Türkiye*

[2] *Bezmialem Vakif University, Institute of Health Sciences, Department of Medicinal Biochemistry, Istanbul, Türkiye*

[3] *Istanbul University, Faculty of Pharmacy, Department of Analytical Chemistry, Istanbul Türkiye*

[4] *Istanbul University-Cerrahpasa, Faculty of Pharmacy, Department of Analytical Chemistry, Istanbul, Türkiye*

Pancreatic cancer is cured with surgical, adjuvant, and neoadjuvant therapies. However, remains challenging to treat since the disease can be diagnosed at late stages and only a small percentage of patients are eligible for surgical treatments [1]. There has been significant interest in using nanoparticle-based drug delivery systems against cancer in recent years [2]. Moreover, nanoparticles can be coated with different types of cell membrane components to improve drug stability and cell membrane penetration [3]. The aim of our study was to investigate the effects of dual targeting PLGA-nanocarriers on pancreatic cancer containing esculetin and curcumin, coated with membrane and cytosolic proteins, which were isolated from pancreatic islet-derived progenitor cells (PID-PC) and MiaPaCa-2 cells. In this context, esculetin, curcumin, and their combination were applied to the MiaPaCa-2 cells both naked and encapsulated in PLGA. Then, membrane and cytosolic proteins were isolated from PID-PC and MiaPaCa-2 cells, and isolated proteins were also applied to the cells as naked and incorporated with PLGA. The cell viability was analyzed with MTT. The sizes of all the nanoparticles formed were determined by the "Dynamic Light Scattering" method, and the drug release profile of the drug-containing nanoparticles was examined. As a result, naked esculetin caused cell death, while naked curcumin did not. However, combined esculetin and curcumin, PLGA-esculetin, and PLGA-esculetin+curcumin caused cell death. On the other hand, PLGA-curcumin decreased cell viability compared to the bare group. The effect of PLGA-esculetin+curcumin is similar to that of the naked esculetin+curcumin combination. There was no effect on cell viability when isolated proteins were applied to cells naked or coated with PLGA. PLGA-esculetin+curcumin with coated protein has significant effect on cell viability. The release behavior of Esculetin and Curcumin from PLGA and protein-coated PLGA nanoparticles is suitable for targeted cancer therapy. In conclusion, the novel nanoformulation designed by us for the first time by coating PLGA with PID-PC and MiaPaca-2 cell membrane and cytosolic proteins has provided important results for the treatment of pancreatic cancer. In light of these results, it can be concluded that the dual-targeted and biocompatible nanoparticle formulation is suitable for the targeted cancer therapy concept.

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Keyword: *Pancreatic cancer, Dual-targeted nanoparticles, esculetin and curcumin, cancer therapy*

DRAFT

ID: 74

Development And in Vitro Evaluation of Semi-Solid Lipid Nanoparticle Formulations

Seda Rençber, Hüsniye Hande Aydın*, Hazal Ezgi Gültekin, Zeynep Şenyiğit
Department of Pharmaceutical Technology, Izmir Katip Celebi University Faculty of Pharmacy, İzmir, Türkiye

Silymarin is a polyphenolic flavonoid derived from the milk thistle plant, scientifically known as Silybum marianum (1). Zinc oxide is one of the most important physical sunscreen filters (2,3). Solid lipid nanoparticles (SLNs) are a novel type of lipid nanoparticles used as drug carriers (4). The objective of this study was to formulate sunscreens incorporating a combination of silymarin and zinc oxide as active ingredients. UV spectrophotometric method was developed and validated for the measurement of silymarin in a PBS/ethanol (4:1) buffer. The semi-solid SLNs were prepared by high shear homogenization technique (5). The melted lipid (80-85ºC) was dispersed, in an aqueous solution of surfactants (80-85ºC) using a high-speed homogenizer. Particle size (PS), polydispersity index (PI) and zeta potential (ZP) were measured at 25°C by Photon Correlation Spectroscopy. F4, F7 and F11 coded blank formulations had smallest PS value among the prepared semi-solid SLNs. The silymarin loaded semi-solid SLNs were determined by in vitro characterization studies (PS, PI, ZP, drug loading efficiency, pH, viscosity, flow, mechanical property, spreadability and in vitro drug release). The PS of the Silymarin loaded formulations ranged from 346.0 to 662.3 nm, ZP values ranged from -22.1±0.23 mV to -23.7±0.95 mV, drug loading efficiency ranged from 74.01%–84.53%. The viscosity, flow and mechanical properties of the Silymarin loaded optimum formulations were found to be suitable for topical application. Afterwards, zinc oxide was added to the optimum formulations and the same characterization studies were carried out. As a result of the characterization studies, the Sun Protection Factor (SPF) of the ideal formulation consisting of F7 + 2% silymarin + zinc oxide was determined, and in vitro permeability studies were conducted. The in vitro permeability from mounting sheep ear skin was evaluated using the methodology of Franz diffusion cells. As a result of the permeability studies, F7 2% silymarin + zinc oxide formulation permeated through sheep ear skin at a rate of 0.365±0.103% in 24 hours. This study showed that SLN-based formulations are promising nanosystems for sunscreens.

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Keyword: *Semi-solid lipid nanoparticle, Nano Drug Delivery Systems, Silymarin, Zinc oxide, Sunscreen*

DRAFT

ID: 148

Bodipy-Included Polymeric Nanocapsules as Singlet Oxygen Generators: Investigating Their Photodynamic Actions

Seda Demirel Topel
Antalya Bilim University, Faculty of Engineering and Natural Sciences, Department of Electrical and Electronics Engineering, Döşemealtı, Antalya, Türkiye

Polymeric capsules have emerged as highly adaptable structures for delivering drugs, safeguarding the active substance from deterioration, enhancing biocompatibility, and enabling precise release. Specifically, if the active substance is insoluble in an aqueous solution, encapsulation presents a viable method to effectively incorporate these materials into physiological environments. In this study, a cellulose acetate (CA) polymer was employed to encapsulate an iodinated BODIPY derivative, serving as a photosensitizer (PS), through a precipitation technique with an encapsulation efficiency ranging from 50.8% to 71.8%. The capsule sizes may be varied from 221 nm to 1250 nm depending on the mixing rates. Nevertheless, the encapsulation facilitated the production of singlet oxygen ($^1O_2$) in aqueous media. The PS/CA capsules thus prepared exhibited stability over a duration of 10 days in a PBS buffer, exhibiting PdI values in the range of 0.264 to 0.698, and effectively generated $^1O_2$ when exposed to 532 nm LED light. Moreover, the thermal stability of the Bodipy PS exhibited a notable enhancement when coated with CA, escalating from temperatures ranging between 223°C to 240°C to approximately 400°C. This considerable advancement presents a valuable benefit in terms of prolonged utilization in PDT applications. This study delves into the influence of PS-loaded CA capsule size on solution stability, photophysical characteristics, encapsulation efficiency, thermal stability, leakage behavior, and PDT activity. Additionally, the research systematically investigated the generation of $^1O_2$ by the PS/CA capsules under varying doses of UV light.

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Keyword: *2,6-diiodo-Bodipy, singlet oxygen, polymeric nanocapsules*

DRAFT

Design and Fabrication of Dopamine-conjugated Polymeric Nanoparticles for Targeted Delivery to Breast Cancer Cells

Ummugulsum Yildiz[*1,2], Berrin Chatzi Memet[1,2], Orhan Burak Eksi[3,2], Turgay Yıldırım[4], Omer Aydın[1,2,5,6]

[1] Erciyes University, Biomedical Engineering, Kayseri, Türkiye
[2] Erciyes University, NanoThera Lab- ERFARMA-Drug Development and Implementation Center, Kayseri, Türkiye
[3] Erciyes University, ERNAM-Nanotechnology Research Center, Kayseri, Türkiye
[4] Saarland University, Helmholtz Institute for Pharmaceutical Research Saarland HIPS, Saarbrücken, Germany
[5] Erciyes University, ERFARMA-Drug Development and Implementation Center, Kayseri, Türkiye
[6] Erciyes University, ERKAM-Clinical Engineering Research and Application Center, Kayseri, Türkiye

Polymer-based nanoparticles have shown promise in improving the efficiency of anti-cancer drug delivery while reducing systemic side effects. However, non-specific drug release hampers their therapeutic efficacy. Active targeting using ligands has emerged as a strategy to enhance the specificity of drug delivery. Breast cancer cells often overexpress dopamine receptors, making them an attractive target for active targeting.
Here, diblock copolymers were synthesized using reversible addition−fragmentation chain transfer (RAFT) polymerization. Biocompatible poly (methyl methacrylate) (PMMA) was used as the hydrophobic block, while the hydrophilic block comprised statistical copolymers of biocompatible oligo (ethylene glycol)-methacrylate (OEGMA) and a dichloromaleimide functional monomer (DCMMA). The nanoprecipitation technique was used for the self-assembly of the synthesized block co-polymer library. Dopamine was conjugated on the surface of nanoparticles using DCMMA monomer, which reacts rapidly with amine-bearing molecules.
The resulting dopamine-conjugated polymeric nanoparticles (DCNPs) were characterized using dynamic light scattering (DLS) and transmission electron microscopy (TEM). The DCNPs exhibited excellent stability and monodispersity. The dopamine conjugation efficiency was high, and the DCNPs demonstrated specific binding to dopamine receptors in breast cancer cells according to flow cytometry analysis.
This study successfully synthesized and characterized DCNPs as targeted drug delivery systems for breast cancer. The conjugation of dopamine offers the potential to enhance the therapeutic efficacy of anti-cancer drugs by specifically targeting breast cancer cells.

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Keyword: *Reversible Addition-Fragmentation Chain Transfer Polymerization (RAFT), Polymeric Nanoparticles, Active Targeting, Dopamine*

DRAFT

Development of Gold Nanoparticles for Drug Delivery Against Ovarium Cancer

Gizem Kursunluoglu[*1], Cansu Umran Tunc[1,2], Munevver Akdeniz[1,3], Aybuke Ulku Kutlu[1,3], Muhammed Ihsan Han[4,5], Mukerrem Betul Yerer[6,7], Omer Aydin[1,3,8,9]

[1] NanoThera Lab, Drug Application and Research Center (ERFARMA), Erciyes University, 38039, Kayseri, Türkiye

[2] Utah Center for Nanomedicine, University of Utah, Salt Lake City, UT, 84112, USA

[3] Department of Biomedical Engineering, Erciyes University, 38039, Kayseri, Türkiye

[4] Department of Pharmaceutical Chemistry, Erciyes University, 38039, Kayseri, Türkiye

[5] Auckland Cancer Society Research Centre, University of Auckland, 92019, Auckland, New Zealand

[6] Drug Application and Research Center (ERFARMA), Erciyes University, 38039, Kayseri, Türkiye

[7] Department of Pharmacology, Erciyes University, 38039, Kayseri, Türkiye

[8] Clinical Engineering Research and Implementation Center (ERKAM), Erciyes University, 38040, Kayseri, Türkiye

[9] Nanotechnology Research and Application Center (ERNAM), Erciyes University, 38040, Kayseri, Türkiye

The development of gold nanoparticles (GNPs) for drug delivery holds great promise in improving therapeutics' targeted delivery, controlled release, and bioavailability. Nanotechnology has been widely explored and utilized to overcome the limited dispersion or solubility issues associated with hydrophobic drugs. Scientists have developed various strategies to enhance hydrophobic drugs' solubility, stability, and bioavailability, leading to improved therapeutic outcomes by employing nanotechnology[1]. Naproxen is the one of the most important non-steroidal anti-inflammatory drugs (NSAIDs) and has hydrophobic properties. Various studies show that the use of NSAIDs shows effectiveness in different types of cancer and is inversely proportional to the incidence of some cancer types[2-3]. In this present study, naproxen derivative chemotherapy drugs with very low water solubility were synthesized and their activities in terms of anti-cancer efficiency were investigated in OVCAR-3 (ovarian cancer cells). Low aqueous solubility is the main problem in the pharmaceutical industry regarding drug development. Different techniques have been used for the enhancement of the solubility of the drug. In particular, nanotherapeutics are being developed to increase the bioavailability and solubility of hydrophobic compounds. In this study, drug delivery to GNPs was carried out in order to overcome the low solubility problem of synthesized naproxen derivative drugs (NDDs) in water.
In order to increase the water solubility of NDDs, AuNPs were first synthesized by using sodium citrate as a reductant. NDDs were conjugated to synthesized AuNPs and characterizations were performed by DLS, UV/Vis spectroscopy, NTA and zeta sizer. While the toxicities of free drug and drug-AuNP conjugations were investigated in-vitro ovarian cancer, on the other hand, cellular cycles and apoptosis activities were also investigated by flow cytometry. By conjugating NDDs to AuNP, their solubility in water was increased. It was determined that the cytotoxic effect of conjugated drugs was higher in OVCAR-3 cells compared to their free forms. In addition, it was determined by flow cytometry that the conjugated drugs developed triggered apoptosis and affected the cell cycle.
It has been shown that the bioavailability of hydrophobic drugs and the NDDs synthesized in the study increase with their water solubility, increasing their effectiveness.

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Keyword: *AuNPs, limited water solubility, NSAIDs, OVCAR-3 cell*

DRAFT

Optimization of Cell Encapsulation in Picolitre Capsules in a Droplet Based Microfluidic System Towards 3D Cell Culture for Monitoring Drug Effects

Elif Gökçen Dilci*, Selis Onel
Hacettepe University, Department of Chemical Engineering, Ankara, Türkiye

Quality and reliability of the technologies developed as part of tissue engineering applications for the medical and pharmaceutical industries are tested by employing bulk amount of cells. Two-dimensional (2D) cell culture systems are not adequate in resembling the response of the cells to various media and drugs as mass transport requires long diffusion distances and is limited to two directions. Therapeutic agents for cancer treatment have been applied successfully in three-dimensional (3D) culture models by using nanodrug delivery systems[1]. Miniaturized systems, such as microfluidic devices, can mechanically constrain cells in microchannels[2], are easier to monitor on a microscope, offer better control over transport phenomena[3], and can better imitate in-vivo conditions[4]. The scope of this study is to design a simple continuous microfluidic platform for 3D cell culture. We designed a two-step microfluidic system, where the first part includes droplet formation and encapsulation of cells and the second includes stabilization of the microcapsules. Ensuring the same conditions for each microcapsule is critical and depends on the uniformity of their size. To reach this goal in the first part, we used a droplet-based two-phase microfluidic device with an x-junction of 100-micron. The number of cells captured in a droplet may vary depending on the flow rate of each phase during encapsulation rendering it as a stochastic process. We optimized the flow conditions for obtaining uniform droplets and interdroplet distances with the desired sizes towards cell encapsulation. We investigated the effects of mass transfer based on the solubility between the two phases on droplet size near the metabolic temperature 37°C. In the second part, the cell encapsulating droplets are transferred to microwells of 1000-micron depth and 500-micron diameter. We observed that droplets remained stable and proved that this design can be further improved and used for 3D culture of cells. By providing systematic information for cell encapsulation and developing the microwell design, we aim to present a 3D cell culture platform that can be used for monitoring cell response to nanodrug delivery systems.

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Keyword: *Drug delivery, Droplet based microfluidics, 3D Cell culture, Cell encapsulation*

DRAFT

Formulation and Evaluation of Orally Disintegrating Films For Antipsychotic Treatment

Hazal Ezgi Gültekin
İzmir Katip Çelebi University, Faculty of Pharmacy, Department of Pharmaceutical Technology, İzmir, Türkiye

Schizophrenia is a chronic psychiatric illness accompanied by various symptoms such as hallucinations, delusions, and cognitive-social disorders. Orally disintegrating films (ODFs) are drug delivery systems that allow rapid disintegration when applied on the tongue or release the drug it contains and provides its swallowing with saliva after disintegration (1). Risperidone is a second-generation antipsychotic drug that is used for the treatment of schizophrenia and bipolar disorder. Patients with schizophrenia resist taking drugs (2, 3). Therefore, ODFs containing risperidone are promising systems for these specific patient groups. The aims of the current study were to manufacture risperidone ODFs and to characterize the prepared films.
ODFs including risperidon and the mixture of the polymers Klucel™ and Kollidon®30 in different ratios were prepared by the solvent casting method. Six different formulations were produced by combining polymers in different ratios. The viscosities of the polymer solutions were measured using a rotational viscometer. In order to measure the thickness of obtained film formulations a digital micrometer was used. The disintegration time of the ODFs was measured in a pH 6.8 buffer solution and the measurements were carried out using the petri dish method. The mechanical properties of the obtained film formulations were evaluated via a texture analyzer. For this purpose, the elongation % of the ODFs was measured. The viscosity values of polymer solutions were found to be between the range of 5.3±0.4-13.3±0.4 cP. The thickness of the ODFs was found to be between 23.7±2.8 and 49.8±9.8 µm. In the present study, all the film formulations disintegrated under 40 sec. Thus, the disintegration properties of the films met the criteria involved in European Pharmacopoeia. The prepared film formulations exhibited acceptable elongation % values for ODFs.
In conclusion, risperidone-loaded ODFs were fabricated and characterized successfully. The results obtained from the characterization studies of the film formulations also showed their suitability for the intended use to increase patient compliance in schizophrenia or other neurological disorders.

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Keyword: *Orally disintegrating films, Risperidone, ODF*

DRAFT

ID: 261

In Vitro Investigation of a New Polymeric Carrier for mRNA Delivery

Müge Savaş*[1], Esra Katkat[2], Şüheyda Yaşarbaş[1], Ece İnal[1], Güneş Özhan[1], Gülistan Meşe-Özçivici[1], Volga Bulmuş[1]

[1] Izmir Institute of Technology, İzmir, Türkiye

[2] Izmir Biomedicine and Genome Center, İzmir, Türkiye

Messenger RNA (mRNA) is a crucial class of nucleic acid therapeutics that can encode therapeutic proteins without integrating into DNA, making it a safe and effective gene therapy tool. Delivering mRNA into target cells poses challenges due to a number of reasons including instability against nucleases, low cellular uptake and inability to escape from endolysosomal pathway. Among non-viral systems, lipid nanoparticles (LNPs) are one of the important mRNA delivery systems. However, due to difficulties in targeting organs other than RES, low stability during transport and storage, difficulties in large-scale reproducible production, and difficulties in chemical modifications, researchers have focused on polymers and polymeric nanoparticles as alternatives to LNPs. The use of polymers, particularly poly(cations), like poly(ethylene imine) (PEI), has shown promise in delivering various nucleic acid therapeutics, including mRNA. A new polymer, P(AEAEMA), has also demonstrated potential in delivering siRNA and plasmid DNA in previous research (Zelcak et al. 2021). In this study, we aim to reveal the mRNA delivery potential of this new cationic polymer, P(AEAEMA). In order to accomplish this, stealth block copolymers, P(OEGMA)-b-P(AEAEMA), having varying chain lengths, were first synthesized via reversible addition-fragmentation chain transfer (RAFT) polymerization. Two copolymers with different cationic block lengths ($P(OEGMA)_{42}$-b-$P(AEAEMA)_{48}$ and $P(OEGMA)_{42}$-b-$P(AEAEMA)_{71}$) were complexed with GFP-encoding mRNA and characterized using various techniques including gel electrophoresis, dynamic light scattering, and zeta potential measurements. Using HEK293T human embryonic kidney and L929 murine fibroblast cell lines, the transfection efficiency and cytotoxicity of the polymer-mRNA complexes were assessed in vitro via fluorescence microscopy and Alamar Blue assay, respectively. As a result, successfully synthesized block copolymers complexed with eGFP encoded mRNA at N/P ratios starting from 1. The hydrodynamic size of polyplexes was found to be less than 150 nm. Their surface charges were slightly negative. The transfection efficiency of P(OEGMA)-b-P(AEAEMA) block copolymers varied based on the type of cell line tested. $P(OEGMA)_{42}$-b-$P(AEAEMA)_{48}$ and $P(OEGMA)_{42}$-b-$P(AEAEMA)_{71}$ block copolymers have shown 54 and 64 % mRNA delivery on HEK293T while golden standard polymer, branched PEI has shown 23 %. $P(OEGMA)_{42}$-b-$P(AEAEMA)_{48}$ and $P(OEGMA)_{42}$-b-$P(AEAEMA)_{71}$ block copolymers have shown 61 and 56 % mRNA delivery on L929 cells while golden standard polymer, branched PEI has shown 41 %. Increased transfection efficiency for HEK293T was achieved with tolerable cytotoxicity when using the copolymer with a longer cationic block. Also,similar transfection efficiency for both block copolymer complexes were observed in L929 cells without any toxicity. However, branched PEI showed no appreciable efficacy because to its serious cytotoxicity. In conclusion; $P(OEGMA)_{42}$-b-$P(AEAEMA)_{48}$ block copolymer is a promising new agent for mRNA delivery and deserves further investigation.

Acknowledgement:
The authors acknowledge the 2210-C Domestic Graduate Scholarship Program, Scientific and Technological Research Council of Turkey (TÜBİTAK) and İYTE BAP (2022İYTE-2-0038).

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Keyword: *mRNA Delivery, Gene Delivery, Cationic Polymers, Gene Therapy*

DRAFT

ID: 284

Lipid Magnetic Nanovectors against Glioblastoma Multiforme

Melike Belenli Gümüş*[1,2], Carlotta Pucci[1], Daniele De Pasquale[1], Attilio Marino[1]

[1] Istituto Italiano di Tecnologia, Smart Bio-Interfaces, Viale Rinaldo Piaggio 34, 56025 Pontedera, Pisa, Italy

[2] Scuola Superiore Sant'Anna, The Biorobotics Institute, Viale Rinaldo Piaggio 34, 56025 Pontedera, Italy

Glioblastoma multiforme (GBM) is the most aggressive brain tumor that originates from glial cells. The median survival rate of GBM patients is approximately 16.9 months and less than 5% of patients can live longer than 5 years due to nearly 90% recurrence rates. Current treatments include surgical resection followed by chemo-radiotherapy; however, these are not sufficient to increase the overall survival rate of patients due to frequent recurrences, invasiveness and drug resistance of GBM[1]. Novel drug delivery strategies based on nanotechnology have great potential in increasing the efficacy of cancer treatments by using nanocarriers loaded with therapeutic agents[2]. Superparamagnetic iron oxide nanoparticles (SPIONs) with an effective coating/functionalization can be targeted to tumor cells and induce local magnetic hyperthermia upon alternated magnetic field (AMF) stimulation. Coating the surface of SPIONs with lipids have many advantages. They increase the ability to cross blood-brain barrier for brain tumor targeting, the surface can be easily modified in order to achieve the desired targeting and chemotherapeutic drugs can be loaded together with SPIONs to construct lipid magnetic nanovectors (LMNVs) in order to benefit from synergistic effect of hyperthermia and chemotherapy[3]. In this work, novel lipid magnetic nanovectors (LMNVs) were developed and tested in vitro against a GBM cell line, U87 MG. In order to achieve a synergistic therapy, SPIONs were encapsulated within lipid nanovectors mainly composed of sphingomyelin, a sphingolipid found in animal cell membranes and derived from porcine brain, along with a chemotherapeutic drug, regorafenib. The magnetic properties of these nanostructures were studied under AMF stimulation. The synergistic effect of magnetic hyperthermia combined with chemotherapy was studied on U87 MG cell line. Promising results demonstrated that LMNVs induced mild hyperthermia and anticancer effects (characterized by the reduction of the proliferation rate and expression of heat shock proteins such as HSP70) against U87 MG cells.

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Keyword: *lipid nanocarriers, superparamagnetic iron oxide nanoparticles, glioblastoma multiforme, magnetic hyperthermia*

DRAFT

Encapsulation of probiotic bacteria by electrospraying in a double emulsion (W1/O/W2) loaded alginate beads to improve the gastrointestinal survival and thermal stability

Canan Yağmur Karakaş[*1], Ruşen Metin Yıldırım[1], Ayşe Karadağ[2]

[1] *Yıldız Technical University, Food Engineering Department, Chemical, and Metallurgical Engineering Faculty, Yildiz Technical University, Istanbul, Türkiye*

[2] *Yıldız Technical University,Food Engineering Department, Chemical, and Metallurgical Engineering Faculty, Yildiz Technical University, Istanbul, Türkiye*

The probiotic properties and health-related beneficial effects of L. plantarum isolates exhibiting high tolerance to gastric transit, colonization in the GI tract, a dose-dependent reduction in irritable bowel syndrome symptoms, and a reduction in certain risk factors for coronary artery disease have been previously demonstrated. For those benefits to be demonstrated, the cells must reach the GI tract alive at a level higher than approximately 10^7colony-forming units (CFU); therefore, the cells must be administrated through a delivery system tolerant of highly acidic conditions in the stomach and the high concentration of bile salts in the small intestine. Additionally, if those bacteria were used in food fortification, the probiotics should have higher viability against thermal conditions encountered in food processing. Therefore, encapsulation methods comprise promising strategies to provide effective physical barriers for probiotics to resist adverse external conditions occurring in food processing and during their passage through the GI tract.

The present study has proposed an encapsulation system to improve the thermal and GI stability of L. Plantarum ELB90, by loading the bacteria in the first layer (W1/O) of the double emulsion (W1/O/W2) system and incorporating this emulsion in Ca-alginate hydrogel beads. Inclusion of double emulsion into the electrosprayed beads resulted in less wrinkled and smoother surfaces, and lower gel strength compared to emulsion-free control beads. When the emulsion-filled hydrogel beads (emulbeads)were exposed to the simulated in vitro GI digestion, a higher survival rate (up to 84%) was observed, which was related to the hindering the action of digestive enzymes and bile salts through the bacteria encapsulated in the inner aqueous core of double emulsion in the gelled network. Similarly, in emulbeads, higher thermal stability of probiotic bacteria was determined because of the reduced heat transfer by eliminating the water surrounding the bacteria. The results of the present study may lead to the design and creation of more effective delivery systems for the addition of probiotics to food.

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Keyword: *probiotics; inulin; chitosan; viability; encapsulation; extrusion*

DRAFT

Tungsten Disulfide Metalens in Visible Region

Mustafa Kırlar[*1], Ekin Aslan[2], Erdem Aslan[1], Mustafa Türkmen[1]
[1] Erciyes University, Kayseri, Türkiye
[2] Kayseri University, Kayseri, Türkiye

Metamaterials are artificial electromagnetic environments consisting of periodic metal or dielectric structures on a smaller scale (sub-wavelength) than the working wavelengths [1]. Dielectric/metal structures, which are the building blocks of these materials, which are composites with artificial periodic array structure exhibiting extraordinary optical properties, can often resonate against incoming electromagnetic fields [2-4]. In this study, focusing of light is achieved with tungsten disulfide (WS_2), which is an anisotropic material, unlike metal or dielectric metamaterials. The focusing performance of the lens with WS_2 has been numerically simulated using the Pancharatnam-Berry (P-B) phase concept. The structure is formed by arranging 550 nm thick WS_2 nanofins on a 500 nm silicon nitride (SiO_2) substrate according to the P-B phase concept. Metalenses at designed wavelengths λ_d = 465 nm, 532 nm and 633 nm are capable of focusing incident light.

Acknowledgment:
This work is supported by the Scientific and Technological Research Council of Turkey (TÜBİTAK− Project No: 121E518).

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Keyword: *metalens, tungsten disulfide, nanooptics*

DRAFT

ID: 76

Silca mesoporous materials in speckle fields

Mohammad Hadi Sadri*[1], Ramin Jamali[1], Fozia Rehman[2], Ali-Reza Moradi[1]
[1] Department of Physics, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran
[2] Interdisciplinary Research center in Biomedical Materials (IRCBM), COMSATS University Islamabad, Lahore Campus, Pakistan

Optical tweezers (OT) is an elegant tool for investigating and manipulating of micro and nano objects. It has numerous applications in multiple fields, such as biomedicine, statistical physics, soft matters, and nanoscience. Conventional OT is performed through focusing a laser beam with a Gaussian intensity profile through a high NA microscope objective. A promising extension of OT is to use a speckle pattern (SP) directly on the sample, which is called speckle tweezers (ST). SP is a random intensity distribution formed by the coherent superposition of several light waves, and contains multiple intensity grains surrounded by dark interconnections. One can manipulate, trap, and control, number of particles simultaneously, either in bright grains, for high refractive index particles, or in dark regions, for low index ones. Due to the main advantages of speckle field over conventional OT, such as easy implementation and multiple trap sites, we can perform basic optical manipulation tasks such as guiding, sorting, and trapping. In this research, we experimentally demonstrate the use of ST in microfluidic channels for sieving, restricting, and sorting of mesoporous silica particles. These particles are an important class of materials having pores in range from 2 to 50 nm in diameter, with applications in nanoscience like targeted drug delivery, dye adsorption, and ion separation.

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Keyword: *Optical manipulation, Speckle tweezers, Mesoporous silica particles*

DRAFT

Quantum Enhanced Raman Spectroscopy (QUPERS): Fano Resonance and Quantum Emitters for Ultra-High Raman Enhancement Factors

Batuhan Balkan[1], Deniz Eren Mol[2], Özge Demirtaş[3], Duygu Gümüş[4], Tarık Taner Aytaş[5], Emren Nalbant[4], Ramazan Şahin[5], Mehmet Emre Taşgın[6], Alpan Bek[*1,7]

[1] Middle East Technical University Physics Department, Ankara, Türkiye
[2] Hacettepe University Nanoscience and Nanomedicine Program, Ankara, Türkiye
[3] Middle East Technical University Micro and Nanotechnology Program, Ankara, Türkiye
[4] Middle East Technical University Chemistry Department, Ankara, Türkiye
[5] Akdeniz University Physics Department, Antalya, Türkiye
[6] Hacettepe University Institute of Nuclear Sciences, Ankara, Türkiye
[7] Center for Solar Energy Research and Applications (ODTÜ-GÜNAM), Ankara, Türkiye

Plasmonic nanostructures allow light to be confined to sub-wavelength regions (hot-spots) while increasing field strength and allow for Fano resonances. This does not only extend lifetime of excitation but also increases Raman signals from molecules located in hot-spots to boosted levels that allow for molecules to be Raman imaged at a high resolution. In quantum enhanced Raman spectroscopy (QUPERS)**,** lifetime extension due to Fano resonances is utilized (Postaci et al., 2018; Limonov et al., 2017; Luk'yanchuk et al., 2010). We have theoretically shown that Raman signal can be increased by thousands of times via interference of multiple conversion paths via an auxiliary molecule while hot-spot intensity is kept nearly constant. So, Raman-active molecules can be imaged with low excitation intensities without hazard of damage. Here we report both theoretical and experimental aspects. Numerical solutions of Maxwell's equations are performed for different sizes and shapes of nanostructures such as nano-stars, nano-rods, metal-coated AFM tips to determine the plasmon modes using MNPBEM (Hohenester ve Trügler, 2012). Next, QUPERS effect for the nanostructures are explored by theoretical simulations with/without auxillary-molecule to obtain the highest possible enhancement factor. Resulting near-field strengths for different Raman modes are calculated to obtain the most suitable Raman molecule.

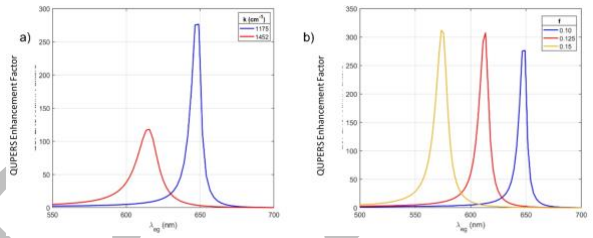

Figure 1: For λ_{Raman}=660 nm a) QUPERS enhancement factor for different Raman lines at a coupling strength of f = 0.1 and b) QUPERS enhancement factor for k = 1175 cm^{-1} at different coupling strengths.

Simulations show that in addition to the regular surface enhanced Raman spectroscopy (SERS), the QUPERS can further increase the Raman signals by a factor of 10^2.

Investigations performed for gold coated Si AFM tips show that QUPERS is also possible in a tip enhanced Raman spectroscopy (TERS) scenario (which we call **QUTERS**).

The novel physics behind QUPERS/QUTERS can be applied to other nonlinear optical processes such as SHG as well as in Raman imaging technology especially for biological imaging. Furthermore, boosting the TERS signal further with the help of an auxillary molecule in QUTERS can provide for Raman imaging at the molecular resolution.

Acknowledgment:
Support from the Scientific and Technological Research Council of Turkey (TÜBİTAK) under grant nr. 119F101 is greatly acknowledged.

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Keyword: *Raman, Quantum enhancement, Fano*

DRAFT

ID: 192

Polyethylenimine Assisted Optimization of Inverted Green-Emitting QLED

Ahmet Faruk Yazıcı[*1], Sema Karabel Öcal[2], Talha Erdem[2], Ayşenur Biçer[3], Ramis Berkay Serin[4], Rifat Kaçar[4], Esin Uçar[4], Alper Ülkü[4], Evren Mutlugün[2]

[1] Abdullah Gül University, Nanotechnology Engineering Department, Kayseri, Türkiye.
[2] Abdullah Gül University, Electrical & Electronics Engineering Department, Kayseri, Türkiye.
[3] Middle East Technical University, Electrical & Electronics Engineering Department, Ankara, Türkiye.
[4] ASELSAN, Microelectronics, Guidance and Electro-Optics Business Sector, Ankara, Türkiye.

Quantum-dot LEDs (QLED) is the most prominent alternative to OLEDs for especially display applications due to high color purity, emission tunability and solution processability, which offers wide range of fabrication methods. Inverted QLED architecture has drawn a growing interest given to several advantages in active matrix displays. Contrary to conventional devices in which transparent electrode is the anode, inverted devices emit from the cathode side. By facilitating a connection between the cathode and the drain line of thin-film transistors in the display, gate-source voltage range is unrestricted by electrical characteristics of QLEDs. [1] In order to improve the charge balance and energy-band alignment between electrodes, carrier transport layers and emissive layer, polyethylenimine (PEI) is utilized in inverted devices. PEI acts as an interfacial dipole layer due to lone pair of electrons in the amine group and lowers the hole-injection barrier. [2] Additionally, it could act as an insulator or passivate electron traps on QDs given to the electron donor properties of the amine group. [3] In our study, we fabricated devices systematically to investigate the two possible effects of the PEI layer by placing it on the only anode, only cathode and both sides of the QD layer. Then, the effect of thickness was studied by changing the concentration of the solution-processable PEI. As a result, it has been shown that employing PEI between QD and hole-transport layer with a concentration of 0.05 wt% led to 3-fold increase in the EQE, maximum luminance and current efficiency compared to the control device with the architecture of ITO/ZnO/QD/PEI/PVK/PEDOT:PSS/Al.

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Keyword: *qled, inverted, polyethylenimine*

DRAFT

Quantum Enhanced Raman Spectroscopy (QUPERS): Au Nanostar Synthesis with Quantum Emitter Coupling and Raman Spectroscopy Analysis

Batuhan Balkan[*1], **Duygu Gümüş**[2], **Özge Demirtaş**[3], **Deniz Eren Mol**[4], **Tarık Taner Aytaş**[5], **Emren Nalbant**[2], **Ramazan Şahin**[5], **Mehmet Emre Taşgın**[6], **Alpan Bek**[1,7,3]

[1] *Middle East Technical University Department of Physics, Ankara, Türkiye*
[2] *Middle East Technical University Department of Chemistry, Ankara, Türkiye*
[3] *Middle East Technical University Micro and Nanotechnology Program, Ankara, Türkiye*
[4] *Hacettepe University Department of Nanotechnology and Nanomedicine, Ankara, Türkiye*
[5] *Akdeniz University Department of Physics, Antalya, Türkiye*
[6] *Hacettepe University Institute of Nuclear Sciences, Ankara, Türkiye*
[7] *Center for Solar Energy Research and Applications (GÜNAM), Ankara, Türkiye*

Plasmonic structures allow incoming light to be confined to sub-wavelength volumes while increasing its field strength and allow Fano resonances to be observed. In Fano enhanced Raman (QUPERS) experiments, effect of prolonging plasmon lifetime of Fano resonances is used (Postaci et al., 2018 ;Limonov et al., 2017; Luk'yanchuk et al., 2010). We have theoretically shown that Raman signal can be increased by thousands of times via interference of multiple conversion paths (Fano) with auxiliary molecule while hot-spot intensity is kept nearly constant. As this is realized, Raman-active molecules can be imaged with lower laser or hot-spot intensities without damaging them. This project consists of theoretical and experimental parts. Experimental part fallows suit the results coming from the theoretical part, QUPERS enhancement is obtained best for Au nano-star particles between the sizes of 30-150 nm with 660nm laser source and for the Stokes-shifted Raman mode of 1175 cm^{-1}. Gold nano-star nanoparticles are synthesized using surfactant directed seed growth method (Elci et al., 2018; Nalbant Esenturk and Hight Walker, 2009; Yuan et al., 2012). Resulting nanoparticles are characterized by UV-Vis spectroscopy and FIB (focused ion beam) microscopy. As auxiliary molecule (quantum emitter QE, quantum dot QD) cadmium selenide zinc sulfide (CdSe/ZnS) core/shell (HiQ Nano) is used. Coupling between quantum emitters and Au nano-stars are characterized by UV-Vis spectrometry, FIB and EDX measurements and can be observed in Figure 1.

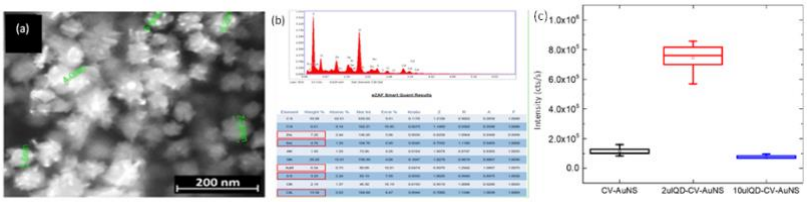

Figure 1: Results of QD and Au Nano-star coupling **a)** FIB images of QD decorated AuNP's, **b)** EDX results of QD decorated AuNP's, **c)** Average Intensity Raman Spectrums of Different Mixtures Between Raman Shift of 1120 $cm^{-1}$and 1220 cm^{-1}: 5 µl 10^{-6} M CV + 10 µl AuNS mixture with 0, 2 and 10 µl QD@ethanol.

Fallowing theoretical results CV (crystal violet) molecule is used. Different Laser sources with different ratios of Au particles to QD particles are investigated for QUPERS enhancement in Raman Signal. Highest enhancement factors are obtained for 660nm laser source with 67nm average AuNP size. After FIB measurements enhancement factors are calculated as 5.5 x 10^7. Effects of QUPERS compared to SERS is shown in Figure 1c.

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Keyword: *Quantum Optic, Quantum Plasmonic, Quantum Path Interference, SERS, TERS*

DRAFT

ID: 229

Distributed Bragg gratings containing photo-sensitive SiON-doped silicon on flexible substrates against counter-feit applications

Ali Karatutlu[*1], **Timuçim Emre Tabaru**[2], **Zehra Gizem Mutlay**[1], **HamidReza Bahari**[1], **Bülend Ortaç**[1]
[1] *Bilkent University UNAM, Ankara, Türkiye*
[2] *Sivas University of Science and Technology, Sivas, Türkiye*

Bragg gratings (BGs) are emerging for advanced applications in lasers and spectrometers and can preserve embedded information using photosensitive parts. This study demonstrates the first study on developing distributed BGs containing photosensitive silicon oxynitride-doped silicon as a versatile material on flexible substrates fabricated using a plasma-enhanced vapor deposition system and their use in preserving CO_2 laser inscribed micro-information. The fabricated BGs were characterized by UV-VIS-NIR reflection spectroscopy, cross-sectional scanning electron microscopy, vibrational spectroscopy probes before and after laser irradiations, laser-scanning optical microscopy, X-ray photoelectron spectroscopy and X-ray diffraction studies. The laser-inscribed BGs show the desired message at certain angles of incident light or polarizations due to their multispectral reflection features.

Keyword: *silicon oxynitride, flexible waveguide, Bragg grating, against counterfeit applications*

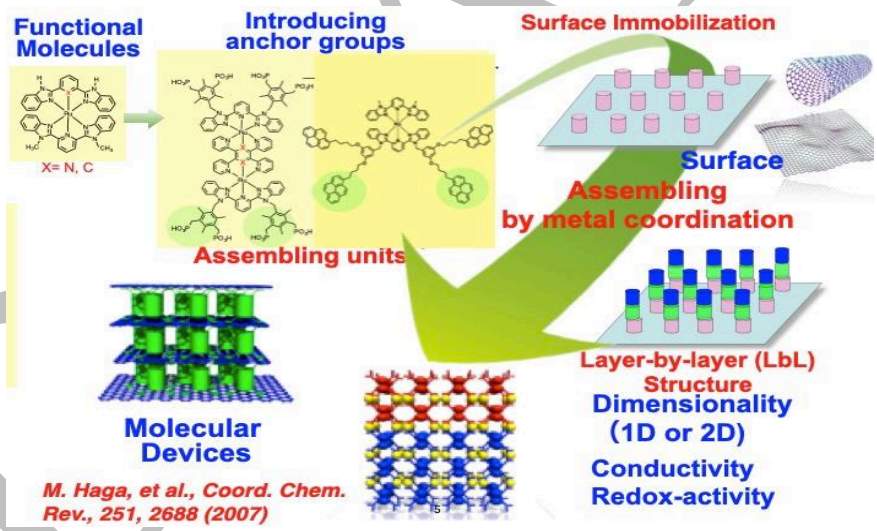
DRAFT

ID: 30

Design and Development of Functional Nano Films based on Redox-active Complexes on Surface

Masa-Aki Haga
Tokyo Institute of Technology / Chuo University, Tokyo, Japan

In creating devices that mimic the human senses, supramolecular chemistry on surfaces plays an important role in providing intelligent surfaces that interface with the outside world through functions such as sensing, energy conversion, and information storage.[1] In this study, layer-by-layer (LbL) coordination network films composed of ruthenium complexes were used to develop molecular electrochemical devices on ITO electrodes (see the image below).[2] Surface LbL nanofilms on ITO surface were prepared by SURMOF method using redox-active Ru complexes with phosphonic acid groups as molecular units and zirconium (IV) ions as a coordination binder for the sequential assembling.[2] The LbL film with homo-layer structure consisting of the same molecular units was grown on an ITO electrode, and the thickness dependence of the electron transfer rate at the electrode was investigated. The long-range electron transfer through stepping-stone mechanism plays an important role in LbL nanofilms composed of redox-active Ru complexes.[3] The homo-layer film in electrolyte solution can also be applied to electrochemical energy storage devices since ion transfer occurs into the film upon redox, thereby the storage capacity was increased by increasing the number of layers in the film.[4] Furthermore, heterojunction thin films consisting of two Ru complexes with different redox potentials exhibit electrochemical rectification on I-V curves. In the rectifying behavior at the heterojunction interface, the charge is trapped by the energy barrier at the interface, but when light irradiation is applied to this interface, the direction of the photocurrent reverses before and after energization. By utilizing the charge trapping state at the heterojunction interface, the heterojunction nanofilm works as a photo-responsive memory device that uses light as an external signal.[5]



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Keyword: *Surface supramolecular chemistry, Layer-by-layer assembly, Metal complexes, photo responsive memory film, Redox-active film*

DRAFT

ID: 275

Investigation of OFETs with Interdigitated ITO Source and Drain Contacts Fabricated by Optimizing Settings of The Laser While Cutting Vinyl Tapes

Hakan Bozkurt*, Canan Varlıklı
Department of Photonics, Izmir Institute of Technology, Urla-Izmir, Türkiye

Organic electronic devices are popular research topics as they can be produced with simpler production techniques and with a lower budget than the electronic devices used today [1]. OFET is one of the well-known and essential applications of organic electronics. OFETs have great potential for memory devices, display technologies, sensors, and mobility measurements of materials [2]. In many papers, P3HT was used for the organic semiconductor active channel layer and according to the literature commonly used drain and source contacts of P3HT-based OFETs are selected as gold [3]. In this work, as drain and source contacts, interdigitated patterns of Indium Tin Oxide (ITO) were applied. To prepare ITO electrodes, photolithography [4] and sputter [5] techniques may be used. An easier and faster approach with the help of laser-cut vinyl tapes was tried for fabricating ITO/P3HT/PMMA/Al structured OFET. Active layer P3HT and, dielectric material PMMA were spin-coated, and Al as the gate electrode was thermally evaporated. Measurements were done in an inert atmosphere glovebox system. Benefiting from the absorption ability of P3HT [3] and transmittance of ITO substrate, the drain current of fabricated OFETs could be modulated by both electricity and light.

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Keyword: *OFETs, ITO Pattern, Laser Cut, PVC Tape*

DRAFT

ID: 152

Fiber Based Triboelectric Nanogenerators for Human Machine Interface

Doga Doganay*, Onur Demircioğlu, Murathan Cugunlular, Melih Ogeday Cicek, Onuralp Cakir, Huseyin Utkucan Kayaci, Simge Cinar Aygun, Husnu Emrah Unalan
Department of Metallurgical and Materials Engineering, METU, Ankara 06800, Türkiye

The rapid advancements in communication technologies, coupled with interdisciplinary collaboration within fields such as the internet of things, artificial intelligence, and data science, have made significant contributions to the progress of wearable electronic devices. At present, these devices rely on rechargeable batteries and capacitors for power supply. However, the drawbacks associated with these power sources impede the widespread adoption of wearable electronics. Primarily, their weight and bulkiness undermine user comfort, while their limited capacity necessitates frequent recharging, posing potential risks. In this regard, triboelectric nanogenerators (TENGs) emerge as a promising solution, offering reliable, sustainable, and economically viable power generation. Here in this work, we have fabricated core-shell fibers using co-axial wet spinning and used them for TENGs. The conductive core of the fibers was composed of composites of carbon black (CB), silver nanowires (Ag NWs) and thermoplastic polyurethane (TPU), while the dielectric shell was bare TPU. Core-shell fibers of 1 km length were easily produced by coaxial wet spinning in a matter of hours on a laboratory scale. An open circuit voltage (Voc) and short circuit current (Isc) of 2V and 43 nA the were obtained from 1 cm long core-shell fiber TENGs, respectively. Fibers showed superior stretchability up to 450% strain (stable TENG performance up to 50% strain) and washing stability up to 20 wash cycles. Fibers were also woven into fabrics with different weaving patterns and their output TENG performances were compared. 4 cm^2 woven fabrics with a 1/1 wrap to weft ratio showed the highest Voc (25 V) and Isc (180 nA) compared to fabrics with wrap to weft ratios of 2/1 (14 V, 40 nA) and 3/1 (16 V, 50 nA). Finally, the fibers were sewed onto commercial fabrics to develop an IoT wristband. The IoT wristband was used to play PACMAN through Wi-Fi protocol and demonstrated control of simple computer operations.

Keyword: *Triboelectric Nanogenerators, Human Machine Interfacing, Coaxial Wet Spinning, Thermoplastic Polyurethane, Silver Nanowires*

DRAFT

Glass based Nanocomposites for Solid-State Lithium-Ion Batteries

Abdullah Uysal[*1], L. Mucahit Dogdu[1], Emre Bicer[2], Solen Kinayyigit[1]

[1] Nanocatalysis and Clean Energy Technologies Laboratory, Institute of Nanotechnology, Gebze Technical University, 41400 Gebze, Kocaeli, Türkiye

[2] Battery Research Laboratory, Faculty of Engineering and Natural Sciences, Sivas University of Science and Technology, 58050, Sivas, Türkiye

Anti-perovskite glass materials require a support material since they cannot maintain their shape and mechanical properties during glass transition. At this point an inert and stable reinforcement material is needed and hexagonal boron nitride nanosheets (h-BNNs) is one of the best candidate for this position since it meets all the requirements.

In this study, we focused on lithium-rich antiperovskites, Li_3OCl to form dense layer of glass electrolyte under mild conditions. According to our investigations, physical transformation into glassy phase of this LiOH−LiCl system was only observed during cooling from melted state, not from transition temperature as said before. So it is not possible to pass melting temperature in an assembled electrochemical cell under pressure. To make it feasible an ion conductive scaffold must be employed with the glass material. In this case, we offer nanosheet reinforcement instead of a monoblock support in one piece.

Herein, we evaluated the wetting abilities of h-BNNs in this glass matrix and their effect on the ion conductivity of the electrolyte. The glass nanocomposite electrolyte was produced through a simple one-pot synthesis method without a second heat treatment step. The final product with different h-BNNs loading concentrations of 1%, 2.5% and 5% mass was characterized by AFM, XRD, DSC, SEM, FTIR and EIS techniques. The ionic conductivity of the nanocomposite (%1) was measured as 2.3×10^{-4} S/cm and has a decreasing trend with increasing h-BNNs loading. It was found out that h-BNNs reinforcement changes solidification behaviour of matrix material by retarding crystallization and promoting glass formation. Based to our knowledge, this is the first study to develop amorphous matrix glass composite as electrolyte. We believe that development of such electrolyte composite materials will eventually enable the elimination of need for anode as well as separator decrease, aiding in the reduction of both total battery cost and the fire risk. Our efforts will continue to produce stable and efficient solid-state electrolyte materials, especially for nanocomposite development towards energy storage applications.

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Keyword: *Glass nanocomposite, antiperovskite, boron nitride, 2D materials, solid-state batteries, solid-state electrolyte*

DRAFT

ID: 62

Synthesis and Characterization of New Random Conjugated Copolymers for Organic Solar Cell Applications

Oğuzhan Karakurt[*1], Şerife Özdemir Hacıoğlu[2], Gönül Hızalan Özsoy[3], Levent Kamil Toppare[1], Ali Çırpan[1]

[1] Middle East Technical University, Department of Chemistry, 06800, Ankara, Türkiye
[2] Iskenderun Technical University, Department of Basic Sciences of Engineering, 31200, Hatay, Türkiye
[3] ODTÜ GUNAM, Middle East Technical University, 06800, Ankara, Türkiye

Importance of renewable energy sources is increasing by understanding detrimental effect of climate change on our daily life and global economic system. At this point, organic photovoltaic technology comes to the forefront with its substantial advantages such as low toxicity, low cost and, ease of production. In this study, six different random conjugated polymers were designed and synthesized. Benzodithiophene core serves as the monomeric donor unit in the obtained polymers, which also contain benzoxadiazole and thienopyrrole as monomeric acceptor units. While this research is partially concerned with investigation of effect of the equivalencies of monomeric acceptor cores, it mostly highlights the impact of different π-bridges on photovoltaic performance. The motivation of π-bridge modifications is optimizing the structures to enhance organic solar cell performance. This motivation directed the research to a comparison of thiophene and selenophene π-bridges. All in all, six different conjugated polymers, **BDTOXS-80, BDTOXS-60, BDTOXS-40, BDTOXSe-80, BDTOXSe-60, and BDTOXSe-40** were synthesized successfully. Structural, optical, electronical characterizations of them are completed. All polymers were served as donor material in the active layer of bulk heterojunction organic solar cells with conventional device architecture of ITO/PEDOT: PSS/polymer: $PC_{71}BM$/LiF/Al. Solar device with **BDTOXS-60** polymer showed the highest $\mathbf{J_{SC}}$ and **PCE** values, **6.89** mA/cm^2 and **3.73%**, respectively.

Acknowledgement:
This study is supported by the Scientific and Technological Research Council of Turkey (TUBITAK) with project number 121C274.

Keyword: *Solar Energy, Organic Photovoltaics, Conjugated Polymers, Selenophene, Thiophene*

DRAFT

ID: 84

Electrochemical Synthesis of Manganese-Iron Oxide Catalyst for Gas Diffusion Electrode

İklime Kayhan*, **Rüya Opna, Gizem Cihanoğlu, Özgenç Ebil**
İzmri Institute of Technology, İzmir, Türkiye

Electrochemical energy storage technologies, especially batteries, have drawn much attention over the past few decades as a result of increased use of portable electronic devices and electrical vehicles [1]. Metal-air batteries are considered as one of the best alternatives to current Li-ion batteries due to their high energy and power densities [2]. However, alkaline metal-air batteries did not reach their full potential due to catalyst corrosion, anode passivation and corrosion, electrolyte loss and pore-clogging leading to performance loss and reduced cycle life [3]. Development of high-performance and low-cost electrodes for metal-air batteries is critical for their use in a variety of energy storage applications. Here we present novel carbon-free Gas Diffusion Electrodes (GDEs) with electrochemically deposited metal-oxide (manganese oxide and iron oxide) catalysts on nickel support and commercial gas diffusion layers for rechargeable metal-air batteries. The effects of pH and precursor concentration on GDE performance have been studied. Electrochemical Impedance Spectroscopy analysis revealed decreased ohmic resistance and faster reaction kinetics for catalysts synthesized in acidic conditions. GDEs with Mn-Fe catalyst synthesized using 0.1 M Fe precursor at pH 4 exhibited the highest onset potentials for ORR (1.2 V) and OER (0.38V) in battery operation. Electrodeposition of catalysts particles provides a fast, well-controlled, low-cost and scalable method for large scale fabrication of GDEs.

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Keyword: *Gas Diffusion Electrodes (GDEs), Metal-air batteries, Electrochemical deposition*

DRAFT

Simulation and Optimization of Thermoelectric Cooler Module with Novel Materials using COMSOL Multiphysics

Saba Sepahban Shahgoli*[1], Melis Ozen[1], Serkan Toros[2], Umut Aydemir[3]

[1] Graduate School of Sciences and Engineering, Koç University, Sariyer, Istanbul-34450, Türkiye, and Koç University Boron and Advanced Materials Application and Research Center (KUBAM), Sariyer, Istanbul-34450, Türkiye

[2] Department of Mechanical Engineering, Nigde Omer Halisdemir University, Nigde-51245, Türkiye, and Prof. Dr. T. Nejat Veziroglu Clean Energy Research Center, Nigde Omer Halisdemir University, Nigde, Türkiye

[3] Koç University Boron and Advanced Materials Application and Research Center (KUBAM), Sariyer, Istanbul-34450, Türkiye, and Department of Chemistry, Koç University, Sariyer, Istanbul-34450, Türkiye

Thermoelectric coolers (TECs) are essential for a wide range of applications, providing compact and energy-efficient cooling solutions. Numerous studies have investigated the design and optimization of TEC modules to enhance their efficiency which addressed geometry optimization, material selection and manufacturing improvements. In this study, COMSOL Multiphysics was utilized to design and optimize a TEC module, primarily by defining its geometry. By varying parameters such as leg area, leg height, number of thermocouples, a better understanding of their impact on module was gained. Through optimization, the optimal module geometry was identified and simulation results demonstrated significant improvements, with the optimized module achieving a maximum temperature difference of 78.5 °C and a maximum cooling capacity of 110.9 W under a 12 A current. This represents a substantial enhancement in performance compared to conventional bismuth telluride, which only achieved a temperature difference of 72.4 °C with the same geometry. Additionally, the coefficient of performance (COP) was improved. These findings hold significant implications for real-world applications like avionic systems.

Additionally, the study highlights the potential of nanoscience and nanotechnology in improving TEC performance through the incorporation of novel nanomaterials. Nanoscale engineering enables researchers to manipulate the structure and properties of materials at the atomic and molecular levels, thereby enhancing their thermoelectric properties. The integration of nanotechnology with TEC design and optimization opens up promising avenues for achieving even higher levels of cooling performance and energy efficiency in practical applications.

Keyword: *thermoelectric cooler, module, comsol multiphysics, simulation*

DRAFT

ID: 108

Effect of Molybdenum Doping on Electrochemical Performance of VO2 for Aqueous Zinc Ion Batteries

Recep Yuksel[*1], Selay Aydin[2], Busra Aydogdu[2]

[1] *Department of Chemistry, Faculty of Science, Eskisehir Osmangazi University (ESOGU), 26040 Eskisehir, Türkiye*

[2] *Electrochemistry and Electrochemical Technologies, Graduate School of Natural and Applied Sciences, Eskisehir Osmangazi University (ESOGU), 26040 Eskisehir, Türkiye*

Aqueous zinc ion batteries (AZIBs) have drawn huge attention because of high theoretical capacity, low redox potential of zinc, natural abundance of zinc, safety, and cost effectiveness. The energy storage capacity of AZIBs is directly related to the cathode active material, and it is difficult to find an appropriate cathode active materials for the AZIBs with good electrochemical performance. In this work, we report the effect of molybdenum doping on the electrochemical performance of vanadium dioxide (VO_2) cathode for AZIBs. Hydrothermally synthesized Mo-doped VO_2 nanostructures are converted to monoclinic phase after the thermal treatment. The fabricated monoclinic Mo-VO_2 material has a metal-insulator-transition (MIT) property and Mo-VO_2 cathodes shows a specific capacity of 200 mAh g^{-1} at 0.1 A g^{-1} and a capacity retention of % 70 after 200 galvanostatic charge-discharge cycles at 1.0 A g^{-1}. We will present a detailed analysis of electrochemical properties of the fabricated batteries to underline their charge storage behavior.

Acknowledgement:
This work was supported by The Scientific and Technological Research Council of Turkey (TUBITAK Grant no: 221M072)

Keyword: *Energy storage, Nanomaterials, Batteries, Vanadium Dioxide*

DRAFT

Synthesis of Highly Stable Zirconium-Based Hydrophobic Materials for Anti-Soiling Applications on Photovoltaic Modules

Halide Diker*, Tamer Yeşil, Ceylan Zafer
Solar Energy Institute, Ege University, Izmir, Türkiye

Photovoltaics (PV) have been a rapidly developing technology in the global renewable energy area. However, dust accumulation on the PV modules is an obstacle to the prevalence of this technology. It induces the soiling effect that causes a dramatic decrement in the spectral transmittance and thus reduces the power conversion efficiency of PV panels by a factor of ~40%. Therefore, anti-soiling coatings based on self-cleaning and hydrophobicity mechanisms, which are utilized to minimize the soiling effects on PV panel surfaces, have attracted great interest in recent years [1]. Polyorganosiloxanes have become more preferred anti-soiling materials due to their broad resistance to oxygen, ozone, and UV light and also excellent thermal stability and high water repellency behaviors. Additionally, silane binding agents (i.e.; 3-aminopropyltriethoxysilane (APTES) and 3-glycidoxypropyltrimethoxysilane (GLYMO)) and some dopant materials (i.e., silica nanoparticles, graphene, carbon nanotubes, and metal-oxides) are used to improve the adhesion of polyorganosiloxanes to the glass surface and to increase their hydrophobicity, respectively [2,3,4].
In this study, hydrophobic nanocomposite materials based on Zirconium-Silane ("Zirconium/(3-Glycidyloxypropyl)trimethoxysilane-Polydimethylsiloxane": "Zr/GLYMO-PDMS"), which could be an anti-soiling coating candidate for PV application, were developed via the sol-gel synthesis method. It was aimed to increase the adhesion of PDMS to the glass surface by the GLYMO functionalization and also to improve the mechanical and outdoor resistance and the hydrophobic nature of PDMS via Zr doping. The stability of Zr/GLYMO hybrid sol was monitored by variation of the reaction pH value (i.e., pH1, pH3, pH5), which controls the precipitation of ZrO2 nanoparticles during the sol-gel process. FTIR results indicated that increasing the pH value led to the formation of more Zr-O-Zr bonds than Zr-OH bonds. It was determined that Zr-O-Zr bonds slightly enhanced the hydrophobic nature of the related Zr/GLYMO-PDMS coatings while it decreased the optical transmittance negligibly. All Zr/GLYMO-PDMS coatings on quartz glass exhibited >92% of transmittance in the visible region and they all have higher hydrophobic character than the bare GLYMO-PDMS coating (CA: 63.5°) with their higher contact angle values (CA: 103.4° -107.1°). Additionally, the existence of Zr was determined to dramatically increase the mechanical and chemical stability of the GLYMO-PDMS coatings.

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Keyword: *Anti-soiling coating, hydrophobic nanocomposites, sol-gel method, mechanical stability*

DRAFT

Design of High Entropy Alloy (HEA) electrocatalysts

Uğur Ünal[*1], Armin Asghari Alamdari[2], Hossein Mahdavi[2], Hadi Jahangiri[3], Amir Motallebzadeh[3]
[1] Koc University Chemistry Department Rumelifeneri yolu Sarıyer Istanbul Turkiye
[2] Koc University Graduate School of Science and Engineering, Rumelifeneri yolu Sarıyer Istanbul Turkiye
[3] Koc University Surface Science and Technology Center (KUYTAM), Rumelifeneri yolu Sarıyer Istanbul Turkiye

High entropy alloys (HEAs) differ from the traditional alloys because traditional alloys are based on a solvent system to which various solute atoms are added to improve specific properties, whereas high entropy alloys consist of at least five principal elements in equimolar or non-equimolar compositions. Significantly high mixing entropies of solid solution phases enhance their stability as compared with intermetallic compounds, especially at high temperatures. Among the many other application of HEAs, catalytic reactions are also considerably important because of fascinating surface properties with many active sites. In this work, non-noble transition metal compositions based on CoCuFeNi system were studied for electrochemical water splitting and nitrogen reduction reaction. Electrocatalysts with different compositions were prepared by mechanically alloying the powders of elements of interest under inert atmosphere. We have showed that the phase of the HEA can be controlled by controlling the composition. For example, a single FCC phase of CoCuFeNiMn system can be converted to a mixture of FCC and BCC phases with the addition of Mo in different amounts. In electrocatalytic reactions, we have showed that introduction of Mo into the CoCuFeNi structure significantly improved the oxygen evolution (OER) and hydrogen evolution (HER) reactions activity. The overpotentials as low as 365 mV for OER and 250 mV for HER were obtained on HEAs with different Mo content. For overall water splitting, the cell voltage required to achieve a current density of 10 mA/cm^2 was measured as 1.76 V for the electrolyzer with 80% faradaic efficiency. In addition to water splitting, we have tried HEAs for electrocatalytic nitrogen reaction (NRR) reaction. In this case, we have observed the effect of Ni amount in the structure on the NRR composition. One composition produced 230 μg NH_3. h^{-1} mg^{-1} at -0.05V vs RHE. This research offers a wealth of empirical and theoretical insights that can be applied in the development of HEA electrocatalysts. The simplicity and efficiency of the fabrication process, in addition to the inexpensive nature of the transition metals utilized, make this material a promising and cost-effective option for electrochemical water splitting and nitrogen reduction reactions.

Keyword: *high entropy alloys, water splitting, electrocatalyst, nitrogen reduction reaction*

DRAFT

Poly methyl methacrylate as protection film against dendrite growth on zinc anodes in aqueous zinc ion batteries

Maryam Abouali* , **Cansu Renklitepe , Sadaf Adhami , Recep Yuksel**
Department of Chemistry, Faculty of Science, Eskisehir Osmangazi University (ESOGU), 26040 Eskisehir, Türkiye

The safety concerns and the increasing costs of lithium-ion batteries (LIBs) have made researchers explore new battery technologies with high safety and low cost. In recent years, aqueous zinc ion batteries (AZIBs) have attracted researchers' attention as promising devices for storing electrochemical energy. However, the performance of AZIBs is limited by rapid dendrite growth on the surface of bare zinc anode during the plating/stripping process. There has been much effort to tackle this problem by applying various strategies such as electrolyte engineering, separator modification, and zinc anode surface modifications. Using polymers as coatings on zinc metal is one of the best strategies to alleviate dendrite formation which results in an extended battery lifespan. Polymers can contribute to even ion distribution through their anion moieties or by zincophilic groups in their backbones. Here, polymethyl methacrylate (PMMA) was chosen as an ion sieving layer to protect zinc metal against dendrite formation. With oxygen-containing groups on its backbone, this polymer was able to extend the cycle life of a symmetric cell assembled of PMMA-coated zinc metal up to 3000 galvanostatic charge-discharge cycles which is a considerable improvement in the stability of zinc anode. We will present a detailed analysis of the electrochemical properties of the fabricated batteries to underline their charge storage behavior.

Acknowledgement:
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Keyword: *Organic Polymers, Energy Storage, Anode Materials, Zn dendrite, AZIBs*

DRAFT

Investigation of impact of hole scavengers on photocatalytic performance of 2D Layered $Ca_2Nb_3O_{10}$- nanosheets

Bengisu Yılmaz* [1] **, Uğur Ünal**[2]

[1] *Department of Materials Science and Engineering, Koc University, 34450, Istanbul, Türkiye*

[2] *Koç University Surface Science and Technology Center (KUYTAM), 34450, Istanbul, Türkiye*

The utilization of 2D layered nanosheets as photocatalysts has gained significant attention due to their unique electronic and structural properties. As ultrathin semiconductors, nanosheets of layered oxides have been used in various photocatalytic reactions, such as overall water splitting. However, the efficient utilization of these materials in photocatalytic reactions still faces challenges, primarily related to the recombination of photoexcited charge carriers. There are various approaches to decrease the recombination rate of photoexcited carriers. Use of co-catalysts, hole and electron scavengers during photocatalytic reactions is required to increase the catalytic efficiency. Particularly, hole scavengers effectively capture the photogenerated holes, thereby minimizing charge carrier recombination and prolonging the lifetime of electrons, for instance, reducing water to H_2. In addition to the water splitting reaction, photocatalytic reduction of CO_2 is another challenging reaction. The photocatalytic CO_2 reaction also requires various hole scavengers to increase the effectiveness of photocatalysts. This study aims to investigate the effect of hole scavengers on the photocatalytic performance of $Ca_2Nb_3O_{10}^-$ nanosheets of a 2D layered $KCa_2Nb_3O_{10}$ perovskite. Various hole scavengers were incorporated into the photocatalytic system to explore their influence on the charge carrier dynamics and overall photocatalytic efficiency. Photoelectrochemical characterization techniques were used to investigate the behavior of hole scavengers on a single $Ca_2Nb_3O_{10}^-$ perovskite nanosheet. We have investigated different hole scavengers such as methanol, triethanolamine, ascorbic acid, and EDTA in K_2SO_4 electrolytes. Cyclic voltammetry and chronoamperometry tests under chopped light were performed to test the effect of the hole scavenger on the behavior of 2D nanosheets of the semiconductor. These findings provide valuable insights into the design and optimization of hole scavengers for enhancing the photocatalytic activity of $Ca_2Nb_3O_{10}^-$ nanosheets and can also be extended to different photocatalysts. Moreover, this research contributes to the fundamental understanding of charge carrier dynamics in a photocatalytic water splitting system.

Keyword: *Layered Perovskites, 2D Nanosheets, Water Splitting, Hole Scavenger, Photoelectrochemistry*

DRAFT

ID: 208

Design of Fly Ash Based Nanocomposites for Improvement Thermal Energy Storage Capacity of The Nitrate Salts

Elif Nida Göksu
TOBB University, Ankara, Türkiye

In recent years, the demand for sustainability and energy efficiency in the energy sector has been rapidly increasing. Renewable and clean energy sources are needed to meet the world's growing energy demand. Concentrated solar power (CPS) plants are seen as an environmentally friendly and efficient source of electricity production among alternative energy sources. In CPS plants, the development of fluids with high performance and low cost that can be used as both thermal energy storage (TES) fluids and heat transfer agents (HTA) is crucial. Choosing suitable HTS and TES materials can provide thermodynamic efficiency while minimizing the costs of heat storage tanks solar energy receivers, and heat transfer devices. Today, due to their physicochemical and thermodynamic properties, salt melts and various mixtures are used in CSP plants and many applications. The fact that salt melts are environmentally friendly materials with high chemical stability, low viscosity, low vapor pressure, high energy density, and low cost make them an ideal fluid to be used in the energy sector. However, when molten nitrate salts are used alone, their thermal stability is low, limiting the storage time. Also, due to the high melting points (>200°C) and low decomposition temperatures (at temperatures above 600°C) of molten salt fluids, they can freeze in cold weather conditions and darkness, causing pipes to clog. Therefore, forming nanocomposites by mixing with a material with high thermal conductivity, such as fly ash, contributes to improving the thermodynamic properties of molten salts. Thus, low-cost HTA and TES materials with low melting points, high storage capacity, and high thermal stability will be obtained in CSP plants. In this thesis study, the aim was to design cheap molten salt and fly ash nanostructures with high thermal conductivity, low melting temperature, and high decomposition temperature. The structural and thermal properties of fly ash-potassium nitrate (KNO_3) mixtures with different weight percentages of fly ash (0.1%, 0.2%, 1%, 2%, and 5%) were experimentally investigated. The structural properties of the prepared nanofluids were examined with scanning electron microscopy (SEM) and X-ray diffraction (XRD); thermal characterization was investigated using thermal properties analyzer (TPS), differential scanning calorimetry (DSC), and thermogravimetric analysis (TGA) methods.

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Keyword: *Molten salts, Fly ash, Melting point, Decomposition point, Heat capacity, Thermal conductivity, Ferroelectric*

DRAFT

Unidirectionally Freeze- Casted Mxene Aerogels for Supercapacitors

Vildan Bayram Karakuşlu[*1], **Suelen Barg**[2], **Ian Kinloch**[3]
[1] *TÜBİTAK RUTE, Ankara, Türkiye*
[2] *University of Ausburg, Augsburg, Germany*
[3] *University of Manchester, Manchester, United Kingdom*

MXenes, which are a new class of two dimensional (2D) materials, have become attractive for their use within energy storage devices, due to their distinguished surface compositions, high conductivity and rich elemental composition [1]. Integration of MXenes into porous electrode structures is of great importance in order to fully translate these properties into practical supercapacitor applications [2]. Some of the current fabrication approaches disturb the functional properties of MXene flakes which results in changes in capacitive performances. Unidirectional freeze-casting is an easily accessible technique that utilizes a physical segregation process to control final morphology of materials [3]. This study surveys the manufacturing of MXene aerogels from aqueous MXene suspensions via unidirectional freeze-casting. The as-prepared MXene aerogels (MAs) by unidirectional freeze-casting possessed highly porous nature (porosities above 99%) and large lamellar spacings. Alterations of freeze-casting parameters such as initial suspension concentration and freezing rate widened the type of created microstructures (e.g. finer/wider pores, excessive bridging, and openings within the walls). Subsequent to the production of MAs, pressing or rolling MAs into practical electrode films provided a wide control of film thickness, volumetric density, lamellar spacing and (hence) final film properties. The investigations on MAs microstructure upon pressing and rolling, and their capacitive performances broadened our understanding of the relation between these two phenomena. These post-processing techniques directly enhanced the volumetric capacitance of Mas [4]. However, the disintegration of pore structure during these processes led to losses in capacitive performance. Pressed MAs (P-MAs) due to inhomogeneity in pore structures and crumbled lamellae only achieved a limited capacitance. On the other hand, rolled MAs (R-MAs) produced via rolling with a calendering machine keep their integrity of lamellae structures and preserved their electrochemical behaviour. The optimized pore structures of R-MAs facilitated ion accessibility and diminished the charge-transfer resistance [5]. The cycling tests of RMAs up to ten thousand cycles demonstrated their stability for long-term practical applications. The simplicity and versatility of the developed fabrication strategy open opportunities for the utilization of MXene lamellae architectures in a wide range of applications requiring controlled porosity including catalysis, filtration, and water purification.

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Keyword: *MXene, 2D Materials, Energy Storage, Ultracapacitors*

DRAFT

ID: 280

Comprehensive Characterization of Indoor PV Devices

Hatice İlhan*[1], Özcan Bazkır[1], Seval Meriç[1], Gökhan Yakın[1], Canan Varlıklı[2], Hatice İlhan[2]
[1] National Metrology Institute, The Scientific and Technological Research Council of Türkiye (TÜBİTAK), Gebze-Kocaeli, Türkiye
[2] Department of Photonics, İzmir Institute of Technology, Urla-İzmir, Türkiye

The application of nanotechnology has been driving the development of advanced photovoltaic (PV) materials that offer both high efficiency in converting sunlight into electricity and economic production for widespread adoption [1]. Traditional solar cells, such as silicon-based PV cells, are primarily designed for outdoor use and rely on direct sunlight to generate electricity. However, the emergence of new types of solar cells and materials has opened up possibilities for indoor applications. Emerging PV technologies such as Organic Photovoltaics (OPV), Dye-Sensitized Solar Cells (DSSC), and Perovskite Solar Cells (PSC) have gained significant attention for indoor energy harvesting, including flexibility, lightweight, broad-spectrum light absorption, and the capacity for large-scale production using cost-effective methods [2], [3]. They can efficiently generate electricity even under low light conditions, making them suitable for indoor applications where the light intensity is lower compared to outdoor environments. Nevertheless, the inherent instability of emerging PV devices presents additional measurement challenges [4], [5]. Comprehensive, reliable, and precise measurements play a vital role in understanding the efficiency, power output, and durability of these devices, considering their inherently unstable nature. Through accurate characterization, the potential of these technologies can be assessed and their limitations identified, paving the way for further improvements and optimizations. This study focuses on characterizing the performance of PV devices by measuring their I-V curves under standard test conditions (AM 1.5G, 1000 W/m^2, 25°C) and indoor conditions. The influence of various factors on the I-V measurement is investigated, such as the voltage sweep rate, voltage step size and scan direction, depending on the cell technology. The study reveals that applying a preconditioning step through light soaking has a stabilizing effect, bringing the device closer to a steady-state measurement. To obtain accurate and reproducible results while avoiding hysteresis effects, it is recommended to conduct measurements by implementing preconditioning with light soaking and scanning the device using a smaller voltage step and controlling the scanning speed to minimize transient effects. This approach enables a more comprehensive understanding of the device characteristics and facilitates meaningful comparisons and evaluations across different technologies.

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Keyword: *Indoor PV Devices, OPV, DSSC, PSC*

DRAFT

Effect of Ramping Rate in the Sulfurization Process on properties of CZTS Thin Film and Its Cell Performance

Mehmet Ali Olğar[1], Serkan Erkan[*2], Recep Zan[1]
[1] Department of Physics, Niğde Ömer Halisdemir University, Niğde, Türkiye
[2] Nanotechnology Application and Research Center, Niğde Ömer Halisdemir University, Niğde, Türkiye

The Cu_2ZnSnS_4 (CZTS) thin films have gained significant attention recently in thin film solar cell technology as an absorber due to its natural abundance, low toxicity, and favorable optoelectronic properties. The 1.4-1.6 eV optical band gap energy range, high absorption coefficient (>10^4), and electrical p-type conductivity makes this compound suitable for photovoltaic application [1]. Although CZTS thin film has >30% theoretical efficiency, the current record efficiency is still too low (13.0%) [2, 3]. There are many optimizations that have been carried out in the literature to boost cell efficiency [4]. Also, the use of flexible substrates makes CZTS thin films more applicable to various surfaces [5]. In this study, effect of heating rate on the properties of CZTS thin films and their photovoltaic performances was investigated. CZTS layers were prepared by a two-stage technique comprising deposition of precursor films by sputtering on Mo-foil substrates (Mo-foil/ZnS/CuSn/Cu) and a sulfurization process utilizing Rapid Thermal Annealing (RTA). Heating rates of 1 °C/s, 2 °C/s, and 3 °C/s were used to reach 550 °C reaction temperature and the best heating rate was determined according to performed analyzes. All samples showed Cu-poor and Zn-rich chemical composition regardless of the heating rate of the sulfurization process. XRD diffraction patterns showed that only kesterite CZTS phase was formed in all samples. Although Raman spectroscopy measurements confirmed formation of kesterite CZTS phase in all samples, forming of Cu_2SnS_3 (CTS) secondary phase was detected in all films except for the sample prepared utilizing a relatively low heating rate of 1°C/s. The largest crystallite size was also found in this sample. All CZTS thin films displayed dense and compact polycrystalline surface microstructure. Optical characterizations showed that the optical band gaps of the films were in the range of 1.48-1.58 eV. PL emission spectra of the films exhibited transition from conduction band to acceptor/defect levels instead of band-to-band transition. Solar cells were fabricated and the highest Voc and conversion efficiency (4.39%) were achieved employing the film obtained with ramp rate of 1°C/s, because of better structural properties and purer crystal structure determined for this sample.

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Keyword: *CZTS, Mo Foil, Heating Rate, Sputtering, Flexible Solar Cell*

DRAFT

Investigation of the Solubility of DMF in Silicone Oil in a Droplet-Based Microfluidic System for Synthesis of MOF Nanoparticles

Gaye Korkmaz*, Selis Onel
Hacettepe University, Department of Chemical Engineering, Ankara, Türkiye

Nanoparticles with metal-organic framework (MOF) crystalline structures have received great attention in the energy, water treatment, pharmaceutical, and medical industries due to their extraordinary adsorption properties. Recently, using microfluidic systems has resulted in synthesis of smaller and more uniform MOF nanoparticles [1]. Two-phase microfluidic systems, where microdroplets are formed in an oil phase and used as mini-reaction vessels, have some drawbacks during application. The nonpolar oil phase and the polar precursor solution phase may not be completely immiscible allowing for mass transfer between the two phases based on the molecular structure and intermolecular forces between the liquids that are enhanced at the micro-scale and at elevated temperatures. Such diffusion of components between the two phases can affect the concentration of the precursor solution, the reaction time, and the quality of the products formed. In this study, we studied the solubility of DMF which is the most frequently used solvent for dissolution of metal salts and organic ligands in the synthesis of MOF crystalline structures in silicone oil, polydimethylsiloxane [-Si(CH3)2O-]n), which is frequently used in the formation and transportation of droplets in microchannels. The reduction in the scale from macro to micro results in surface forces becoming more dominant over volume forces such that capillarity and interface phenomena become more effective in determining the flow behavior. Such problem has not been pronounced until now in the studies of MOF syntheses employing microfluidic systems with DMF and silicone oil used together because the microfluidic channels consisted of opaque capillary tubes [2-5]. The microfluidic system used in this study to form uniform droplets of the precursor solution in silicon oil is a transparent polydimethylsiloxane (PDMS) chip. We compared the solubility of DMF in silicone oil in macro and micro scales and under stationary and flow conditions using a 1. stationary macro-scale system, 2. stationary microsystem, and 3. microfluidic system. We discussed the effect of convective diffusion by comparing the results obtained at macro and micro scales using stationary and flow conditions and showed that solubility is enhanced under flow conditions at smaller scales. This study has been supported by TUBITAK 1001 Project 220M002.

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Keyword: *Two-phase microfluidics, Solubility, N,N-dimethylformamide, Silicone oil, Mass transport*

DRAFT

Characterization and Biological Activity of Silver Nanoparticles Synthesized *with Clitoria ternatea* L. Flower Methanol-Ethyl Acetate Extract

Büşra Dalgıç*[1], Neslihan Demir[2]

[1] *Çanakkale Onsekiz Mart University, School of Graduate Studies, Department of Biology, Çanakkale, Türkiye*

[2] *Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye*

Nanotechnology has made great contributions to the scientific world in the development of new production methods. It is known that the products obtained by these improved new methods are used in many fields, including treatment of diseases. Nanoparticles, with their unique properties, are one of the most researched topics in recent years. Compared to high cost and time-consuming methods such as physical and chemical methods, nanoparticles synthesized with the biologically green synthesis method make it possible to save both cost and time.

Since plants have been used in alternative medicine for many years by humans, they also come to the fore in nanoparticle synthesis. Many different herbs are still used for medicinal purposes today. Clitoria ternatea L. is a medicinal plant belonging to the Fabaceae family, commonly known as butterfly pea or blue pea flower. The seeds and leaves are known to be widely used by the public as tranquilizers and to improve memory. The aqueous extract and flowers obtained from the plant were used as an antidote against snake bites. These medicinal uses are thought to originate from the plant content. Compounds reported to be present in flowers are ternatin, anthocyanins and various flavanol glycosides of kaempferol, quercetin and myricetin.

In this study, C. ternatea flowers was extracted with ethyl acetate-methanol and silver nanoparticles were synthesized using green synthesis method. Absorbance band of the synthesized nanoparticles was taken between 300-600 nm by UV-Vis Spectrophotometer. The biological activities of the plant and silver nanoparticles were investigated as DNA cleavage activity and antioxidant activity. DNA cleavage activities were investigated with agarose gel electrophoresis method. Antioxidant activity was investigated by DPPH free radical scavenging method. Experiment results showed that plant and silver nanoparticles cleave DNA oxidatively; In addition both have good antioxidant activity. We suggest that it is possible to use silver nanoparticles synthesized with C. ternatea industrially with more detailed in vitro and in vivo studies on this subject in the future.

Keyword: *Green Synthesis, Clitoria ternatea L., Silver Nanoparticles, Characterization, Biological Activity*

DRAFT

Antibacterial Activities and In Vitro Release of *Valeriana officinalis* L.-Loaded Chitosan Nanoparticles

İrem Akyol[*] [1], Neslihan Demir[2]

[1] *Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Molecular Biology and Genetics, Çanakkale, Türkiye*

[2] *Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye*

Nanotechnology has revolutionized biotechnology, nanomedicine, and various other fields like drug delivery, electronics, cosmetics, and biosensors. The synthesis of nanoparticles with diverse sizes and shapes can be achieved through physical, chemical, or biological means. Physical and chemical approaches for nanoparticle synthesis have drawbacks like high energy consumption, low yield, high costs, and environmental hazard. In contrast, green synthesis which utilizes microorganisms or plants, offers a cost-effective, simpler, and eco-friendly method for nanoparticle production.

The preservation and controlled release of bioactive protection in the right place at the right time can be achieved by encapsulation. Plant extracts were encapsulated within chitosan nanoparticles (CSNPs), enabling gradual release and potentially amplifying the antioxidant and antimicrobial attributes of the CSNPs.

Valeriana officinalis, commonly referred to as valerian, is a long-lasting blooming plant classified under the Caprifoliaceae family. Since ancient times, specifically during the periods of ancient Greece and Rome, valerian has been recognized and utilized as a herbal remedy in traditional medicine. It is employed as a nervous sedative, cardiac tranquilizer, and hypotensive agent, and is useful in insomnia and cardiac neuroses, among other therapeutic applications. This plant contains several functional compounds, including bornyl acetate, ß-pinene, borneol, limonene, and camphene. These compounds have been identified as contributors to the sedative properties associated with valerian.

In this study, our investigation focused on in vitro release and assessing the impact of nanoencapsulation on the antibacterial properties of plant extract. The presence of extract-loaded nanoparticles exhibited promising antibacterial activity in in vitro studies, with the effectiveness depending on the concentration of the extract. The findings of this study demonstrated the efficient encapsulation of V. officinalis extract within CSNPs, resulting in sustained release properties of V. officinalis-CSNPs. Our results suggest that V. officinalis-CSNPs are a promising plant-based extract-CSNPs delivery system for use as a therapeutic agent.

Keyword: *Valeriana officinalis, Chitosan, In Vitro Release, Antibacterial Activity*

DRAFT

DNA Cleavage and Photocatalytic Activity of Synthesized Copper Oxide Nanoparticles From the *Pimpinella anisum* L. Aqueous Extract

Sultan Sücü[*1], **Neslihan Demir**[2]

[1] *Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Molecular Biology and Genetic, Çanakkale, Türkiye*

[2] *Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Biology, Çanakkale, Türkiye*

Nanoparticles are substances in atomic, molecular, and macromolecular sizes between 1-100 nm that can be synthesized by chemical, physical and biological methods. The biological synthesis of nanoparticles, also called green synthesis, is a method that aims to reduce or prevent the use of toxic and harmful substances. This method is more advantageous compared to other methods because it is easy, inexpensive, and environmentally friendly. In the green synthesis method, nanoparticle production is carried out by using yeast, fungi, algae, and plants. Plants are frequently preferred by researchers as they shorten the synthesis time and form more stable structures. Turkiye has a rich flora in terms of both medicinal and aromatic plants. These plants have been described as medicinal by humans for centuries. Pimpinella anisum L., also known as anise, is one of the plants frequently used by the public because of its carminative and diuretic properties. Studies are showing that P. anisum has an anticarcinogenic effect.

In this study, DNA cleavage activity and photocatalytic activity of P. anisum extract and copper oxide nanoparticles (CuONPs) were investigated. DNA cleavage activity is important to design drugs. DNA cleavage activity was investigated in two ways as hydrolytic and oxidative with different concentrations. H_2O_2 was used as an oxidizing agent in oxidative DNA cleavage activity. Toxic substances, such as dyes, pollute the water and cause serious damage to the ecosystem. In addition to removing these harmful chemicals, the used substance should not pollute the water. Therefore, environmentally friendly methods are preferred.

Within the scope of the study, the characterization of nanoparticles was determined using UV-Vis spectrophotometer. Then, the UV-Vis spectrophotometer measured between 200-800 nm, and the maximum absorbance value seen at 387 nm was confirmed for the presence of nanoparticles. It has been observed that CuONPs synthesized from anise and extract, cleaved plasmid DNA in the absence of oxidizing agent (hydrolytic) and completely denaturated DNA in the presence of oxidizing agent (oxidative) in high concentrations. It was observed that CuONP degraded methylene blue by approximately 50% in the first 30 minutes.

This study was supported by the Scientific and Technological Research Council of *Türkiye* (TÜBITAK) 2209-A Program.

Keyword: *Green Synthesis, CuONP, Pimpinella anisum L., DNA Cleavage Activity, Photocatalytic Activity*

DRAFT

ID: 269

Echinacea purpurea L. Plant Extract Mediated Green Synthesis of Copper Oxide Nanoparticles, Their Characterization and Biological Activity

Ecem Kuru[*1], **Neslihan Demir**[2]

[1] *Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Molecular Biology and Genetics, Çanakkale, Türkiye*

[2] *Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye*

Green synthesis is a method that has been increasingly used recently to make the production of nanoparticles more environmentally friendly and efficient by reducing the disadvantages. Organisms such as viruses, bacteria, algae, fungi, yeast, and plants can be used in the production of nanoparticles by green synthesis. The use of plants in green synthesis enables nanoparticle formation in a short time, production at affordable costs, reproducibility, and investigation of pharmaceutical effects.

The green synthesis method is also becoming widespread in metal nanoparticles used in cancer treatments and many biotechnological applications. Substances such as flavonoids, phenolics, terpenoids, cofactors in natural extracts are used as reducing agents in the green synthesis process of metal nanoparticles such as silver, gold, copper, zinc, cerium, titanium, palladium, lithium, and iron. In addition to the medical use of metal nanoparticles, it is also used to reduce the harm of environmentally harmful dyes, which are used in fields such as printing, paper, and textile industries, to the aquatic ecosystem.

Echinacea purpurea L. popularly known as Echinacea, is traditionally used in the treatment of diseases such as cough, cold, flu, infections, wounds, pain, and inflammation. The reducing components contained in the extracts of the plant are associated with antioxidant, anti-inflammatory, analgesic, antiviral, antibacterial, antifungal, immunomodulatory and anti-cancer properties.

In our study, copper oxide nanoparticles (CuONPs) were synthesized using E. purpurea plant extract. Nanoparticles were characterized by UV-Vis spectroscopy analysis. DNA cleavage activities were observed in the presence and absence of the oxidizing agent H_2O_2 by agarose gel electrophoresis method. According to the results CuONPs are more effective than extract. We suggest that the study can be improved with the continuation of the research.

Keyword: *Echinacea purpurea L, Copper Oxide Nanoparticle, Green synthesis, Biological activity*

DRAFT

ID: 271

The Biological Synthesis of Copper Oxide Nanoparticles Using Arnica (*Arnica montana* L.) Extract, Investigation Antioxidant Activity and Interactions with DNA

Akın Akyel[*1], **Neslihan Demir**[2]

[1] *Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Molecular Biology and Genetics, Çanakkale, Türkiye*

[2] *Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye*

Nanoparticles possess significant activities and can be synthesized using chemical, physical, and biological methods. The biological synthesis of nanoparticles, also known as green synthesis, is considered a promising alternative compared to physical and chemical methods. Among various biological synthesis methods, plant-mediated synthesis appears to be a suitable approach due to its ability to facilitate the formation of stable nanoparticles in a shorter period and simplify the synthesis process.

Arnica montana L. is a flowering plant in the Asteraceae family. It is widely used as a medicinal plant and finds applications in the cosmetic and liqueur industries. A. montana contains volatile oils, terpenoids, sesquiterpene lactones, and flavonoids. Sesquiterpene lactones are the most active components. A. montana is known for its antioxidant, anti-inflammatory, antibacterial, analgesic, and wound healing properties.

In this study, copper nanoparticles were synthesized using A. montana via the reduction method. Characterization of nanoparticles are investigated with UV-Vis spectrophotometer method. The antioxidant activity of the obtained copper nanoparticles was determined using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging method, and their DNA-cleavage activities were investigated using agarose gel electrophoresis. The hydrolytic and oxidative interactions of pBR322 plasmid DNA with A. montana extract were also examined.

The results indicate that the nanoparticles and extracts obtained from A. montana exhibit DPPH activity and are capable of scavenging free radicals. Experiments conducted using pBR322 plasmid DNA along with extract and nanoparticles demonstrated the oxidative cleavage activity on DNA.

Keyword: *Arnica montana L., Biological Synthesis, Copper Oxide Nanoparticles, DNA Cleavage Activity, DPPH Free Radical Scavenging Activity*

DRAFT

Smartphone-Assisted Dual-Channel Discriminative Detection of Hg(II) and Cu(II) Ions with a Simple, Unique, Readily Available Probe

Erman Karakuş*[1], Eda Erdemir[2], Garen Suna[1], Lokman Liv[3], Songül Eğlence-Bakır[2], Musa Şahin[2]

[1] Organic Chemistry Laboratory, Chemistry Group, The Scientific & Technological Research Council of Türkiye, National Metrology Institute, (TUBITAK UME), Gebze, Kocaeli, Türkiye

[2] Department of Chemistry, Faculty of Science, Istanbul University, Istanbul, Türkiye

[3] Electrochemistry Laboratory, Chemistry Group, The Scientific & Technological Research Council of Türkiye, National Metrology Institute, (TUBITAK UME), Gebze, Kocaeli, Türkiye

Heavy metal ions are well-known atmospheric and environmental pollutants and cause long-term damage to humans. Mercury is one of the most toxic and hazardous one that induce critical motor disorders and a variety of diseases [1,2]. Likewise, excess copper can lead to Alzheimer's and Parkinson's disease, as well as various other health conditions [3]. Therefore, selective and sensitive methods for determining and visualizing mercury and copper remain necessary [4]. In our study, we developed the first-ever optical-electrochemical method of discriminatively detecting Hg2+ and Cu2+ ions using 1-thioglycerol (TG)-modified gold nanoparticles (AuNPs) and by altering the solution's medium. Adding Hg2+ ions to AuNP–TG in ultrapure water changed the original burgundy color blue, the initial absorbance value (i.e., 520 nm) decreased, and a new absorbance peak appeared at λmax = 670 nm. In a phosphate-buffered solution, Cu2+ ions issued a similar response. However, neither Hg2+ nor Cu2+ ions exhibited cross-reactivity under those sensing conditions. The optical mechanism for detecting both metal ions seems to have relied on the destabilization and aggregation of AuNPs. On the one hand, the electrochemical detection of Cu2+ stemmed from the reduction of the complex between Cu2+ and TG's neighboring hydroxyl groups in the probe, whereas the electrochemical detection of Hg2+ stemmed from the fact that Hg2+ broke the AuNP–S bond, after which the AuNPs clustered and significantly increased the electrode's electron transfer rate. Last, because the method involves using a smartphone to read signals without requiring professional equipment, it considerably decreases the cost of detection and shows promise for the rapid on-site detection of Hg2+ and Cu2+ ions [5].

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Keyword: *Gold Nanoparticles, Toxic heavy metal ions, Environmental pollution, Multi-channel probe, Smartphone application*

DRAFT

ID: 23

Signal-Enhanced Electrochemical Determination of Quercetin with Poly(chromotrope fb)-Modified Pencil Graphite Electrode in Vegetables and Fruits

Lokman Liv[*1], **Erman Karakuş**[2]

[1] *Electrochemistry Laboratory, Chemistry Group, The Scientific and Technological Research Council of Türkiye, National Metrology Institute, (TUBITAK UME), 41470 Gebze, Kocaeli, Türkiye*

[2] *Organic Chemistry Laboratory, Chemistry Group, The Scientific and Technological Research Council of Türkiye, National Metrology Institute, (TUBITAK UME), 41470 Gebze, Kocaeli, Türkiye*

A novel signal-enhanced electrochemical sensing strategy was constructed for quercetin determination with a peculiarly developed poly(chromotrope fb)-modified activated pencil graphite electrode in vegetables and fruits. The oxidation signal of quercetin at 118 mV in an alcoholic solution served as the analytical response. The produced platform, characterized by cyclic voltammetry, electrochemical impedance spectroscopy, scanning electron microscopy, energy-dispersive X-ray spectroscopy, and X-ray photoelectron spectroscopy, could detect 1.9 nM of quercetin in the range of 0.01–1.2 μM. The extracted quercetin contents of red onion, red cabbage, cranberry, black mulberry, black raisin, and carob were determined by both the developed method and UV–visible spectroscopy. The results were statistically evaluated at the 95% confidence level, and no significant difference between the results was found.

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Keyword: *Quercetin, Chromotrope FB, Pencil Graphite Electrode, Vegetables and Fruits, Voltammetry*

DRAFT

Functional Metal Oxide Surfaces: Photocatalytic, Self-Cleaning, Sensing, and Micro-/Nanostructuring Applications

Salih Veziroglu*, Josiah Shondo, Tim Tjardts, Franz Faupel, Oral Cenk Aktas
Chair for Multicomponent Materials, Institute of Materials Science, Kiel University, 24143 Kiel, Germany

Titanium oxide (TiO_2) is one of the most used photocatalytic materials for various applications such as environmental remediation, (solar)water splitting, and self-cleaning due to its high activity, low cost, high chemical, and physical stability. However, the photocatalytic activity of TiO_2 is limited by the wide energy of the bandgap, low quantum efficiency, and rapid recombination of photogenerated charge carriers (electrons and holes). During the last decades, numerous approaches, such as tailoring the morphology (nanoparticles, thin film, etc.), combining with metal, noble metal, and metal oxide micro/nanostructures, have been demonstrated to enhance the photocatalytic activity of TiO_2. However, it is still a major challenge to find the best photocatalytic combination for specific applications. Recent studies have revealed that particle size plays a considerable role in the photocatalytic activity of TiO_2. Reducing the particle size (increasing active surface area) indicates a higher photocatalytic activity. Nevertheless, the use of photocatalytic nanoparticles in continuous flow systems (such as water remediation, water splitting, etc.) has some practical limitations such as reusing and splitting them up from the reaction media. Hence, the use of robust and stable thin film photocatalysts becomes more suitable rather than nanoparticle systems for practical applications. Nevertheless, thin films are restricted by low surface area in contrast to nanoparticles and they show extremely limited photocatalytic activity. Here we present some case studies on enhancing the photocatalytic performance of TiO_2 thin film by modification with metal [1] and oxide [2,3] nanostructures for practical applications such as water purification, self-cleaning, selective oil absorption [4], and organic molecule sensing [5].

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Keyword: *metal oxide, functional surfaces, photocatalysis, self-cleaning, PIERS*

DRAFT

Development of Nano-structured Surface Acoustic Wave (SAW) Gas Sensor for Detection of Human Breath Biomarkers

Alp Kılıç*, **Onur Alev, Serkan Büyükköse**
Gebze Technical University Department of Physics, Gebze, Koceli, Türkiye

Introduction

Breath analysis has become a significant attention due to its non-invasive and patient-friendly nature for the detection of diseases. Human breath consists of various gaseous components such as volatile organic compounds (VOCs), humidity, etc. Over the 1 ppm acetone in the human exhaled breath corresponds to diabetes disease [1]. Therefore, the fabrication of highly sensitive gas sensors is a big demand for breath analysis. A typical gas sensor has two main parts: a transducer and a sensing layer. Regarding the transducer part of the sensor, surface acoustic wave (SAW) technology has attracted much attention due to its various advantages [2, 3]. In addition, ZnO has been widely used for gas sensor applications as a sensing layer due to its superior electrical and nanostructural properties [4, 5].

Materials and Method

SAW sensor platforms were fabricated by optical lithography on quartz substrates. ZnO nanorods were grown on SAW sensor platforms by seed-mediated hydrothermal technique. Sensor tests were performed against various breath biomarkers and their interferences such as acetone, ammonia, HCN, H_2S, ethanol, relative humidity, etc.

Results

During all measurements, the frequency shift and insertion loss for the sensor against the target gas were simultaneously measured. The power loss measurements at the frequency value of the ZnO-based SAW sensor was performed for 10 different concentration levels of target gases, as shown in Figure 1.

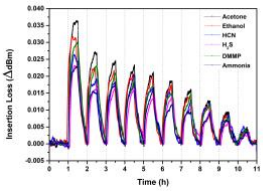

Figure 1. The insertion loss of sensor against target gases.

The sensor response curve of the ZnO-based SAW sensor against acetone at different concentration values is shown in Figure 2. The sensor response values of the highest and lowest measured acetone concentrations, which are 7.5 ppm and 750 ppb, respectively, were calculated as 294.605 Hz and 13.113 Hz. The theoretical detection limit was calculated with linear extrapolation. Accordingly, it is foreseen that sensor can provide a response of approximately 0.00642 Hz to the lowest detection limit of 400 ppb acetone.

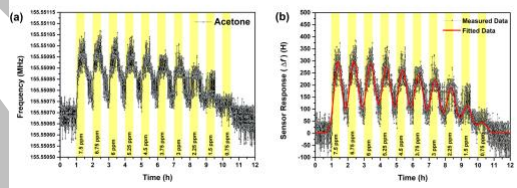

Figure 2. The response of sensor against acetone **(a)** at different concentrations and **(b)** fitting of measured data.

Acknowledgements

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Keyword: *Surface Acoustic Waves (SAW), Gas Sensor, Sensor Platform, Acetone, Breath Analysis*

DRAFT

Evaluation and Characterisation of e-Greases with Using Nanoparticles

Sevda Şahan, Ece Korkut*
Petrol Ofisi Technology Center (POTEM), Derince, Kocaeli, Türkiye

Interest in electrical and hybrid vehicles increased in recent years. Besides that electric and hybrid vehicles market is growing globally. Commercial greases have some potential to usage in electrical and hybrid vehicles applications. Despite that, tribological, electrochemical and thermal properties must be improved according to the requirements of electrical and hybrid vehicles.
In this study we have been investigated the development of upgraded grease products for usage of electrical and hybrid vehicles wheel bearings with using different types of nanoparticles.
Different types of base oils and grease soap matrices have been investigated to potential of usage in e-greases. Carbon nanotubes, molybdenum disulfides and titanium dioxides have been evaluated in this study.
Mainly poly alpha olefin types base oils have been evaluated in this study. Additionally, superiorities of PAO's on the other types base oils have been reported. Advantages of using carbon nanotubes, molybdenum disulfides and titanium dioxides seperately evaluated with group 3 and group 4 type base oils in the same grease soaps to produce e-greases with using conventional soaps.

Keyword: *nanoparticles, electrical vehicles, hybric vehicles, greases, wheel bearings*

DRAFT

Engineering flexibility of site-controlled Pyramidal quantum dots as sources of photonic and spin quantum bits

Gediminas Juska*, Francesco Mattana, Iman Ranjbar Jahromi, Emanuele Pelucchi
Tyndall National Institute, University College Cork, Cork, Ireland

GaAs quantum dots (QDs) produced by droplet etching epitaxy have been recently making remarkable progress as state-of-the-art sources of single, indistinguishable, polarization-entangled photons, and also as a low-noise environment for single charge carriers. Herein we present the results of the endeavor to transfer these outstanding properties and advantages to GaAs QDs fabricated by a conceptually different approach – metalorganic vapour-phase epitaxy (MOVPE) growth on (111)B-oriented GaAs substrates pre-patterned by the micrometer-scale tetrahedron recesses [1]. Within the bigger picture, this new generation of site-controlled QDs is being researched as a potential resource of photonic cluster states.
GaAs QDs, in comparison to their counterpart InGaAs QDs [2,3,4], is a new generation within this QD family. Using time-resolved, polarization-resolved, resonant excitation methods we present a comprehensive study of a typical GaAs QD energetic structure - a fingerprint of a general structural uniformity. For example, we will show several QD design and fabrication strategies to reduce the fine-structure splitting of the exciton state and by two resonant two-photon excitation demonstrate these QDs as promising sources of polarization-entangled photons. Also, a specific emphasis has been placed on states and methods to initialize the QD with a single charge carrier to be utilized as an entangler of the cluster state [5]. We identified and investigated an excited positively charged exciton (trion) states as a possible channel to inject a QD with a hole having a defined (pseudo)spin. Contrary to the typically observed picture where heavy- and light-hole mixing can easily compromise selection rules, we show that being strain-free and, in a specific design, less confined, Pyramidal GaAs QDs typically have nearly pure light-hole-like excited states. By resonantly exciting one of these excited states, based on the optical selection rules, we could clearly demonstrate a process of laser-polarization state-mapping to the polarization state of the emitted ground trion. Such a process enables QD initialization encompassing a hole with a well-defined spin state – a critical step towards the cluster state demonstration. As a further step, coherent properties of the initialized light-hole-like states are studied.

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Keyword: *quantum dot, entangled photons, spin qubit, cluster states, single photons*

DRAFT

Neuromorphic backend for an infrared absorption based electronic nose system

Özlem G. İnci, Asma Djehiche, Ruslan Garifullin, Mecit Yaman*
Department of Aeronautical Association, University of Turkish Aeronautical Association, Ankara, Türkiye

Nanotechnology-based sensors for electronic nose applications is one promising approach [1] to improve sensitivity. We previously demonstrated nanostructured hollow core fibers [2] as optical/photonic sensor arrays [3] and developed it further by exploiting rudimentary statistical learning for data analysis [4].
Neural early pathway of the vertebrate olfactory system comprises of hundreds of different types of chemoreceptors, as opposed to current instances of most electronic noses with a dozen or so sensor types. With this in mind, we scaled up our sensor arrays to thousands by repurposing the mid IR spectra of an FTIR system as 'virtual sensors'. In this way, we can nearly create a digital twin not only of the vertebrate olfactory chemoreceptors and but also of the olfactory bulb [5].
Having decided on the physical layer, we explored various computational approaches for processing sensor information. A recent deployment of spike-time-dependent-plasticity (STDP) based one-shot learning technique [6] was touted as superior to other big data approaches such as deep learning. We tested the performance of this spiking network architecture using our FTIR based electronic nose system and find that the spiking algorithm is not superior to Naïve Bayes classifier. Thus, we concluded that the superior performance of the spiking neural network is not due to spiking architecture, time resolution information or the STDP per se.
To test the one-shot learning spiking network, we created our own variable dataset. The dataset is conceived such that it models environmental and archetypal variance of typical odors. We prepared ten odorous mixtures, by randomly selecting and mixing a set of 16 volatile organics. Each odorous mixture is produced from a set of stable core chemicals and a variable/changing matrix. The headspace odorous gases from the core and matrix flasks are transported using the nitrogen carrier gas to the FTIR gas cell for recording their infrared absorption spectra.
We conclude that neuromorphic circuitry seems to be a plausible biological spiking network implementation of a Bayesian classifier, featuring learning, recall and representation capacities using a spiketime coding, but it still requires either an odor concentration tolerance layer, or multiple-shot learning, to handle signal statistics.

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Keyword: *electronic nose, neuromorphic, sensors, spiking networks, infrared absorption*

DRAFT

ID: 223

Nanoscale Friction of High Entropy Alloy Sulfide Thin Films in Comparison with Molybdenum Disulfide

Gokay Adabasi[*1], Aditya Deshpande[2], Koichi Tanaka[2], Joshua Ancheta[1], Emmanuel Maldonado[1], Mehmet Ozdogan[1], Suneel Kodambaka[3], Mehmet Z. Baykara[1]

[1] University of California Merced, USA
[2] University of California Los Angeles, USA
[3] Virginia Tech, USA

The outstanding wear and corrosion resistance exhibited by high entropy alloys (HEA) make them ideal candidates for coatings in mechanical systems. On the other hand, the question of whether HEA thin films will also act as solid lubricants remains open.

Here, we perform nanoscale friction measurements on HEA-sulfide ((VNbTaMoW)S_2) thin films via AFM. Results reveal (i) the influence of deposition time on film morphology and (ii) the presence of isolated areas of low friction on film surfaces. We compare the friction results on (HEA)S_2 thin films with those on sputter-deposited molybdenum disulfide (MoS_2) and find that they are on the same order. Finally, variable temperature X-ray diffraction (XRD), performed up to 800°C, reveals that (HEA)S_2 films exhibit improved oxidation resistance when compared with MoS_2 films. Combined, the results show that (HEA)S_2 thin films exhibit remarkable potential as environmentally-resistant solid lubricant coatings.

Keyword: *Nanotribology, High Entropy Alloys, Friction, AFM*

DRAFT

ID: 50

Development of Detergent Products with Synthesized Nanosilver

Hande Uçak Merdol*, Cem Barış Olçeşer, Ceyda Hemen
Viking Cleaning & Cosmetic Industry Co., İzmir, Türkiye

Thanks to the rapid progress of science and technology, the fact that the raw materials in the formulations have different functional properties was initially considered as an innovation, but today it is a necessity. With its unique chemical and biological properties, silver has been used in many studies in the past such as drinking water disinfection, prevention of eye infections. It has also been shown that viruses can inhibit the reproduction of such micro-organisms because they can bind to –SH structures in proteins and inhibit these structures. In order to transfer the properties of silver to cleaning and cosmetic products, the appropriate synthesis method was determined within the scope of this study and the synthesis conditions were optimized. Colloidal silvers in nano-sizes were synthesized using the "Turkevich" reduction method using trisodium citrate ($C_6H_5O_7Na_3$). Citrate was used in the reaction as both a reducing agent and a capping agent. During the study, it was aimed to synthesize colloidal nanosilver, to carry out characterization studies and to create liquid laundry detergent, surface cleaner and fabric softener products selected from the cleaning/cosmetic product range with the synthesized colloidal nanosilver. The synthesized colloidal nanosilver structures were characterized by ICP-MS, UV-VIS Spectroscopy and SEM analyses. According to the ICP-MS analysis results, the synthesized colloidal nanosilver concentration was found to be 159,08 mg/L. According to the results of UV-VIS analysis, the absorbance value was 0.9317, while the wavelength was observed around 448 nm. SEM images showed that the synthesized particle was 40-50 nm in size. For the liquid laundry detergent product containing colloidal nanosilver, pH, viscosity, stability, microbial product analysis and SEM analyzes were performed. The SEM images taken showed that the colloidal nanosilver in the product was 35-45 nm in size. The 3-month stability results on the product were evaluated as appropriate. In addition to liquid laundry detergent, synthesized silver nanoparticles have been trialled in different products such as surface cleaners and fabric softener. 3-month stability studies have been initiated and when these studies are completed, the analysis for characterization will continue.

Keyword: *Colloidal particle, Nanosilver, Turkevich method*

DRAFT

Investigation and Comparison of Conventional and Droplet Based Microfluidic Approaches to the Solvothermal Synthesis of Ti-MOFs (MIL-125)

Anıl Hatiboglu[*1], Selis Onel[2]
[1] *Nanotechnology and Nanomedicine Division, Hacettepe University, Ankara, Türkiye*
[2] *Department of Chemical Engineering, Hacettepe University, Ankara, Türkiye*

Solvothermal synthesis of particles with titanium based metal organic framework structures has been studied for over two decades since the discovery of MIL-22 and similar structures with a phosphorus ligand [1]. The discovery of MIL-125 was a great success which paved the way for the synthesis of many MOF structures having carboxylate type ligands. Ti-MOF crystals promise great uses in photocatalytic applications, such as alcohol oxidation, dye degradation, polymerization, H_2 production, and CO_2 photoreduction [2]. Synthesis of Ti-MOF crystals has been a challenge due to the high reactivity of titanium with oxygen. Synthesis conditions, such as temperature, existence of moist air, type and amount of the metal salt, ligand, and solvent heavily decide and alter the outcome of the synthesis as observed in the polymorphism between MIL-125 and Ti-MIL-101 [1,3]. Therefore, it is important to control the physical, chemical, and thermodynamic conditions in the synthesis environment. Microfluidics offer great benefits in terms of controllability and adjustability of the conditions for nanoparticle synthesis, providing enhanced heat and mass transfer, faster reaction times, better isolation from the ambient, and identical synthesis conditions for the whole product [4]. Studying the challenging synthesis of Ti-MOFs in microfluidic systems might shed light to the synthesis of new products with better performance and tunability. In this study, we used a precursor solution consisting of titanium (IV) isopropoxide, terephtalic acid (benzenedicarboxlylic acid(H_2BDC)), n,n-dimethylformamide(DMF), and methanol to synthesize MIL-125 nanocrystals at 100 °C both in a hydrothermal autoclave reactor and in picoliter sized monodispersed droplets generated in a microfluidic device. Here, we compare the thermodynamic and physicochemical properties in the conventional batch reactor and the droplet based microfluidic systems, and discuss their influence on the synthesized product. The probability of hydrolysis of Ti^{4+} leading to the formation of different complexes, such as TiO_2, hinders the formation of titanium oxoclusters that are the backbones of the MOF structure. The outcomes of this work might shed light into Ti-MOF formation processes, "the coordination 'habit' of titanium ion" [1], and bring new ideas to overcome the challenges in Ti-MOF synthesis.

This study has been supported by TUBITAK 1001 Project 220M002.

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Keyword: *Microfluidics, Metal-Organic Frameworks, Nanocrystals*

DRAFT

ID: 104

Synthesis of Multilayer MXene and Investigation of Drug Loading Efficiency

Ayça Tunçel[*1], Gül Kaya[2], Buse Sert[2], Şeyma Karagül[3], Ersan Harputlu[2], Fatma Yurt[1], Cumhur Gökhan Ünlü[4], Kasim Ocakoglu[2]

[1] Ege University, Department of Nuclear Applications, Institute of Nuclear Science, 35100, Bornova, Izmir, Türkiye.

[2] Tarsus University, Faculty of Engineering, Department of Engineering Fundamental Sciences, 33400 Tarsus, Türkiye.

[3] Ege University, Department of Biomedical Technologies, The Institute of Natural and Applied Sciences, 35100, Bornova, Izmir, Türkiye.

[4] Pamukkale University, Faculty of Technology, Department of Biomedical Engineering, 20070, Denizli, Türkiye.

One of the newest members of the 2D material family, MXene is transition metal carbides, nitrides, and carbonitrides. MXenes attract attention in the world of science and technology with their features such as high surface area, electrical conductivity, hydrophilicity, and chemical stability, and find applications in many fields such as energy, medicine, biomedical and environment [1]. The two-dimensional planar structure and physicochemical properties of MXenes show that they can be good carriers for the delivery of chemotherapeutic drugs in cancer treatment. In addition, its large active surface areas and high drug-loading efficiency increase the effectiveness of chemotherapy [2]. Although surface functionalization is done to increase its biocompatibility, it has been shown that it has sufficient biocompatibility and does not have a toxic effect even without this process. Considering the application areas and properties, MXene synthesis is very important; In this study, Mo-based MXene (Mo_2CT_x) synthesis was performed and drug loading efficiency was investigated. MXene synthesis was carried out in two steps. In the first stage, the MAX phase (Mo_2Ga_2C), which is the precursor to MXene, was synthesized by the vacuum sintering method [3]. Molar ratios of starting materials, sintering temperature, sintering time, and inert environment parameters are very important in the MAX phase synthesis process. These parameters directly affect the synthesis of high quality and purity MAX phase and thus the synthesis of MXene. In this context, synthesis of the MAX phase was carried out by sintering at 850°C using starting materials (Mo_2C and Ga) under an Ar atmosphere. The MXene synthesis from the MAX phase was carried out by hydrothermal method [4]. Since a mixture of HF is not used as an etching agent in MXene synthesis, no additional treatment was required to remove fluorinated groups, which is not preferred in biological studies. The synthesized MXene structure was examined using FE-SEM, TEM, XRD, and XPS characterization techniques. The drug loading properties of Paclitaxel (PTX), which is used as an anti-cancer drug for triple-negative breast cancer (TNBC), were examined in order to gain chemotherapeutic activity to MXene structures.

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Keyword: *MAX phase, MXene, hydrothermal method, paclitaxel, breast cancer*

DRAFT

Preparation of Nanohybrid Perovskite Structures and Investigation of Their Drug Loading Efficiency

Buse Sert[*] [1] , Derya Ozel[2] , Gul Kaya[1] , Seyma Karagul[3] , Ersan Harputlu[1] , Fatma Yurt[2] , Cumhur Gokhan Unlu[4] , Kasim Ocakoglu[1]

[1] Tarsus University, Faculty of Engineering, Department of Engineering Fundamental Sciences, 33400 Tarsus, Türkiye.

[2] Ege University, Department of Biomedical Technologies, The Institute of Natural and Applied Sciences,35100, Bornova, Izmir, Türkiye.

[3] Ege University, Department of Nuclear Applications, Institute of Nuclear Science, 35100, Bornova, Izmir, Türkiye.

[4] Pamukkale University, Faculty of Technology, Department of Biomedical Engineering, 20070, Denizli, Türkiye.

The heating mechanism of a particle in magnetic hyperthermia application occurs through Brownian and Néel relaxations under an alternating magnetic field. In self-regulated hyperthermia, the magnetic phase transition of the particle should be within the range of 41-46 °C. Considering these criteria, many studies have been conducted on compounds from the perovskite family, particularly $LaSrMnO_3$, due to their suitability for the mentioned properties. In the study, the surfaces of the perovskite nanomaterials were modified through silane and carbon coating processes to prevent excessive heating of healthy tissue, and to enhance the surface area of the modified magnetic nanoparticles (MNP), silane and carbon-coated nanoparticles were integrated onto graphene oxide (GO) layers [1,2]. FE-SEM analyses revealed a heterogeneous distribution of MNPs on GO layers with low agglomeration levels, and the presence of $LaSrMnO_3$ on the surface was detected by EDS measurements. Temozolomide (TMZ), a chemotherapy drug for Glioblastoma Multiforme (GBM) cancer, was loaded to the resulting nanohybrid structure (GO-MNP), and then drug release from nanoparticles was examined [3].

This research has been financially supported by The Scientific and Technological Research Council of *Türkiye*, TUBITAK (Grant: 221S429)

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Keyword: *Glioblastoma Multiforme cancer, temozolomide, combine treatment*

DRAFT

ID: 138

Synthesis of Zinc Chalcogenide Based Nanoplatelets with Cation Exchange

Çağatay Han Aldemir*, Alkim Baris Cengiz, Nehir Ergezer, Yusuf Keleştemur
Department of Metallurgical and Materials Engineering, Middle East Technical University, 06800, Ankara, Türkiye

Colloidal semiconductor nanoplatelets are emerging class of nanomaterials with their unique properties that are important in various fields of applications. These materials are highly attractive for next generation display technologies. They offer increased efficiency, enhanced colour gamut, improved brightness and contrast for displays. However, most of these materials are cadmium based, which are known as a toxic material. Furthermore, obtaining highly-efficient blue-emitting nanoplatelet is challenging and there are only a few examples in the literature. In this study, we demonstrate the synthesis of zinc chalcogenide based nanomaterials with cation exchange method. We started with CdSe/ZnS core/shell nanoplatelets and by using cation exchange reaction, we successfully synthesized $Cd_xZn_{1-x}Se$/ZnS having emission in the blue spectral region – 450 and 500 nm - with a narrow emission linewidth - down to 30nm.

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Keyword: *nanoplatelets, nanocrystals, cation exchange, zinc chalcogenide, luminescent materials*

DRAFT

ID: 147

Realization of a Micro-Sized Single-Cell Based Memristor Device Implementation

Nora Ali Abdo Saleh Al-jawfi*, Bünyamin Özkal, Gökhan Ekinci, Sinan Kazan
Department of Physics, Gebze Technical University, Kocaeli, Türkiye

The conventional passive circuit elements, namely the resistor, capacitor, and inductor, were long considered the fundamental components for nearly two centuries. Nonetheless, in 1971, Dr. Leon Chua introduced the concept of an additional passive circuit element, called the memristor [1]. This theoretical device remained hypothetical until 2008 when HP Labs successfully showcased a practical model of the memristor [2]. The memristor possesses distinctive characteristics that have the potential to greatly enhance current electronic systems and computing architectures. Furthermore, it holds the potential to revolutionize the field of neuromorphic computing.

In this study, we present the structural and electrical characterization of single cell memristor device in the form of Si/SiO2/Ta/Pt/TiOx /Pt thin film stack using the mask and optical lithography techniques where the mask designed has been drawn on Cr mask using the Heidelberg dwl66 model mask printer and lithography method to produce single-cell memristor devices with square surface areas of 5 μm, 10 μm, 25 μm, and 50 μm on a maximum area of 10x10 mm^2 substrate . The bottom metal electrode (Ta/Pt) were grown on self-oxidized Si substrate in sputtering chamber and the binary metal oxide TiO_2 were grown in Pulsed Laser Deposition (PLD) chamber with suitable growth condition.

The characteristic memristive behavior and quasi-static electrical characterizations of this device has been studied and the experimental current-voltage curves shows that the fabricated device is suitable for the analog behavior that can work as a perceptron in machine learning or mimic biological synapses as an analog processor which leads to the development of new generation neuromorphic networks that can mimic the human brain's ability to have both memory and computing capabilities in the same unit cell.

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Keyword: *Memristor.*

DRAFT

Direct Synthesis of Zinc Chalcogenide Based Nanoplatelets

Muhammed Said ES*, Ebrar Colak, Yusuf Kelestemur
Department of Metallurgical and Materials Engineering, Middle East Technical University, 06800, Ankara, Türkiye

The properties of semiconductor nanocrystals (NCs) are highly dependent on their morphology. For instance, colloidal semiconductor nanoplatelets (NPLs) have very promising optical characteristics owing to their two-dimensional (2D) electronic structure and quantum confinement effect. Especially, present-day obligations for Cd-free non-toxic blue emitters reveal the significance of blue-emitting ZnSe NPLs. There are hot injection, chemical reduction, and heating up methods for the synthesis of these NPLs. In all of these methods, different types of solvents and ligands have been used to understand their effect on the colloidal nanoplatelets (NPLs). Nevertheless, there is still uncertainty about the effects of oleylamine (OLA), octylamine (OCA), and oleic acid (OA) with respect to their amounts in the synthesis. In this study, we proposed a new method in order to obtain ZnSe NPLs with an absorption at 345 nm. Furthermore, we also developed a new way to synthesize different populations having 367 nm and 396 nm. We also analyzed the TEM and XRD results of these NPLs and corroborated these findings. These studies show that there is the possibility to synthesize ZnSe NPLs without using oleylamine (OLA) or octylamine (OCA).

Acknowledgment
The authors acknowledge the financial support from TUBITAK 1001 Program - 221M086.

Keyword: *semiconductor nanocrystals, colloidal semiconductor nanoplatelets, optical characteristics, Cd-free non-toxic blue emitters, ZnSe NPLs, oleylamine (OLA), octylamine (OCA), oleic acid (OA), absorption at 345 nm*

DRAFT

ID: 153

Production and Applications of Two-Dimensional Colloidal Templates with Self-Assembly

Elif Lülek*[1], Yavuz Nuri Ertaş*[1,2]
[1] *ERNAM – Nanotechnology Application and Research Center, Erciyes University, Kayseri, Türkiye*
[2] *Department of Biomedical Engineering, Erciyes University, Kayseri, Türkiye*

Periodic and hexagonal close-packed (HCP) structures obtained using colloidal nanoparticles are in high demand from different application areas due to their unique properties. In the method called nanosphere lithography, it is aimed to develop and apply surfaces with different functions by transferring the template structures obtained at the air/water interface to various surfaces as mono/multi layer. Unlike other lithographic processes used in surface development studies, nanosphere lithography has recently come to the forefront due to its advantages such as easy applicability, simplicity, reproducibility and low cost [1, 2]
The methods used to obtain template structures using nanosphere lithography can be roughly divided into two groups: air/water interface coatings and spin-coating. The high amount of solution used in the spin-coating method and the high amount of solution wasted due to centrifugal force have led the interest to coating at the air/water interface [3, 4]. Many disadvantages limit the application of nanosphere lithography such as the application of monolayer and HCP film structures on large surfaces, being defect-free, being able to be coated on surfaces regardless of particle size, the need for setup during deposition, and solution wastage.
In this study, we offer a new approach for coating at the air/water interface, taking into account the drawbacks of coatings at the air/water interface and the requirement for nanosphere lithography in lithographic-based systems. The technology has been demonstrated by reducing material waste at the air/water interface by covering polystyrene spheres (PS) with ethylene glycol and ethanol in specific amounts. Using an inductive coupled plasma-reactive ion etching (ICP-RIE) technology, the coated surfaces were etched with oxygen plasma at predetermined periods to create polystyrene spherical patterns in various sizes. PS spheres with an initial size of 320 nm were reduced up to 60 nm without disturbing the template structure. After covering with a thin layer of gold, the Raman behavior of PS spherical templates created with various etching times was also examined. As a result, the methodology we developed as an alternative to coatings at the air/water interface has proven to be suitable for covering very large areas with the least amount of solution without the need for any setup and pretreatment.

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Keyword: *nanosphere lithography, polystyrene spheres, air/water interfaces, colloidal particles, self-assembly*

DRAFT

Co-precipitation Synthesis of Iron Oxide Nanoparticles for Hyperthermia Applications

Hala Alsife[*1], Nour Jamaleddin[1], Nilay Gunduz Akdogan[2], Ozan Akdogan[3], Canan Bagcı[1]
[1] Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353, Istanbul, Türkiye
[2] Faculty of Engineering, Piri Reis University, 34940, Istanbul, Türkiye
[3] 1Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353, Istanbul, Türkiye

Magnetic nanoparticles, particularly magnetite (Fe3O4) nanoparticles, have diverse applications in MRI, biomedicine, and hyperthermia for cancer treatment[1]. Hyperthermia involves raising the temperature of cancerous tissues to 42°C, as cancer cells are more sensitive to temperatures between 41°C and 44°C. Magnetite nanoparticles possess superparamagnetic activity, high saturation magnetization, non-toxicity, and excellent biocompatibility, making them ideal for hyperthermia[2].

In this study, we synthesized Fe3O4 magnetic nanoparticles using a chemical co-precipitation approach, focusing on their potential for hyperthermia applications. Co-precipitation is a simple and cost-effective method for preparing mixed oxide precursors, avoiding the use of hazardous materials. Various variables, such as reaction temperature and coating agent concentration, affect the particle size[3]. Fe3O4 nanoparticles were synthesized using ferrous chloride tetrahydrate and ferric chloride anhydrous as precursors, with ammonium hydroxide as the precipitating agent. The nanoparticles were coated with oleic acid for stability and dispersibility, followed by ethanol removal of excess coating agent. Characterization using XRD and SEM confirmed the spherical shape and cubic spinel crystalline structure of the iron oxide nanoparticles. VSM results revealed lower saturation magnetization values for oleic acid-coated magnetite due to reduced suppression of surface moments, consistent with literature findings[4]. Additional FTIR analysis will determine characteristic peaks of the nanoparticles.

Efficient dispersion of nanoparticles in a solvent and maintaining consistent particle size and shape are crucial for successful hyperthermia[5]. A stable solvent for Fe3O4 nanoparticles was prepared using Agar-Agar, enabling dispersion and subsequent hyperthermia treatment. The synthesized solvent demonstrated effective heating properties, achieving a temperature increase from 21.5°C to 45°C within 7 minutes using a 400A current. The average crystalline size of the magnetite nanoparticles was 7nm, and saturation magnetization, remanence, and coercivity values were measured as 54.87 emu/g, 3.51 emu/g, and 56.76 Oe, respectively, at room temperature.

In conclusion, this study successfully synthesized magnetic nanoparticles using the chemical co-precipitation method, highlighting the importance of synthesis conditions and nanoparticle characterization. The nanoparticles demonstrated potential for hyperthermia applications in raising the temperature of cancerous tissues.

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Keyword: *Magnetic Nanoparticles, Chemical Co-precipitation method, Hyperthermia, Size-controlled magnetite*

DRAFT

Synthesis and Structural Survey of VO_2 Thin Films for Memristive Systems

Gökhan Ekinci[*1], Bünyamin Özkal[2], Nora Ali. A. S. Al-Jawfi[2], Sinan Kazan[2]
[1] Pîrî Reis University, Gebze Technical University, Kocaeli, Türkiye
[2] Gebze Technical University, Kocaeli, Türkiye

Memristors, instead of complementary metal oxide-based circuits (CMOS), have made great advances in recent years as a new candidate for neuromorphic hardware. Memristors are memory devices that can store information. Memristors perform this function by regulating the distribution of oxygen anions or metal cations that cause sharp changes in resistance [1]. It has been observed in studies that VO_2 - based memristor devices successfully perform most of the known biological neural functions [2]. The conductivity of VO_2 can be changed by an applied electric field, even at room temperature. This switching mechanism, which consists of changing the conductivity, depends on the rearrangement of the positively charged oxygen vacancies in VO_2. With the applied voltages, the mobile oxygen spaces in the VO_2 memristor devices are rearranged and nano-sized conductive channels are formed that lead to the switching behavior [3]. Therefore, structural defects, especially oxygen defects, have a significant effect on the memristive characteristics of VO_2 memristor devices.

In this study, we presented nanosized VO_2 thin films on Si/SiO_2 substrates at different substrate temperatures (room temperature- 300°C and 400°C) using the Pulsed Laser Deposition (PLD) system. Also, by using X-Ray Photoelectron Spectroscopy (XPS), Raman and Fourier Transform Infrared (FTIR) Spectroscopy techniques we investigated the effect of different substrate temperatures on the structural state and oxygen content of the films produced. And Defect structures, especially oxygen defects in the films, were examined in detail by means of Photoluminescence Spectroscopy (PL) measurements. We also examined the surface morphologies of the films with Scanning Electron Microscopy (SEM) measurements.

In the XPS measurements, the binding energies tell us that all films are formed in the form of VO_2. Also, the oxidation state of vanadium reports that the films have very good chemical stability. SEM images show that the films have a smooth structure. With the increase of substrate temperature, more uniform and homogeneous film structures were obtained. No characteristic VO_2 signal was observed in Raman Spectroscopy measurements. It can be said that higher substrate temperatures are required to form the VO_2 crystal form. PL measurements report that oxygen defects and characteristic emission peaks occur in all films.

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No: 121F390.

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Keyword: *Memristor, VO2, PLD, Thin Film, PL*

DRAFT

Fabrication of Stable and Efficient Perovskite Nanocrystal Composites with Superhydrophobic Coatings

Sema Karabel Öcal* [1] **, Nusret Çelik[1] , M.Serdar Önses[1] , Evren Mutlugün[2]**
[1] *Department of Materials Science and Engineering, Erciyes University, Kayseri, 38039, Türkiye*
[2] *Department of Electrical and Electronics Engineering, Abdullah Gul University, Kayseri, 38080, Türkiye*

Perovskite nanocrystals (PNCs) have a narrow band structure, high photoluminescence quantum efficiency (PLQY) and excellent optical properties, as well as low cost and high performance. It has been used in applications such as light-emitting diodes (LED)[1], display[2] and photodetector[3]. However, PNCs are very sensitive to ambient conditions such as humidity and temperature due to their ionic properties which practically limit their application[4].

In this study, modified superhydrophobic Si NPs (HSNPs) were used to improve the stability of PNCs in environmental conditions. It is an easy and low cost method compared to other developed methods. Due to the developed composite materials, excellent water resistance and thermal stability of PNCs are provided. NCs synthesized by the hot injection method were blended with superhydrophobic modified Si NPs. The PLQY measurements of the synthesized HSNPs@PNCs composites were determined as 20%, 46% and 19%. HSNPs@PNCs with halogenic elements (Cl, Br, I) have been produced in a wide range of colors.

Stability studies are directly related to the development of application areas of PNCs. As it is known, PNCs rapidly interact in the aquatic environment and lose their ability to radiate. With these composite materials we have developed, it maintains 75% of its initial yield for 30 days in water stability studies. The composites produced showed excellent water resistance. Another important stability test for PNCs is thermal stability. Therefore, PNCs and HSNPs@G-PNCs were exposed to different temperatures, such as 70°C, 120°C and 170°C, to investigate their stability. The PL density of PNCs decreases drastically with high temperature. The main reason for this is the greater separation of surface ligands with increased heating. However, HSNPs@PNCs were able to maintain 78% of their efficiency even at 120°C. Therefore, HSNPs made a significant contribution to the thermal stability of PNCs.

We have developed superhydrophobic composites, they are stable materials that radiate in the visible spectral region of 450nm-650nm without damaging the original structure of the PNCs. HSNPs@PNCs have clearly demonstrated improved stability to water, heat treatment and photostability. These results showed that HSNPs@PNCs composites are very advantageous in improving stability for imaging technology.

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Keyword: *Perovskite NC, Superhydrophobic Silica NPs, Stability, Photoluminescence*

DRAFT

Determination of Heavy and Trace Elements in Commercial Green Teas By SEM-EDX and XRF Analysis

Zehra Sinem Yılmaz*, Duygu Oğuz Kılıç, Mine Bahçeci, Mutlu Devran Yaman
İzmir Institute of Technology University, Center for Materials Research, İzmir, Türkiye

Green tea is made from the leaves of the plant Camellia sinensis. Theaceae and is thought to have anti-cancer, anti-obesity, anti-atherosclerotic, anti-diabetic, anti-bacterial and anti-viral effects. So, the elements contained in green tea are very important for the health of the human body. This study, To determine the heavy metal and trace element composition of 8 different commercial green tea powders.
A, B, C, D, E, F, G, H coded powder green teas attached to stub with carbon tape. Elemental composition in green teas have been determined by point analysis wıth EDX from different contrast areas with BSE detector in SEM. Moreover, The elemental composition of the EDX results from 5 different areas of each sample was also determined and these average is taken.
In this study, the amounts of heavy metals and trace elements in 8 different herbal green tea powders were determined by EDX area analysis. The human body also needs a variety of elements for all aspects of bodily function. A deficiency of essential minerals leads to a wide range of diseases, while some elements are harmful to the body even at low concentrations. K and Na are essential for life and also play important roles in the during excitation and transmission in nerve cells. Ca, which improves the quality of bones and teeth and teeth, also plays a role in the coagulation process. For example, the potassium (K) ratio in the EDX analysis taken from the areas in green tea coded D is 1.44%, while it is 0.65% in green tea coded F. Aluminum also regarded as a toxic element was present at a high concentration in the green tea coded G (the result of EDX area analysis is 1.27%) but was much lower in green tea coded H (the result of EDX area analysis is 0.46%). The highest levels of aluminium could be the cause of pathological changes in the human lungs, the central nervous system and the bones. Approximately 0.3 g of the plant material was weighed and elemental chemical analysis was carried out using the XRF (X-ray fluorescence spectrometry) method. The percentage values of the elements in green teas were determined as follows. Trace element oxides were also detected in powder green teas. For example; Na2O (Sodium oxide) in green tea coded F has 20.31%, but ZnO (Zinc oxide) is 0.1432%. In addition to the total amounts of elements, their chemical forms, i.e. chemical species (speciation), are also very important for their bioavailability. For this reason, studies to determine the type s of elements active in the body have become increasingly important in recent years. At the same time, this study is a preliminary study on the use of green synthesis in the production process of green tea.

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Keyword: *Green tea, SEM-EDX, XRF, Heavy and Trace elements, Green Synthesis*

DRAFT

ID: 241

Nitrogen-Rich Porous Organic Polymers for Water and Air Purification

Ferit Begar*, **Yasmin Geçalp, Mustafa Erdoğmuş, Onur Büyükçakır**
Izmir Institute of Technology, İzmir, Türkiye

Through the utilization of nitrogen-rich shape-persistent compounds as organic linkers possessing varying inherent cavity sizes, we have successfully synthesized two porous organic polymers. The structural characterizations revealed that the porosity of the polymers could be enhanced by expanding the void sizes of the shape-persistent-building units incorporated in the polymers. The as-synthesized polymers were tested as an adsorbent for capturing radioactive iodine (I_2) in both the gas phase and aqueous solution, providing valuable insights into their effectiveness in iodine sequestration. The results demonstrate the high capacity of polymers to absorb iodine. Also, increasing the dimensions of cage monomers further increased the iodine uptake capacity. These results clearly show that the porosity and iodine capture performance of the porous polymers can be tailored by adjusting the sizes of the shape-persistent precursors and bringing a new perspective on designing next-generation porous polymers with targeted functionalities for specific applications.

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Keyword: *polymeric frameworks; porous organic polymers; iodine capture; microporosity; shape-persistent compounds*

DRAFT

Green Synthesis of Silver Nanoparticles

Betül Öztürk Köksal*, Fatma Rabia Karaduman, Nesrin Horzum
İzmir Katip Celebi University, İzmir, Türkiye

A growing understanding of the need for a sustainable environment has made the synthesis and use of green nanoparticles crucial. Metal nanoparticles are generally synthesized by physical and chemical methods using chemicals such as reducing agents (sodium borohydride, hydrazine, formaldehyde, oleylamine, etc.) which are toxic and harmful to the environment[1]. Therefore, it is necessary to develop environmentally friendly methods using biological alternatives (algae, plants, bacteria, fungi, actinomycetes, yeasts, and viruses)[2]. Biogenic silver nanoparticles (AgNPs) were synthesized using the microalgae (Spirulina sp.) and macroalgae (Cystoseira barbata) as reducing and stabilizing agents. The effect of silver precursors (silver nitrate and silver acetate) and reducing agents (algae-based powder and electrospun fiber)[3] on the size and shape of the nanoparticles were investigated. Furthermore, several parameters, including contact time, amount of reducing agent, pH levels, and temperature were screened to optimize the AgNPs synthesis. The resulting AgNPs were characterized by Ultraviolet–Visible (UV–Vis) spectroscopy, Scanning Electron Microscopy (SEM), Particle Size Analysis, Fourier Transform Infrared spectroscopy (FTIR), and X-Ray Diffraction (XRD).

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Keyword: *algae-based reducing agents, biogenic synthesis, electrospinning, nanoparticles*

DRAFT

Synthesis of SNPs (<100nm) Using Hybrid Micelles

Esra Sıla Gündüz[*1], **Tuğçe Tunç Gulıyev**[1], **Hürriyet Polat**[2], **Mehmet Polat**[1]
[1] *İzmir Institute of Technology, Department of Chemical Engineering, İzmir, Türkiye*
[2] *İzmir Institute of Technology, Department of Chemistry, İzmir, Türkiye*

Silica (SiO_2) nanoparticles are versatile materials which find use in many advanced applications such as drug delivery, electronics, and photonics. The Stöber method is widely used for the synthesis of silica nanoparticles (SNPs). However, it is a challenging endeavor to synthesize SNPs below 100 nm with this method. The surfactant-micelle template method is an alternative employed in the literature for manufacturing such particles. The positively charged CTAB surfactant is the most commonly used surfactant for the purpose. However, silica nanoparticles synthesized using CTAB alone are not sufficiently small and tend to agglomerate.

In this study, a triblock co-polymer (P-123) was employed together with CTAB to produce hybrid micelles with desired size and surface charge characteristics for generating suitable nucleation sites for achieving sizes below 100 nm. It was observed that the size control depended greatly on the number of positively charged CTAB molecules in the micelle assembly. By proper manipulation of the chemistry, it was possible to produce well-dispersed mono-sized SNPs below 100 nm. The particles produced were characterized using DLS for in-situ size and zeta potential measurements. XRD, SEM, STEM, and FTIR analyses were also carried out for further characterization.

Keyword: *silica nanoparticles, micelles, hybrid micelles, surfactants*

DRAFT

Analysis of the Parameters Used to Produce the Collagen Type I/PVA Nanofiber Composite for Tissue Regeneration

Hayrullah Çetinkaya[*1], Mustafa Özgür Öteyaka[2], Gökçe Özden Gürcan[3], Gamze Kara Mağden[4], Mehtap Şahin[4]

[1] Eskişehir Osmangazi University, Faculty of Engineering and Architecture, Department of Chemical Engineering, Eskişehir, Türkiye

[2] Eskişehir Osmangazi University, Eskişehir Vocational School, Department of Electronic and Automation, Eskişehir, Türkiye

[3] Eskişehir Osmangazi University, Eskişehir Vocational School, Department of Machinery and Metal Technologies, Eskişehir, Türkiye

[4] BUGAMED Biyoteknoloji Sanayi Ve Ticaret A.Ş., Eskişehir, Türkiye

This study aims to analyze the effect of electrospinning and solution parameters on the nanofiber diameter of collagen type I/PVA composite. For this purpose, the nanofiber composites were produced using different variables such as PVA ratio, collagen ratio, PVA mixing ratio-collagen mixing ratio, voltage, and feed rate. The morphology and the average diameter of the nanofiber composite scaffold were characterized using field emission scanning electron microscopy (FESEM) and ImageJ software. Main effects, surface plots, and interaction plots were obtained by employing the Minitab software. The results show that the nanofibers were randomly distributed according to FESEM analysis. In general, the average nanofiber diameter increased with increments in the PVA ratio, collagen ratio, mixing ratio, and feed rate. On the other hand, the average nanofiber diameter decreased when the applied voltage increased. Furthermore, it was observed that the average nanofiber diameter was greater than 500 nm when using a higher collagen ratio and mixing ratio. The lowest average nanofiber diameter was recorded with higher voltage, 8 wt.% PVA, 0.5 ml/h feed rate, the lowest mixing ratio, and collagen Type I ratio.

Keyword: *Electrospinning, Nanofiber, Statistical analysis, Collagen type I, PVA*

DRAFT

Determination of Photothermal Heating Effect and Conversation Efficiency of Mo_2C@C@Fuc / Mo_2CTx-MXene@Fuc Hybrid Nanomaterial

Ayça Tunçel[*1], Gül Kaya[2], Buse Sert[2], Ersan Harputlu[2], Cumhur Gökhan Ünlü[3], Kasim Ocakoglu[2], Fatma Yurt[1]

[1] Ege University, Department of Nuclear Applications, Institute of Nuclear Science, 35100, Bornova, Izmir, Türkiye.

[2] Tarsus University, Faculty of Engineering, Department of Engineering Fundamental Sciences, 33400 Tarsus, Türkiye.

[3] Pamukkale University, Faculty of Technology, Department of Biomedical Engineering, 20070, Denizli, Türkiye

Nanoheaters, or photothermal conversion nanoparticles, have emerged as promising technology with several applications in various fields [1], [2]. They enable spatially confined and non-contact heating of the surrounding environment, creating new opportunities in fields such as solar light energy harvesting, photocatalysts, and photoactuators [3]. Moreover, nanoheaters offer great potential in cancer photothermal therapy (PTT), especially after their successful application in clinical trials for prostate cancer treatment [4]. Cancer cells are known to be more susceptible to overheating beyond 41 °C, making PTT a promising approach for cancer therapy. Thermal ablation at temperatures above 48 °C can also be utilized to damage the affected cells6 [5]. In our study, we investigate the light-to-heat conversion capabilities of Mo_2C@C@Fuc / Mo_2CTx-MXene@Fuc hybrid nanomaterials and discuss their potential applications in photothermal therapy (PTT) for cancer treatment. The key information to be examined is the light-to-heat conversion efficiency, representing the material's ability to convert light into heat energy. Therefore, considering various parameters, the study establishes a qualitative capacity based on light-to-heat conversion efficiency. The evaluation focuses on Mo_2C@C@Fuc / Mo_2CTx-MXene@Fuc hybrid nanomaterials prepared at different concentrations and their light-to-heat conversion properties under laser irradiation at different wavelengths (808 and 1064 nm). The nanomaterial is selected at the highest laser power (2 W/cm^2) and maximum concentration (100 µg /200 µL) to determine its photothermal conversion capacity. Furthermore, the study examines the impact of nanomaterial distribution in different colloidal solutions (pure water, pH 7 PBS, and pH 5 PBS) on its photothermal conversion capacity. In this context, the Mo_2C@C@Fuc/Mo_2CTx-MXene@Fuc hybrid nanomaterial demonstrates a photothermal conversion capacity of 18 %, along with its achieved maximum temperature and photostability properties, suggesting its suitability as an agent for PTT. Additionally, the nanomaterial's photothermal stability is investigated, revealing minimal changes even after five repeated laser stimulations. Based on the data obtained, it is believed that the Mo_2C@C@Fuc / Mo_2CTx-MXene@Fuc would be sufficient for the thermal ablation of tumor cells/tissues.

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Keyword: *Nanoheaters, photothermal heating efficiency, Photothermal therapy, MXene nanomaterials*

DRAFT

ID: 315

Investigation of Antibacterial Activity and Polyethersulfone (PES) Membrane Usability of Delafossite Type Oxide Nanoparticles

Rahel Yıldırım[*1], Mehmet Gülcan[1], Sadin Özdemir[2], Gülşah Tollu[2], Nadir Dizge[2]
[1] Van Yüzüncüyıl Üniversitesi, Van, Türkiye
[2] Mersin Üniversitesi, Mersin, Türkiye

Delafossite type oxide nanoparticles, usually expressed with the $CuMO_2$ (M = Al, Cr, Fe, Ga, Mn) formula, are interesting materials with potential applications in many areas, especially in catalysts, photoelectrochemical cells and multiferroic devices. In this work, delafossite type oxides such as $CuMnO_2$ and amine-functionalized $CuMnO_2$ ($CuMnO_2$-NH_2) were synthesized and the prepared materials were characterized by FESEM, P-XRD, FTIR and BET techniques. The biological properties such as antioxidant, antimicrobial, cell viability, antidiabetic, antibiofilm and DNA fragmentation of the delafossite type oxide materials were examined. $CuMnO_2$ and $CuMnO_2$-NH_2 showed good antioxidant, antimicrobial and antibiofilm properties. The highest antioxidant activity for $CuMnO_2$ was 75.93% at 100 mg/L, while the highest antioxidant activity for $CuMnO_2$-NH_2 was 92.35% at 100 mg/L. The most effective MIC value against E. hirae, E. faecalis and S. aureus was obtained as 32 mg/L. Finally, the application of polyethersulfone (PES) membrane coated with $CuMnO_2$ and $CuMnO_2$-NH_2 compounds for E. coli removal were perfomed in membrane industry.

Keyword: *Antibacterial, Biofilm inhibition, Delafossite, DNA cleavage, PES membrane*

DRAFT

3D Porous Laser-induced Graphene Sponges

Fatmanur Kocaman Kabil[*1], **Nihan Aydemir**[1], **Ahmet Yavuz Oral**[2]
[1] *Institute of Nanotechnology, Gebze Technical University, Gebze, Kocaeli, Türkiye*
[2] *Department of Material Science and Engineering, Gebze Technical University, Gebze, Kocaeli, Türkiye*

Porous materials are used in a variety of applications, including flexible electronics, sensors, energy and more. In this study, we have fabricated macroporous graphene/Ecoflex sponges with pore sizes ranging from 420 to 850 μm using the sugar templating method. First, we prepared graphene powder by laser-induced graphene (LIG), which offers significant advantages due to the low-cost, simple, fast, and scalable alternative graphene fabrication technique. Then obtained graphene powder was used to prepare a conductive ink and this ink was embedded in an Ecoflex sponge. We studied the shape of the graphene sponges and determined their mechanical and electrical properties. Conductive sponges, which can be made very stretchable, are very promising for flexible and wearable sensing applications.

Keyword: *conductive sponges, laser-induced graphene, flexible electronics*

DRAFT

ID: 13

Kirigami Inspired Graphene Based Stretchable Electronics

Berkcan Zülfikar*, **Nihan Aydemir**
Gebze Technical University, Kocaeli, Türkiye

Electronics that possess stretching and flexible capabilities without breaking are known as stretchable electronics. For instance, soft robotics, healthcare prosthetics, wearable technologies, and electronic gadgets are common examples that stretchable electronics can be utilized. Nanoparticles, CNTs, and graphene can be used in composites to produce flexible electronic components. Herein we introduce stretchable graphene-based electronics that preserve their conductivity and electron transfer rates in the presence of mechanical strain. Using the laser induction method, the polyimide films are converted to graphene films and Kirigami-style designs are employed to induce structural stretchability as polyimide is not intrinsically stretchable. The presented research explains the fabrication and characterization of laser-scribed graphene, explores novel Kirigami designs that can induce stretchability on a rigid polymeric film, and investigates the concept of graphene-based stretchable electronics via Kirigami-inspired designs. First, graphene films are fabricated, then kirigami designs are implemented through laser cutting, and at last the current-potential (I-V) curves will be measured in the presence of the mechanical strains that will stretch the films up to %200. The electrical current vs level of strain is measured and recorded. The change in stretchability and mechanical properties as well as the impact on electrical properties are also investigated.

Keyword: *Graphene, Stretchable Electronics, Kirigami, x-ray photoelectron spectroscopy, scanning electron microscopy, x-ray diffraction spectroscopy, raman spectroscopy*

DRAFT

ID: 57

Wearable, Flexible MXene-based Iontronic Pressure Sensor for Human-Machine Interface

Melih Ogeday Cicek*, Oyku Cetin, Tufan, Bölükbaşı, Husnu Emrah Unlan
Department of Metallurgical and Materials Engineering, Middle East Technical University, Ankara, Türkiye

Over the last decade, flexible electronics became an important part of our life and started to be used excessively. Among the family of flexible electronics, flexible pressure sensors constitute a significant portion due to their multifunctionality, adaptability, and facile fabrication. The need for state-of-the-art flexible pressure sensors is increasing in various fields such as real-time healthcare monitoring, human-machine interface, and intelligent robotics However, a remarkable portion of the previously reported pressure sensors suffer from limited flexibility, excessive weight, and insufficient sensitivity. Additionally, reported wearable pressure sensors demonstrated limited functionality to overcome the demands of today's electronics. Consequently, the development of wearable, flexible and highly functional pressure sensors with no sacrifice in performance is a necessity. This study presents the development of a versatile, portable iontronic pressure sensor using Ti_3C_2 MXene current collectors and an ionically conductive gel composed of thermoplastic polyurethane (TPU) and 1-Ethyl-3-methylimidazolium bis(trifluoromethyl sulfonyl)imide (EMIM TFSI). The sensor is integrated into a foam structure, offering flexibility and wearability. The fabricated iontronic pressure sensor demonstrated high sensitivity of 10 kPa^{-1} with an outstanding pressure resolution lower than 1 Pa. Furthermore, the sensor demonstrates exceptional mechanical durability throughout 10,000 cycles of compression-release and bending, showcasing its remarkable stability. Finally, to demonstrate a real-life application, flexible, wearable, and highly sensitive iontronic pressure sensors are utilized a smart glove for human-machine interface.

Keyword: *Ti3C2 MXene, iontronic pressure sensor, human-machine interface*

DRAFT

ID: 99

Fabrication of 2D Titanium Disulfide Electrode Active Materials for Supercapacitor Applications

Ali Deniz Ucar*, **Sumeyye Kandur, Mete Batuhan Durukan, Husnu Emrah Unalan**
Department of Metallurgical and Materials Engineering, Middle East Technical University, Ankara, Türkiye

Two-dimensional materials have attracted a lot of intention due to their unique properties that enable them to be used in various applications, especially for energy storage. Electronic, chemical, and optical properties of transition metal dichalcogenides (TMDs) can be tailored through their fabrication route. Mostly studied TMDs are molybdenum disulfide (MoS_2) and tungsten disulfide (WS_2). Among TMDs, titanium disulfide (TiS_2) is the lightest member of TMDs and a promising material for supercapacitors. In this work, electrically conducting 2D TiS_2 flakes were fabricated and utilized as supercapacitor electrodes. Self-standing and flexible TiS_2 films were fabricated using vacuum filtration. Poor oxidation stability of the self-standing TiS_2 films was improved with the dopamine treatment. A specific capacitance of 8 F/g and a capacity retention of 89% was obtained after 5000 cycles for TiS_2 based symmetric supercapacitor device.

Keyword: *titanium disulfide, supercapacitors, 2D nanomaterials, transition metal dichalcogenides*

DRAFT

ID: 156

Synthesis of Lead Chalcogenide Based Nanoplatelets

Ulaş Yaprak*, Eren Topcu, Melis Şimşek, Yusuf Keleştemur
Department of Metallurgical and Materials Engineering, Middle East Technical University, Ankara, Türkiye

Two dimensional colloidal lead chalcogenide nanoplatelets are emerging material as an active material in next generation solar cells. They exhibit broad bandgap tunability, high absorption cross-section and suppressed Auger recombination rates. While suppressed Auger recombination rates is useful for reducing the non-radiative recombination, the high bandgap tunability allows for better current matching capabilities in tandem cells. However, there is a problem with the synthesis of lead chalcogenide nanoplatelets. During the cation exchange reactions, the morphology of the nanoplatelet could not be preserved. Here, we propose a novel approach by using a core/crown nanoplatelet for cation exchange reactions. The proper passivation our periphery of core nanoplatelets with the crown layer may protect the morphology of the sample while showing similar electronic properties to core only particles. We synthesized PbSe/PbS and PbSe/PbTe core/crown nanoplatelets and observed that PbSe/PbTe core/crown nanoplatelets successfully preserve their morphology. Thank you for your consideration of this abstract

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[1] The authors acknowledge the financial support from TUBITAK 2247-D Program – 121C227.

Keyword: *nanoplatelets, colloidal quantum dot*

DRAFT

Comparison of photocatalytic degradation of methylene blue: Preparation of reduced graphene oxide by Chemical, Thermal and Microwave Methods

Marwah Ali Ibrahim*, Teoman Ozturk, Halit Cavusoglu
Department of Physics, Faculty of Science, Selçuk University, Selçuklu, 42130, Konya, Türkiye

Dye substances have been extensively used in industries, leading to resource depletion and pollution. The removal of organic dyes from wastewater is crucial due to its negative impact on the environment. Various techniques, such as coagulation, biodegradation, membrane filtration, chemical oxidation, adsorption, and photocatalysis, are employed for dye removal[1, 2]. The use of photocatalysts for the degradation of synthetic and organic contaminants has evolved as an efficient technology for wastewater treatment. Therefore, many researchers have focused on different types of photocatalytic materials such as two-dimensional carbon nanostructures, like graphene oxide (GO) and reduced graphene oxide (RGO). GO can be reduced to obtain reduced graphene oxide (rGO) using chemical, thermal, or microwave methods[3]. The present work "Comparison of photocatalytic degradation of methylene blue: Preparation of reduced graphene oxide by Chemical, Thermal and Microwave Methods" focuses on characterizing and exploring the photocatalytic performance of rGO synthesized through various reduction methods. The photocatalytic degradation of methylene blue (MB) under UV light irradiation was utilized as a test reaction to determine the impact of the preparation process on the physico-chemical parameters. SEM, XRD, and FTIR analysis were employed to characterize the synthesized rGO samples, confirming structural integrity, crystalline nature, and reduction of functional groups from GO. The SEM images confirmed that the reduction methods maintained the structural integrity of the graphene sheets in rGO. XRD patterns indicated the crystalline nature of rGO, suggesting the removal of oxygen-containing functional groups. FTIR spectra showed a significant reduction in functional groups such as -OH, -COOH, and -C=O in rGO compared to GO. Notably, rGO synthesized via the microwave reduction method exhibited the highest photocatalytic activity, followed by the thermal and chemical reduction methods. This enhanced photocatalytic activity can be attributed to the efficient reduction of GO and the presence of more active sites on the graphene sheets. rGO has emerged as a potential photocatalyst for environmental treatment and offers new possibilities for graphene-based nanocomposites.

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Keyword: *Reduced Graphene Oxide, Photocatalysis, Methylene Blue*

DRAFT

ID: 249

Investigation of the Photo-response of Graphene/Silicon Photodetector in the Ultraviolet Region

Çicek Kaplan*, Cem Çelebi
İzmir Institute of Technology, Department of Physics, Quantum Device Laboratory, Urla, İzmir, Türkiye

The effect of athmospheric adsorbates on the optoelectronic characteristics of p-graphene/n-silicon (p-Gr/n-Si) Schottky junction photodetector has been investigated under ultraviolet (UV) radiation. p-Gr/n-Si photodetector devices were fabricated on n-Si substrates with different doping concentrations and resistivities (ρ=1-5 Ω.cm and ρ=1-10 Ω.cm) to see the substrate effect on their UV sensitivity. All the devices revealed a strong rectification behaviour as determined by current-voltage (I-V) measurements conducted under dark envorinment. The spectral responsivity measurements taken in between a wavelength range of 250 nm – 1050 nm showed that the wavelength of the maximum spectral responsivity of devices shifts from 920 nm to 810 nm as the substrate resistivity is increased from ρ=1-5 Ω.cm to ρ=1-10 Ω.cm. In order to determine the effect of adsorbates on the UV response of p-Gr/n-Si photodetector , the spectral responsivity measurements were carried out under high vacuum conditions (10-5 mbar pressure) for the wavelength range between 250 nm and 400 nm. Under athmospheric conditions the spectral responsivity of the device with ρ=1-5 Ω.cm resistivity was measured as 0.09 AW-1 at 400 nm wavelength. After an intense UV light exposure applied under high vacuum conditions, the spectral responsivity of the sample was found to be decreased to 0.06 AW-1 for the same wavelength. The obtained results showed that the atmospheric molecules such as O2, N2, and H2O already attached to graphene shift its Fermi level due to charge transfer process. This shift at the p-Gr/n-Si interface leads to an enhancement in the Schottky barrier height from 0.77 eV to 0.79 eV. Our findings provide an insights into the effect of adsorbates on the optoelectronic characteristics of the photodetectors fabricated out of 2D materials and conventional semiconductors.

Keyword: *Photoresponse, optoelectronic, graphene, silicon, adsorbates*

DRAFT

ID: 285

First-principles investigation of 2-dimensional tetrahexagonal InN alloys: Anisotropic mechanical, electronic, and charge carrier transport properties for photocatalytic water splitting

Doğukan Hazar Özbey*[1], Mehmet Emin Kılıç[2], Engin Durgun[1]
[1] *UNAM-Institute of Materials Science and Nanotechnology, Bilkent University, Ankara, Türkiye*
[2] *Korea Institute of Science and Technology, Seoul, 02792, Republic of Korea*

Two-dimensional (2D) materials with unique physical properties lead to new possibilities in future nanomaterial-based applications. Among them, 2D structures which are suitable to be the solar-driven catalyst for water splitting reactions have become excessively important since the demand for clean energy sources increases in conjunction with the environmental harm of fossil fuels. Apart from the conventional crystals with well-known symmetries, recent studies showed that materials that have exotic decorations could possess superior features. In this respect, we investigate novel 2D tetrahexagonal (th-) InN crystal and its ordered alloys $In_{0.33}X_{0.67}N$ (X=Al, Ga) that can be utilized as effective catalysts for water splitting reactions. Proposed structures possess robust energetic, dynamical, thermal, and mechanical stability with a versatile mechanical response. After a critical tensile strain value, all monolayers exhibit strain-induced Negative Poisson's ratio in a particular crystal direction, making them half-auxetic materials. The examined materials are indirect semiconductors with desired bandgaps and band edge positions for water splitting applications. Due to their structural anisotropy, they have direction-dependent mobility that can keep the photogenerated charge carriers separated by reducing their recombination probability, which boosts the photocatalytic process. Relatively high absorption capacity in the wide spectral range underlines their potential performance. The versatile mechanical, electronic, and optical properties of 2D th-InN and its alloys $In_{0.33}X_{0.67}N$ (X=Al, Ga), together with their remarkable structural stability, indicate that they can appropriately be exploited in the future for water splitting applications.

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Keyword: *2D Materials, Photocatalytic Water Splitting*

DRAFT

ID: 307

Geometrically Asymmetric MoS_2 Diodes for Solar Cell Application

Amin Abnavi*, **Ribwar Ahmadi, Michael Adachi**
School of Engineering Science, Simon Fraser University, Burnaby, BC, Canada

Recently, geometrically asymmetric 2D materials-based devices have gained a great interest for solar cells and self-powered photodetector applications due to their simplicity in design and fabrication. However, the exact mechanism behind the current rectification and high optoelectronic performance of such devices is still unclear. Here, we have investigated the effect of the degree of contact area asymmetry on the electronic and optoelectronic properties of the Cr/MoS_2/Cr devices. We have shown that the current rectification ratio of the geometrically asymmetric MoS_2 devices (GA-MoS_2) is directly dependent on the degree of asymmetry in the contact area. The I-V measurements of the geometrically asymmetric Al_2O_3-coated MoS_2 devices suggest that the observed current rectification ratio is likely due to the unequal number of surface states at the MoS_2/Cr interfaces and therefore the presence of different Schottky barriers. Finally, under solar illumination, the device demonstrates a high open-circuit voltage (V_{oc}) of 430 mV and a short-circuit current density (J_{sc}) of −13.42 mA/cm^2, resulting in a high power conversion efficiency (PCE) of ~3 %, which is the highest reported for a lateral 2D solar cell.

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Keyword: *MoS2, Solar cell, 2D materials, Optoelectronics*

DRAFT

ID: 26

A Novel Dark Catalyst Material Based on Fe_3O_4/MWCNT/SiO_2 Magnetic Nanocomposite for Ultrafast Degradation of Methylene Blue from Water

Elham Molahosseini[*1], Farzad Farahmandzadeh[2], Mehdi Molaei[2], Hakimeh Zare[1]
[1] Department of physics, Yazd University, Iran
[2] Department of physics, Vali-E-Asr University of Rafsajan, Iran

Degradation and removal of organic dyes from industries' wastewater has attracted great attention in this days due to water shortage crisis. In this work, a novel dark catalyst material based on Fe_3O_4/MWCNT/SiO_2 magnetic nanocomposite was introduced. Fe_3O_4/MWCNT/SiO_2 nanocomposites were synthesized by a facile, simple, rapid, and one-pot synthesis method by ultrasonic probe. The prepared Fe_3O_4/MWCNT/SiO_2 magnetic nanocomposites were characterized by different analysis such as; XRD, Raman, FESEM, FT-IR, Zeta, TEM, and EDS analysis. The dark catalyst results showed that Fe_3O_4/MWCNT/SiO_2 nanocomposites had excellent dark catalyst ability and they could degraded methylene blue (MB) dyes from water in an ultrasonic process in 30 s. The obtained results showed that the degradation efficiency decrease in acidic media. The radical scavengers experiment results confirmed that electrons play a key role in degradation of MB dye by Fe_3O_4/MWCNT/SiO_2 magnetic nanocomposites.

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Keyword: *Fe3O4/MWCNT/SiO2, Dark catalyst, Ultrafast degradation, Wastewater treatment*

DRAFT

Synthesis and Functionalization of Gold-Nickel Magnetic Nanomotor

Aysegul Turker[*1], Gozde Yurdabak Karaca[2], Y. Emre Bulbul[3], Filiz Kuralay[4], Lutfi Oksuz[5], Aysegul Uygun Oksuz[3]

[1] Suleyman Demirel University, Faculty of Engineering, Bioengineering Department, Isparta, Türkiye
[2] Suleyman Demirel University, Isparta Health Services Vocational School, Medical Services and Techniques, Isparta, Türkiye
[3] Suleyman Demirel University, Faculty of Arts and Science, Department of Chemistry, Isparta, Türkiye
[4] Hacettepe University, Faculty of Arts and Science, Department of Chemistry, Ankara, Türkiye
[5] Suleyman Demirel University, Faculty of Arts and Science, Department of Physics, Isparta, Türkiye

Nano/micromotors are synthetic systems in nano or micro sizes that have the ability to convert energy into motion [1]. They have many applications such as rapid drug delivery and release capability, high tissue penetration, and motion control in biomedical, environmental remediation, and nanosurgery fields [2-3]. The guidance of these systems, which can move due to chemical or external stimuli, is achieved magnetically.
In this work, gold-nickel (Au-Ni) nanomotor was synthesized electrochemically using a triple electrode system, and the Ni coating was performed using a DC magnetic sputtering device. The surface of Au-Ni nanomotors was functionalized using different agents for further drug loading and delivery systems. Poly(sodium 4-styrenesulfonate) (PSS), poly(allylamine) (PAA), and folic acid (FA) are used biocompatible molecules for functionalization of nanomotors. The characterization of nanomotors was examined using scanning electron microscopy (SEM), speed and fluorescence intensity measurements using optical microscope, electrochemical and zeta measurements.
The velocity measurements of the synthesized nanomotors were performed under an optical microscope. The velocity of the Au-Ni nanomotor was measured as 31 μm/s under a magnetic field strength of 18 mT (millitesla). The functionalized Au-Ni-PSS nanomotor exhibited a velocity of 17 μm/s under the same magnetic field strength. Similarly, the velocity of the Au-Ni-PAA nanomotor functionalized with PAA was measured as 11 μm/s under the same magnetic field strength. Finally, the velocity of the Au-Ni-FA nanomotor functionalized with FA was measured as 20 μm/s under the same magnetic field strength. Comparing the velocity measurements under the optical microscope, it can be observed that the Au-Ni-FA nanomotor has the highest speed among the functionalized nanomotors.
Fluorescence intensity measurements of the nanomotors were also conducted under a fluorescence microscope. The fluorescence intensity of the Au-Ni nanomotor was measured as 490 a.u. (arbitrary units). The functionalized nanomotors exhibited the following fluorescence intensities: Au-Ni-PSS: 460 a.u., Au-Ni-PAA: 360 a.u., Au-Ni-FA: 370 a.u.

Acknowledgments:
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Keyword: *Nano/micromotors, Magnetic guidance, PSS, FA, PAA*

DRAFT

Magnetically Driven Functionalized Gold-Nickel Nanomotors for Drug Delivery

Gozde Yurdabak Karaca[*1], **Aysegul Turker**[2], **Y. Emre Bulbul**[3], **Lutfi Oksuz**[4], **Aysegul Uygun Oksuz**[3]
[1] *Suleyman Demirel University, Isparta Health Services Vocational School, Medical Services and Techniques, Isparta, Türkiye*
[2] *Suleyman Demirel University, Faculty of Engineering, Bioengineering Department, Isparta, Türkiye*
[3] *Suleyman Demirel University, Faculty of Arts and Science, Department of Chemistry, Isparta, Türkiye*
[4] *Suleyman Demirel University, Faculty of Arts and Science, Department of Physics, Isparta, Türkiye*

Advancements in nanotechnology have brought significant innovations in targeted drug delivery. Nanomotor technology, which is a relatively new technology enabled by nanotechnology, holds great promise for cancer diagnosis and treatment, offering hope for the future [1]. Artificial nano/micromotors, with their capabilities of capture, transport, and cargo delivery, have gained a significant position in the field of biomedicine, particularly in drug release and early diagnosis of diseases, especially cancer[2–4].
In this study, the synthesis of magnetic gold-nickel (Au-Ni) nanomotors has been fabricated using alumina membranes, through electrochemical and magnetron sputtering techniques. These nanomotors have been functionalized with biocompatible polymers; Poly (sodium 4-styrenesulfonate) (PSS), polyallylamine (PAA), and folic acid (FA), with the aim of loading the anticancer drug Doxorubicin (DOX). Different concentrations of DOX (2, 4, 6, and 8 mg/mL) were loaded onto the developed nanomotors to obtain an effective dosage of DOX. To facilitate the interaction between the nanomotors and DOX during the loading process, the motors were incubated with DOX prepared in pH 8.0 phosphate-buffered saline (PBS) for 24 hours at -4°C in the dark. After the incubation, the final product was collected by centrifugation (8000 rpm, 5 minutes) and washed three times with PBS to remove any unbound DOX in the solution. To determine the drug loading efficiency, supernatants were collected and the free DOX concentration in the supernatants was measured at 490 nm using a UV-visible spectrophotometer with a standard absorbance-concentration calibration curve. The drug loading efficiency was determined for each concentration of DOX. Also, for each concentration of DOX, nanomotor speed and fluorescence intensity changes were measured using Nikon Ti Eclipse Fluorescence Microscopy. The stability of the colloidal dispersion, which is an important factor to evaluate, was assessed using zeta potential analysis for the Au-Ni, PSS/Au-Ni, FA/Au-Ni, and PAA/Au-Ni nanomotor samples. Additionally, the zeta potential values were compared before and after DOX incubation to confirm electrostatic interactions. The effectiveness and efficiency of the loaded drug in different functionalized motors were compared to determine which functional motor exhibited higher efficacy and efficiency.

Acknowledgments:
The authors gratefully acknowledge TUBITAK-COST Project (Project No: 122M674).

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Keyword: *micromotor, drug delivery, PAA, PSS, FA*

DRAFT

Silver Nanowire Network Optimization for Transparent, Smart Devices

Onuralp Cakir[*1], Doga Doganay[1], Melih Ogeday Cicek[1], Murathan Cugunlular[1], Onur Demircioglu[1], Umran Ceren Baskose[1], Yusuf Tutel[1], Sahin Coskun[2], Husnu Emrah Unalan[1]

[1] Department of Metallurgical and Materials Engineering, Middle East Technical University (METU), Ankara, Türkiye

[2] Department of Metallurgical and Materials Engineering, Eskisehir Osmangazi University (ESOGU), Eskişehir, Türkiye

Silver nanowire (Ag NW) networks are powerful transparent conducting electrodes (TCEs) that are up to challenge indium tin oxide (ITO). Yet, with all TCEs, there is a trade-off between the two main variables, that are optical transmittance and sheet resistance. While individual Ag NWs have a defect-free structure, the capping agent polyvinyl pyrrolidone (PVP) layer surrounding the Ag NWs hinders electron transfer between nanowires. This creates junction resistance in the order of MΩ levels. The improper contact between Ag NWs poses a problem in producing high-performance TCEs. Great efforts have been made to solve this problem. However, there is still a gap in the literature as all Ag NWs used have different lengths, diameters, PVP thicknesses, and purities depending on the vendor. Therefore, the efficacy of a post-treatment on Ag NWs with different properties remains elusive. Furthermore, the combination of facile and effective methods is yet to be found. This work examined various post-treatment works in the literature, and the most effective method was developed. The optimized Ag NW networks displayed a reduction of the sheet resistance from 360 Ω/sq to 12 Ω/sq with an optical transmittance of 90% (at a wavelength of 550 nm). Furthermore, the optimized Ag NW networks were utilized in transparent triboelectric nanogenerator (TENG) droplet sensors and electrochromic devices. A thin PDMS layer was deposited onto the Ag NW network to fabricate transparent TENG electrodes. The triboelectric response between water droplets and the PDMS layer was investigated. The TENG device was found to produce up to 1.8 V and 10 μA per water droplet. This sensor was capable of sensing the pH and solution concentration. The electrochromic windows utilized optimized Ag NW electrodes with tungsten trioxide (WO_3) and nickel oxide (NiO) as the two electrochromic layers and a $LiClO_4$/PC/PMMA gel electrolyte. Electrochromic devices showed high coloration efficiency with a fast response.

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Keyword: *Silver Nanowires, Triboelectric Nanogenerator, Droplet Sensor, Electrochromic, Electrochromic Device*

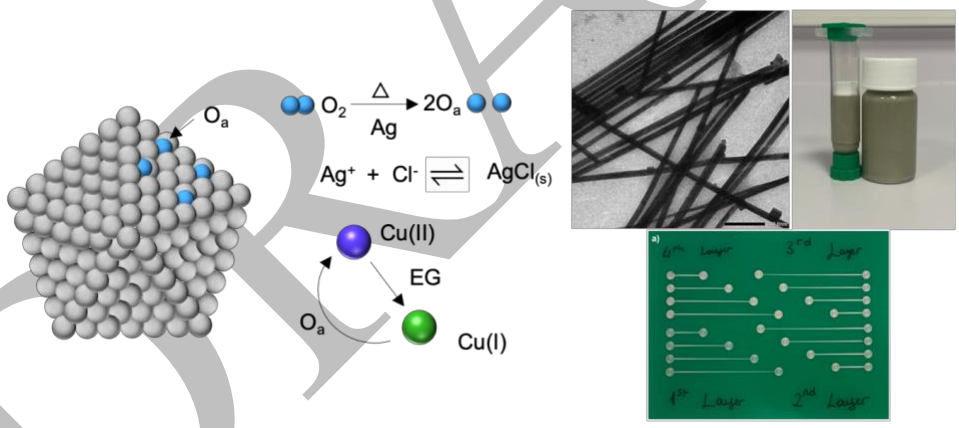
DRAFT

ID: 131

Development of silver nanowire based conductive ink for direct writing applications

Elif Sümeyye Cirit*, Seda Aygül Akyüz, Zeliha Cansu Canbek Özdil
Department of Materials Science and Nanotechnology Engineering, Yeditepe University, Istanbul, Türkiye

This work presents a parametric study for optimizing the synthesis of silver nanowires (AgNWs) using a polyol method for conductive ink applications. First of all, the effects of various parameters, including reaction time, reaction temperature, and the type of metal halide on the properties of the AgNWs were investigated systematically. The kinetics of AgNW formation is analyzed by UV-Vis Spectroscopy and TEM. A series of experiments have conducted to further investigate the role of the metal halide in the production of silver nanowires in the classical polyol synthesis. We have demonstrated that even though the stoichiometric ratio of Ag^+ /Cl^- is kept constant, the type of halide source is directly related to the formation of high-yield silver nanowires. The optimized synthesis conditions are found to result in AgNWs with high aspect ratios to prepare a conductive ink with desired viscoelastic properties for direct writing applications. The inks with various PEO and AgNW concentrations are prepared, and the printing process is carried out utilizing a commercial desktop direct writing printer named Voltera V-One. AgNw inks with two different PEO concentrations (4 wt.% and 5 wt.%) are prepared to investigate the effect of binder concentration on viscoelastic properties of the ink. The AgNW ink prepared with 4 wt.% PEO mixture can automatically level itself at the specified frequency, while the 5 wt.% solution requires an external force to spread out. Then the performance of the inks with %5 and %10 AgNW concentrations is tested by using V-One printer on both FR4 substrate and pre-treated glass substrate. The resulted samples underwent various post-treatment methods presented in literature. The results highlight the importance of substrate selection, surface treatment, and post-treatment methods in the printing process, in addition to optimizing the AgNW doping level. Furthermore, it emphasizes that the achievement of desired conductivity levels in the printed ink relies on effectively removing insulating additives and binders and adhesion of silver nanowires to the surface.



Keyword: *Silver Nanowire, Direct Ink Writing, Polyol Synthesis*

DRAFT

ID: 174

Investigation of HfO_2/TiOx Based Memristor Devices

Bünyamin Özkal*, Nora Ali Abdo Saleh Al-Jawfi, Gökhan Ekinci, Sinan Kazan
Department of Physics, Gebze Technical University, Kocaeli, Türkiye

The concept of the memristor was first proposed by Leon Chua, a professor at the University of California, Berkeley, in 1971. Chua postulated that a fourth fundamental passive circuit element, in addition to the resistor, capacitor, and inductor, could exist. He theorized that this element, which he named the "memristor" (a combination of "memory" and "resistor"), would have the unique property of exhibiting a relationship between charge and magnetic flux linkage[1]. In 2008, a team of researchers led by Dr. R. Stanley Williams at Hewlett-Packard Laboratories announced the successful development of a solid-state memristor based on a thin film of titanium dioxide (TiO2)[2]. In next years, Hafnium dioxide (HfO_2) memristors have emerged as an improved alternative, offering lower switching voltages, higher endurance, and better stability. HfO_2 memristors are actively researched for memory devices, neuromorphic computing, and artificial intelligence applications. Their potential for high-density, low-power, and fast non-volatile memory solutions drives advancements in memristor-based technology [3].

We propose a single cell memristor devices made of a Si/SiO_2/Ta/Pt/HfOx(16nm)/Pt and Si/SiO_2/Ta/Pt/HfO_2(24nm)/TiOx(3, 15, 10 nm)/Pt thin film stack that has been electrically and structurally characterized. On a self-oxidized Si substrate, the bottom and top metal electrodes Ta/Pt(10nm Bottom) and Pt(20nm Top) have been fabricated in a sputtering chamber, and the metal oxides HfO_2 and TiO_2 Metal-Oxide layers have been grown in a Pulsed Laser Deposition (PLD) chamber under optimum growth conditions. X-ray reflectivity (XRR) measurements were used to assess the thickness of HfO_2, and X-ray photoelectron spectroscopy (XPS) measurements were used to evaluate the composition rates and structural characteristics of metal oxide. Following that, these devices' typical memristive behavior and quasi-static electrical characterizations have been investigated.

Our results show that , the fabrication of the devices is applicable for the analog computing and digital non-volatile memory element applications, according to experimental electrical measurements.

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Keyword: *HfO2, TiO2, Memristor, Resistive Switching*

DRAFT

ID: 27

Prediction of Activation Energies for Exciton Transport over Conjugated Polymer Chains

Zafer Erzurumluoğlu[*1], **Esra Kose**[2], **Muhammet Erkan Kose**[1]
[1] *Kocaeli University, Department of Chemistry, Kocaeli, Türkiye*
[2] *Kocaeli University, Department of Physics, Kocaeli, Türkiye*

Hot excitons formed upon light absorption relax to the bottom of the potential energy surface at the excited state with the aid of vibrational modes. The relaxed excitons can then move along the conjugated backbone within the lifetime of exciton. The rate constant for such intrachain motion can be modelled by using Fermi's Golden Rule. Nevertheless, intrachain motion of an exciton can also be simulated with an activated form of energy transfer equation specifically developed for conjugated systems. Such activated expression has been used to predict the activation energies of exciton migration along a conjugated backbone in this study. A long chain of poly(3-hexylthiophene) is chosen to reveal the magnitude of activation energies required for hopping of both singlet and triplet excitons. A simple undistorted but displaced harmonic oscillator approximation is exploited to estimate the activation energies and the relevant vibrational modes involved in exciton dynamics. In this poster presentation, the mechanistic differences of exciton migration between singlet and triplet excitons will be compared for the model polymer chain mentioned above. The implications of results for conjugated systems used in organic electronic applications will also be discussed.

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Keyword: *exciton, energy transfer, conjugated polymers, organic electronics, activated transport*

DRAFT

ID: 135

Pristine and Hydrogenated structures of $Sb_2O_2Se_2$: electronic and vibrational properties

Yağmur Bozkurt*[1], Zebih Çetin[2], Mehmet Yağmurcukardeş[2]

[1] *Department of Chemistry, Izmir Institute of Technology, 35430, Izmir, Türkiye*

[2] *Department of Photonics, Izmir Institute of Technology, 35430, Izmir, Türkiye*

Two dimensional bismuth oxy selenide (Bi_2O_2Se) has gained a great attention in material science studies owing to its several features such as; distinctive structure, high electron Hall mobility (Wu et.al, 2017), tunable bandgap and inert stability. Such properties make Bi_2O_2Se a good candidate for artificial synapses, infrared photodetectors, and transistor applications. Bismuth oxy chalcogenide has a variety family with several modifications that can be splitted into two classes; replacing selenium atom with other chalcogenides (Bi_2O_2S, Bi_2O_2Te (Song, et.al, 2019)), and replacing oxygen with chalcogenide atoms (Bi_2Te_2S (Tao et. al, 2021), Bi_2Te_2Se (Yang et.al,2022), Bi_2Se_2Te (Choi et. al,2015)).

In previous studies, although pristine and altered forms of bismuth chalcogenides have been studies, no studies have been found to replace the bismuth atom with another 5A element. In this study, Antimony oxy selenide ($Sb_2O_2Se_2$) and its hydrogenated phase ($Sb_2O_2Se_2$) are studied by means of their structural, electronic, and vibrational properties by using Density Functional Theory-based ab-initio calculations.

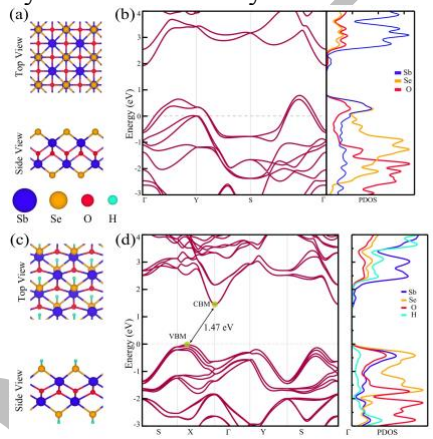

Figure 1.a)Top and side view of monolayer of Sb2O2Se2 b) Electronic band structure and corresponding orbital partial density of states (PDOS) of Sb2O2Se2 c) Top and side view of monolayer of Sb2O2Se2H2 d) Electronic band structure and corresponding orbital partial density of states (PDOS) of Sb2O2Se2H2

Structural optimizations revealed that $Sb_2O_2Se_2$ has an isotropic structure while $Sb_2O_2Se_2H_2$ exhibits slightly anisotropic feature. Simulated STM images indicated the presence of hydrogen atoms on the surface. Phonon band dispersion calculations showed the dynamical stability of both pristine and hydrogenated $Sb_2O_2Se_2$ crystals. Electronically, it was found that the metallic behavior of pristine $Sb_2O_2Se_2$ can be converted into a semiconducting feature by saturating all surface Se atoms with Hydrogen atoms. In addition, the calculated Raman spectra of pristine and hydrogenated $Sb_2O_2Se_2$ revealed their distinctive vibrational properties, an important indication for future experiments to distinguish the structural variations between the two structures.

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Keyword: *Computational Nanoscience, DFT calculation, Two Dimensional Materials, Semi-conductor material, Nano technology*

DRAFT

ID: 248

Evaluation and Validation of an HPLC Analytical Method for Lamivudine

Hüsniye Hande Aydın[*1], **Zeynep Şenyiğit**[1], **Hatice Yeşim Karasulu**[2]

[1] *Department of Pharmaceutical Technology, Izmir Katip Celebi University Faculty of Pharmacy, İzmir, Türkiye*

[2] *Department of Pharmaceutical Technology, Ege University Faculty of Pharmacy, İzmir, Türkiye*

Lamivudine is a first-generation nucleoside reverse transcriptase inhibitor (NRTI) approved for the treatment of HIV-1 infection and hepatitis B virus (HBV) infection (1). In this study, it was aimed to develop and validate new and rapid high-performance liquid chromatography (HPLC) methods for the determination of Lamivudine (LAM) in distilled water and simulated nasal electrolyte solution (SNES).

The methods were developed with a C18 column (Macherey-Nagel EC250/4.6 Nucleosil 100-5 C18 250x4.6 mm, 5µ SN:E11110004, LOT:21301011) using UV-detector HPLC (HP Agilent 1100 Series). A mixture of distilled water and methanol (60/40, v/v) was used as the mobile phase. The mobile phase was degassed using an ultrasonic bath and then introduced into the system. The flow rate was set to 1 mL/min, the injection volume was 10 µL. The eluent was monitored by UV detection at 270 nm. The methods were validated in accordance with the ICH Q2A guidelines (2). The validation parameters include specificity, linearity and range, precision, accuracy and recovery, LOD (Limit of Detection), LOQ (Limit of Quantification) and stability.

The calibration curves were found to be linear in the range of 2-60 µg/mL for all media ($r2 \geq 0.998$). The analysis were performed in less than 10 min and the retention time of LAM was 3.8-4.3 min for distilled water and SNES, respectively. For both methods, the LOQ ranged from 1.5 to 4.5 µg/mL and recovery ranged from 100% to 102%. The results showed that HPLC methods were proved to be sensitive, simple, reproducible, rapid, and precise for in vitro samples.

Acknowledgement:
This study was supported by Ege University Scientific Research Projects Coordination Unit (Project number 23983).

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Keyword: *Lamivudine, HPLC, Validation*

DRAFT

ID: 300

Molecular Dynamics Simulations of MPT64 Proteins

Bilge Suyolcu[*1], Tuğba Arzu Özal İldeniz[2], Erkan Mozioğlu[3]

[1] Department of Molecular Biology and Genetics, Faculty of Science and Letters, Acıbadem Mehmet Ali Aydınlar University, Istanbul, Türkiye

[2] Department of Biomedical Engineering, Faculty of Engineering and Natural Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

[3] Department of Medical Biotechnology, Institute of Health Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

In the literature, it is reported that recombinant MPT64 proteins which is Mycobacterium tuberculosis immunogenic proteins are mostly obtained as inclusion bodies. The dissolution and refolding of proteins produced as inclusion bodies introduces a major challenge. Although the use of different chemicals such as urea, guanidinium HCl, DTT helps to solve the problem in the laboratory, their mechanisms of action are not yet fully understood. In this study, the structural changes of this protein were investigated by molecular dynamics simulations. These simulation results were analyzed with root mean square deviation (RMSD), Root mean square fluctiation (RMSF), Radial distribution function (RDF), and solvent accessible surface area (SASA) analyses.

Acknowledgments

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Keyword: *Design of synthetic biomolecules, recombinant protein production, Mycobacterium tuberculosis, diagnosis, biosensors*

DRAFT

Fabrication of the Polyvinylidene Fluoride with a Graphene Filler for the Thermoelectric Applications

Vala Can Aşkan[*1], Nihan Aydemir[1], Ahmet Yavuz Oral[2]
[1] Gebze Technical University, Institute of Nanotechnology, Kocaeli, Türkiye
[2] Gebze Technical University, Department of Material Science and Engineering, Kocaeli, Türkiye

Polyvinylidene fluoride (PVDF) is a complex material that can be used in mechanical, and electronic applications and as a membrane. These properties depend on the crystallographic phase of the PVDF. In this work, we will produce a beta-phase PVDF with a drop-casting method for thermoelectric applications. First PVDF will be analyzed with the X-ray Diffraction (XRD) method and Fourier Transform Infrared Spectroscopy (FTIR). In the meantime, the graphene powders will be fabricated with a laser-inducing method and will be analyzed with XRD, X-ray Photoelectron Spectroscopy, and FTIR. When we obtain the beta phase of the PVDF and graphene, we will add graphene nanopowders inside the PVDF structure around weight percent %20. The composites will be analyzed with Scanning Electron Microscopy (SEM), XPS, XRD, and FTIR. Finally, thermoelectric properties (electrical, thermal conductivity, Seebeck Coefficient) will measure both pure PVDF and PVDF-graphene composite and the influence of the graphene will be put forth.

Keyword: *PVDF, graphene, thermoelectric*

DRAFT

ID: 49

Protective Epoxy Copolymers via Chemical Vapor Deposition for Optical Surfaces

Merve Karabıyık*, Gizem Cihanoğlu, Özgenç Ebil
İzmir Institute of Technology, İzmir, Türkiye

Optical materials (glasses, mirrors, lenses, prisms, filters, etc.) are widely used in a variety of applications such as electronic and medical equipment, automotive and construction sector, aerospace industries, and various military and civilian electro-optic devices. Due to their widespread use, these materials may work in very harsh, unstable and corrosive conditions, and can be exposed to various solvents, dust and humidity, vibration, radiation, rapid temperature changes and physical abuse. Such conditions can reduce the performance and useful lifespan of these materials [1,2,3]. Repairing damaged optical surfaces is usually expensive if not impossible, and protection of the materials is thus essential. There is a main requirement for protective coatings on optical surfaces. The coating should provide acceptable chemical and/or physical protection. In this regard, polymer films have attracted a lot of interest since they can provide physical and chemical protection to optical surfaces. Today, solventless vapor phase deposition methods are most commonly used techniques for protective coating applications. Initiated chemical vapor deposition (iCVD) of polymers is a suitable method for the fabrication of thin film coatings and it has many advantages such as low production cost, low temperature, 3D geometry coating performance and high deposition rate [4,5]. Here, we present fabrication of copolymer thin films of glycidyl methacrylate (GMA), ethylene glycol dimethacrylate (EGDMA) and 2,4,6,8-tetramethyl-2,4,6,8-tetravinylcyclotetrasiloxane (V4D4) via initiated chemical vapor deposition (iCVD) as protective coatings for optical surfaces. Chemical durability in various solvents, corrosion resistance, adhesion to substrate and thermal resistance of the films were evaluated. Crosslinked thin films exhibited high chemical resistance to strong organic solvents and excellent adhesion to substrates. Poly(GMA-co-EGDMA) and poly(GMA-co-V4D4) copolymers demonstrated protection against water (<1% thickness loss) and high salt resistance (<1.5% thickness loss) making them ideal coating materials for optical surfaces. Combining increased mechanical properties of GMA and chemical durability V4D4, the iCVD process provides a fast and low-cost alternative for the fabrication of protective coatings.

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Keyword: *copolymer thin film, protective coatings, optical surfaces, iCVD*

DRAFT

ID: 59

Ion Specificity on the Surface of Sugar-Based Macromolecules

Yaren Şevval Özdoğan*, **Sobia Farooq, Halil İbrahim Okur**
Department of Chemistry, Bilkent University, Ankara, Türkiye

Ions can be categorized by their ability to increase (salt-in) and decrease (salt-out) the solubility of proteins and various macromolecules in aqueous solutions. This effect is called the specific-Ion Effect and the ion classification is named the "Hofmeister Series". Although the specific effects of ions have been tested for a plethora of macromolecules, the molecular-level understanding of the ion effect on molecular surfaces is still elusive. In this study, lower critical solution temperature (LCST) and NMR measurements were performed for a deeper understanding of the interactions between the Hofmeister ions and various thermoresponsive sugar-based macromolecules, namely dextran, hydroxy propyl cellulose (HPC), and methylcellulose (MC). The weakly hydrated anions (SCN-, ClO4-, I-) show salting-in whereas strongly hydrated ones (SO42-, Cl-, and F-) demonstrate salting-out behaviors. In contrast, dextran exhibited no favorable interaction with both weakly and strongly hydrated anions. We proposed that such intriguing behavior of dextran is due to the lacking side chain compared to HPC and MC. The side chain of these macromolecules is responsible for the interactions of the Hofmeister ions. Both the LCST and NMR measurements support the mechanism that there are site-specific interactions of ions to the sugar-based macromolecules at the side groups of HPC and MC, while there are no such interactions on the dextran.

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Keyword: *Specific Ion Effect, Hofmeister Series, Sugar-Based Macromolecules, LCST, NMR*

DRAFT

ID: 60

Effect of π-bridge Groups on Optical, Electrochemical, and Photovoltaic Properties of Conjugated Polymers

Meltem Türkatar*, **Oğuzhan Karakurt, Ali Çırpan**
Department of Chemistry, Middle East Technical University, 06800, Ankara, Türkiye

The ability to transform solar energy into electrical energy is crucial for the development of clean and renewable energy technology. Several more affordable and highly effective technological systems can convert solar energy into electrical energy. When compared to other solar cell technologies, OSCs (Organic Solar Cells) take the forefront because they are affordable, adaptable, and suitable for mass production solar energy technology. The π bridge groups have the power to control the HOMO and LUMO levels, energy gap, and absorption spectra of conjugated polymers. The effect of the π bridge groups, which are selenophene and thiophene, on the photovoltaic properties of conjugated polymers will be investigated in this study. Additionally, benzodithiophene and quinoxaline-based conjugated polymers will be synthesized through Stille coupling reactions and the effects of chlorine and fluorine atoms on quinoxaline will be investigated. It was discovered that adding fluorine atoms to the conjugated side chains of the polymers reduced the HOMO energy level, which improved V_{oc}. The levels of LUMO and HOMO may be decreased by fluorination and chlorination, respectively. Nuclear Magnetic Resonance (NMR), Gel Permeation Chromatography (GPC), and Infrared Spectroscopy (IR) will be used to characterize the synthesized polymers. UV-Vis Spectroscopy and Cyclic Voltammetry (CV) will be used to examine their optical and electrochemical properties. In a nitrogen-filled glovebox system, organic solar cells with an active layer composed of conjugated polymers and acceptor materials will be constructed. A solar simulator that emits AM 1.5G light will be used to examine the current-voltage characteristics of the devices. The collected current-voltage curve will be used to calculate the short circuit current density (J_{sc}), open circuit voltage (V_{oc}), fill factor (FF), and power conversion efficiency (PCE) characteristics.

Acknowledgement:
This study is supported by the Scientific and Technological Research Council of Türkiye (TUBITAK) with project number 222Z151.

Keyword: *Solar Energy, Organic Photovoltaics, Conjugated Polymers, Selenophene, Thiophene, Chlorine, Fluorine.*

DRAFT

ID: 61

Synthesis of Halogen Containing Novel Quinoxaline-based Conjugated Polymers for Organic Solar Cell Applications

Sevgi Aydın*, Oğuzhan Karakurt, Ali Çırpan
Department of Chemistry, Middle East Technical University, 06800, Ankara, Türkiye

One of the most crucial technologies for ensuring human sustainability in the future is the ability to harness solar energy from the sun to produce power. Due to their potential benefit of being produced in large areas, lightweight flexibility, and cheap cost of solution processing, polymer solar cells (PSCs) have drawn extensive attention over the past two decades. Halogen substitution on the main chain of organic photovoltaic materials has been shown to be an effective strategy for adjusting electronic energy levels, intermolecular interaction, and aggregation morphology, all of which are crucial for enhancing the power conversion efficiency (PCE) of organic solar cells (OSCs). In this study, selenophene π-bridged quinoxaline-based novel one fluorine and two fluorine atom containing acceptor molecules were synthesized successfully. The benzodithiophene-based donor molecule and selenophene π-bridged quinoxaline-based novel acceptor molecule will be polymerized by a Stille crosscoupling reaction to produce donor conjugated polymers. Investigating the properties of OSC by introducing Cl and F atoms to the main chain of the quinoxaline-based acceptor is the main goal of the study. The polymer will be characterized using Gel permeation chromatography (GPC), Nuclear Magnetic Resonance (NMR), Infrared Spectroscopy (IR), UV-Vis spectrometry, and cyclic voltammetry (CV). Ternary organic solar cells (TOSCs), whose active layer is composed of a combination of conjugated donor-acceptor polymers and fullerene-based acceptor material, will be built in a glovebox system. By using a solar simulator illuminated by AM 1.5G, the current-voltage characteristics of the devices will be evaluated. The short circuit current density (Jsc), open circuit voltage (Voc), fill factor (FF), and power conversion efficiency (PCE) characteristics will be assessed using the data obtained from the current-voltage curve.

Acknowledgment:
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Keyword: *Solar Energy, Organic Photovoltaics, Conjugated Polymers, Selenophene, Halogen effect*

DRAFT

ID: 82

Investigation of Effect of Tetraalkyl Ammonium Iodide Salts on Aqueous Macromolecules

Ertan İşsever*, Halil İbrahim Okur
Department of Chemistry, Bilkent University, Ankara, Türkiye

The solution properties of macromolecules are affected by the nature and concentration of present ions. The ion-specific effects are known as the Hofmeister series. The cationic effects, although less well-understood, have been shown to influence the macromolecules with various mechanisms. In this work, we focused on the influence of salts on the most weakly hydrated cations and weakly hydrated anions. We have recently discovered that greasy cations strongly interact with neutral macromolecules. In order to expand our understanding, we explored the influence of salts including tetraalkylammonium (NMe_4^+, NEt_4^+, NPr_4^+, NBu_4^+) cations and iodide anion (surface-active). A systematic macromolecule solubility, NMR, and ATR-FTIR study on poly (N-isopropyl acrylamide)(PNIPAM), as a model system is carried out. Since both ions are surface active, an overall salting-in behavior is expected. Surprisingly, for NBu_4^+, a salting-out behavior was observed, yet other salts simply increase the solubility of the macromolecules. The ion-macromolecule interaction mechanisms were also investigated in the collapsed and soluble forms of PNIPAM by ATR-FTIR and NMR spectroscopic, respectively.It was shown that the interaction sites for anions and cations were different on the macromolecules. The anion binds to C-H groups next to electron-withdrawing groups, whereas cations bind to hydrophobic isopropyl groups of PNIPAM. When the hydrophobicity dominates binding of both ions decreases the solubility of the macromolecule as exemplified by NBu_4I.

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Keyword: *Hofmeister Series, Themoresponsive Polymers, Specific Ion Effect, LCST, ATR-FTIR*

DRAFT

ID: 210

ATP: A Promising Stabilizer for Neutral Biomacromolecules

Cansın Ayvaz[*1,2], Dilşad Simay Peker[1], Aykut Erbaş[2], Halil Ibrahim Okur[1,2]
[1] *Department of Chemistry, Faculty of Science, Bilkent University, Ankara, Türkiye*
[2] *UNAM - National Nanotechnology Research Center, Bilkent University, Ankara, Türkiye*

Adenosine triphosphate (ATP), one of the most important biomolecules of life, plays a vital role as the primary energy source within cells for various essential biological functions. However, it has recently been discovered that ATP can also serve as a biological hydrotrope to destabilize protein aggregates. Herein, a multi-instrumental approach including lower critical solution temperature (LCST), NMR, and FTIR was carried out to investigate ATP's recently discovered hydrotropic nature, exploring the salting-in & salting-out behavior and the interactions between ATP and macromolecules. To do so, the influence of ATP and its derivatives, such as adenine, adenosine, adenosine monophosphate, and triphosphate, was investigated on thermoresponsive macromolecules, specifically poly(N -isopropyl acrylamide) (PNIPAM) and poly(N, N-diethyl acrylamide) (PDEA). The results demonstrated that adenine and adenosine had minimal effects on macromolecule solubility, while ATP, AMP, and triphosphate acted as salting-out agents, contrary to the expected hydrotropic behavior of ATP. Furthermore, FTIR and NMR measurements did not indicate any specific interactions between ATP and macromolecules. As such, it is proposed that the influence of ATP on aqueous macromolecule solutions should be governed by electrostatic and pi-pi stacking interactions. In the absence of these binding sites, ATP acts as an effective salting-out agent, rather than exhibiting hydrotropic behavior for nanoscopic coacervates.

Keyword: *Adenosine triphosphate, Hydrotrope*

DRAFT

ID: 247

Heteroatom-Rich Microporous Organic Polymers for Environmental Applications

Mustafa Erdogmus*, **Onur Buyukcakir**
Izmir Institute of Technology, Department of Chemistry, Izmir, Türkiye

The release of radioactive isotopes of iodine (I^{131}, I^{129} etc.) as a waste product of the nuclear industry threatens the human health environment.[1] To address this issue, iodine capture from point sources and water has attracted colossal academic and industry interest. Porous organic polymers have been seen as promising platforms to capture iodine due to their high physicochemical stability, high surface area, large porosity, sustainability, and affordable cost.[2] In this study, three different heteroatom-rich microporous organic polymers were synthesized and characterized using various characterization techniques. The iodine capture performances of the polymers were investigated. They show high iodine uptake capacities compared to the literature. In this presentation, we will share the iodine uptake performance of polymers in detail and propose an uptake mechanism that is supported by experimental measurements and theoretical calculations.

Acknowledgments
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Keyword: *polymeric frameworks, porous organic polymers, iodine capture, microporosity*

DRAFT

ID: 44

Fe and Fe_3O_4 Ferromagnetic Nanoparticle Base Composit Micro-Magnets

Bahar Gungordu[*1], Selin Su Karakol[1], Nilay Gunduz Akdogan[2,3], Ozan Akdogan[1,3]
[1] *Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353, Istanbul, Türkiye*
[2] *Faculty of Engineering, Piri Reis University, 34940, Istanbul, Türkiye*
[3] *NANOTerial Technology Corporation, 34077, Istanbul, Türkiye*

Bio-Microelectromechanical Systems (Bio-MEMS) is a distinct subdivision of Micro-Electro-Mechanical Systems (MEMS) that has gained prominence as a specialized area of research in biomedical science and the development of microdevices for medical applications. Bio-MEMS pertains to micro- or nanoscale devices or systems that are utilized for the purpose of detecting, processing, transmitting, manipulating, or analyzing biological and chemical entities. The development of micromagnets with superior performance has become a subject of growing interest, owing to their extensive utilization in diverse domains such as microfluidics, microchannels, magnetic gradient patches, bio-MEMS, and diagnostic biosensors for disease detection.
The present study is about the synthesis of Fe_3O_4 and Fe based composite micro-magnets through the utilization of a photolithography methodology. The synthesis of Fe_3O_4 and Fe nanoparticles was effectively achieved via co-precipitation and Y-junction methods, respectively. The experiment involved the combination of Fe_3O_4 and Fe nanoparticles in different weight ratios, specifically in a 1:1 weight percentage. Subsequently, a homogeneous mixture of negative photoresist and Fe_3O_4/Fe at a concentration of 40% wt. % was prepared, and these mixtures were subjected to photolithography using the spin coating method at speeds ranging from 1000 to 1500 rpm. The size of Fe_3O_4 nanoparticles has been identified as 7 nm using X-ray diffraction analyses. In addition, the results obtained from the transmission electron microscopy analysis indicate that the particles possess a mean value of 7.6 nm and a standard deviation of 1.3 nm. These findings serve as an indication of the superparamagnetic characteristics of the particles. The preference for negative photoresist is attributed to its chemical stability and compatibility with bio-MEMS technology. Micro small islands consisting of Fe_3O_4-Fe micromagnets are produced following the manufacturer's instructions for high-quality negative photoresistors. Efficient synthesis of micromagnets with a grid-like pattern has been achieved, and micromagnets with a size of up to 500 µm were successfully synthesized.
The present investigation aims to conduct a comprehensive examination of the magnetic, structural, and microstructural characteristics of micromagnets. The implementation of the methodology proposed in this study has the potential to facilitate the production of micromagnets, which could contribute to the progression of bio-MEMS towards more advanced systems.

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Keyword: *Bio-MEMS, Micromagnets, Photolithography, Ferromagnetic Nanoparticles, Magnetophoresis*

DRAFT

Synthetic Limb, Implant and Prosthesis from Magnetic Microparticle Doped Hydrogel

Ruya Sera Polat[*1], Emir Erol[1], Asia Alnaseri[1], Ileyna Uvak[1], Nilay Gunduz Akdogan[2,3], Canan Bagci[1], Ozan Akdogan[1,3]

[1] Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353 Istanbul, Türkiye
[2] Faculty of Engineering, Piri Reis University, 34940, Istanbul, Türkiye
[3] NANOTerial Technology Corporation, 34077, Istanbul, Türkiye

3D printing has the potential to revolutionize prosthetics production, but challenges remain, including creating bio-inks that sustain cell survival and match natural tissues' mechanical and chemical features. Hydrogels are the preferred bio-ink for 3D printing.

Microparticles can be added to hydrogels to make them more suitable for printing complex structures. Particles can also enhance cell proliferation in hydrogel bio-inks, promoting the growth and survival of cells in 3D structures (1).

Ferromagnetic particles can also be used in bio-inks for 3D printing, as they are responsive to magnetic fields and can be shaped with precision and accuracy. Here, ferromagnetic microparticles are used to generate composite hydrogels, and a basic hydrogel recipe whose biocompatibility has been established (2) is chosen for usage. According to the results, the selected hydrogel composition (gelatin-cellulose-alginate, 5:2:2%) and post-crosslinking method using $CaCl_2$ are appropriate for improving the material's 3D printability and cytocompatibility (2). Several ferromagnetic particles like $Fe_{12}O_{19}Sr$, NdFeB, Bismuth, Graphene, and Fe are employed to provide the hydrogel's magnetic characteristics. Adding additional properties like magnetism and addressing the hydrogel's weak mechanical strength are the goals of this improved recipe. The mechanical qualities of composites are a hybrid of those of their constituent materials; in certain cases, composites even outperform their components (3).

Printing optimization is crucial for manufacturing $Fe_{12}O_{19}Sr$-Hydrogel suspensions. The ideal speed is 6 mm/s, and complete strings can be produced by adjusting particle concentration. High-viscosity $Fe_{12}O_{19}Sr$-Hydrogel suspensions cannot be printed with a 0.89 mm nozzle; particle concentration and nozzle size are optimized for optimal printing. Optimization parameters and magnetic hydrogel have led to successful prototypes like $Fe_{12}O_{19}Sr$ and NdFeB ear prostheses.

Lastly, to meet the bio-ink demand and to analyze their effect on cell growth and viability, magnetic hydrogels will also be tested on the HEK293 fibroblast cells, commonly used in biomedical research for testing various materials (4,5). The colorimetric MTT assay, which is based on the cellular mitochondrial dehydrogenase enzyme reaction in viable cells, will be used to evaluate the cytocompatibility of the magnetic hydrogels.

Magneto-responsive hydrogel ink offers biocompatibility and magnetic capability in extrusion-based 3D printing, enabling efficient synthetic limbs, prostheses, and implant manufacturing.

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Keyword: *bio-ink, ferromagnetic particles, cytocompability, extrusion-based 3D printing, magneto-responsive hydrogel*

DRAFT

ID: 63

Green/Phyto Synthesis of Silver Nanoparticles Using Hazelnut Husk Extract

Defne İpek Baytore[*1], **Nilay Gunduz Akdogan**[2], **Ozan Akdogan**[3]

[1] *Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353, Istanbul, Türkiye*

[2] *Faculty of Engineering, Piri Reis University, 34940, Istanbul, Türkiye/NANOTerial Technology Corporation, 34077, Istanbul, Türkiye*

[3] *Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353, Istanbul, Türkiye/NANOTerial Technology Corporation, 34077, Istanbul, Türkiye*

Green synthesis of metal nanoparticles is a developing field of study, driven by the demand for eco-friendly and economically viable procedures. Traditional methods involve heavy chemical materials, which have considerable harmful effects on the environment and biological organisms (1). In response, the concept of "Green Synthesis" has emerged, aiming to obtain nano-materials from various metals and/or their oxide forms using extracts from plants rich in polyphenols. This approach minimizes the use of chemical substances in the synthesis process. Several studies have demonstrated the potential of these plant extracts as reducing agents in nanoparticle synthesis (2). This study on the green synthesis of Silver Nanoparticles (AgNPs) using Hazelnut Husk (Corylus Avellana L.) extract as a reducing agent from AgNO3 is reported. Additionally, the cytotoxic effects of taxanes found in hazelnuts, particularly in hazelnut husks, on cancer cell proliferation (3).

This study (patent pending) uses characterization data of the green synthesized silver nanoparticles using 0,1mM C. An extract, TEM, and XRD analysis results revealed that the particle size ranges between 6.7-10 nm with a spherical shape, additionally UV-VİS spectrometry results in the absorbance peak range between 450-475 nm. The antimicrobial property test exhibited an inhibition zone, providing a significant advantage by achieving 79% availability against the E. coli bacterium (4). Furthermore, characterization and phytochemical analysis of Hazelnut Husk extracts were conducted using FT-IR analysis to identify the presence of phenolic compounds. The corresponding chemical bond vibrations of functional organic groups and phytochemicals, such as phenolic compounds, were observed at specific wavenumbers (1044.75, 1413.58, 1382.00, 1326.03, 879.72, and 1274.37). The bend vibrations indicated the presence of polyphenols, nitriles, amine groups, ketone groups, hydroxyl groups, carboxylic groups, and aliphatic groups. To evaluate the efficacy of the silver nanoparticles (AgNPs) as antibacterial agents, an antibacterial property test was performed against the gram-negative bacterium Escherichia Coli (E.Coli), utilizing a concentration of 0.5 mM. The objective was to assess the antibacterial activity of the AgNPs against the model organism E. Coli.

Overall, this study demonstrates the successful green synthesis of silver nanoparticles (AgNPs) using Hazelnut Husk extract as a reducing agent. Investigating the potential use and properties of the silver nanoparticles, diagnosis, treatment, and building nanocarriers from the particles for macromolecule transferring, etc. will be epochal.

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Keyword: *Silver Nanoparticles (AgNPs), Green synthesis, Hazelnut Husk, Phenol, Phytochemical Synthesis*

DRAFT

Biomimetic Lipid Bilayer Coating of Gold Nanoparticles

Canan Çil*, Abdulhalim Kılıç
Molecular Biology-Genetics and Biotechnology Programme, Istanbul Technical University, Istanbul, Türkiye

There is a need to develop affordable, user-friendly, rapid, and robust platforms for point-of-care (POC) devices. The development of appropriate detection kits/tests should focus on high sensitivity and specificity, enabling the implementation of personalized treatments. Among the novel detection technologies, nanoplasmonic sensing strategies rely on localized surface plasmon resonance (LSPR), which is highly sensitive to refractive index changes near the metal surface. Gold nanoparticles (AuNPs) are widely known for their unique chemical, optical, and electrical properties. However, to obtain clinically relevant results and facilitate their translation to primary care and POC settings, trials using these platforms must be conducted with body fluids rather than just buffer systems. The main challenge of working with complex biological media lies in the non-specific interactions between the sensing metal surface and high-density, untargeted blood cells/proteins, which can increase the limit of detection (LOD). Additionally, the colloidal instability of AuNPs in biological buffers/body fluids presents another challenge, along with the potential loss of native conformation/function of the immobilized recognition element designed for the target due to strong interactions between the substrate surface and the recognition element.
In this study, the aim is to leverage the advantages of biomimetic supported lipid bilayers (SLBs) and utilize them to coat AuNPs. This approach is expected to enhance the colloidal stability of AuNPs and reduce non-specific binding by taking advantage of the nonfouling and biocompatible properties of SLBs. Moreover, SLBs can create a native microenvironment within their fluid structure, which can be beneficial for accommodating recognition elements. To achieve this, a multilamellar vesicle (MLV) suspension is first prepared using the thin-film hydration technique prior to coating citrate-stabilized AuNPs with SLBs. Subsequently, the AuNPs are sonicated in the MLV suspension to downsize MLVs to encapsulate AuNPs. Various parameters such as incubation temperature, duration, and surface form are optimized using a sonic water bath. The successful coating of AuNPs with SLBs is confirmed by observing a spectral shift in the UV-Vis absorption, attributed to their differing localized surface plasmon resonance (LSPR). Additional evidence is provided through dynamic light scattering and zeta potential measurements, as well as assessing colloidal stability under high-ionic strength conditions. Finally, the colloidal stability of SLB-coated AuNPs is validated. As a future prospect, biofunctional SLB-coated AuNPs will be prepared by combining various lipids and biomolecules to achieve specific targeting and detection.

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Keyword: *Biomimetic supported lipid bilayers, Gold nanoparticles, Nanoplasmonics*

DRAFT

ID: 91

Antibody Conjugation and Stabilization of Silver Nanoparticles for Multicolor and Multiplex Lateral Flow Assay Kits

Ozge Ozufuklar*, Ece Efecan, Bilge Asci Erkocyigit, Faezeh Ghorbanizamani, Emine Guler Celik, Suna Timur

Ege University, İzmir, Türkiye

Diagnostic kits are essential tools for global health because of their time saving and portablity. They can be used in the field, hospital, ambulance, traffic, and even at home without the need for any professional equipment or personnel. These portable kits are used to detect the presence or absence of one or more substances (analytes) in organic samples (saliva, urine, etc.). In this study, a diagnostic kit for the detection of different substances on a single platform was prepared with the design of a lateral flow assay (LFA) kit, and studies were carried out on the formation of color signals in different colors. While gold nanoparticles (AuNPs) are generally used as signal probes in LFA test kits, silver nanoparticles (AgNPs) were used in this work. Generally, AgNPs are not preferred nanoparticles owing to their stability problems[1]. However, if stable bioconjugates can be prepared, they exhibit highly successful optical and electrical properties, making their use in POC tests interesting and promising. Therefore, in this study, AgNPs with different colors (such as blue, orange, and green) were synthesized and optimized by performing stability tests. Therefore, each synthesized AgNPs with different size and morphologies was applied LFA platform to label a different substance, and the results were obtained as positive or negative with colored signals in the presence or absence of substances. Thus, the results showed that multiplex and multicolor LFA systems can be obtained for the detection and monitoring of different biomarkers, viruses, bacteria etc.

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Keyword: *Biosensor, Point of Care, Lateral Flow Assay, Silver Nanoparticles, Multiplex*

DRAFT

Nanogel-based Rapid Diagnostic Kit for Veterinary Applications

Ece Efecan*, Faezeh Ghorbanizamani, Emine Guler Celik, Suna Tımur
Ege University, İzmir, Türkiye

Point-of-care (POC) tests, which are considered as the diagnostic technologies of the future in health monitoring, are detection systems that do not require professional use outside the traditional laboratory environment and provide cost-effective and fast results. Owing to their hand-held nature, supported by mobile phones, the measurement of test signals with smartphones has enabled results to be obtained without the use of expensive devices or equipment. POC diagnostic technologies are frequently preferred for health applications in both humans and animals. Rapid diagnostic kits used in veterinary applications are card tests in an immunochromatographic test format, which are screening tests that provide only qualitative results, and advanced laboratory tests are required for confirmation or quantitative analysis. Based on these requirements, in this work, we aimed to design a rapid diagnostic test for nanogel-based spot test formats that will enable rapid diagnosis of fatal diseases such as distemper and bloody diarrhea in dogs. In this context, nitrocellulose membrane surfaces were biofunctionalized for Canine Parvovirus and Canine Distemper Virus antigens, which are the target viruses, and a sandwich test kit was designed using dye-loaded nanogels as a signal component. In this test kit designed using the colorimetric working principle as detection technology, dye-loaded nanogels were used for the formation of color signals. The color signals generated in the presence of antigen can be evaluated both with the naked eye as presence/absence and quantitatively calculated by mobile phones.

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Keyword: *Biosensors, Nanogel, Point of Care, Spot Test, Smartphone sensing*

DRAFT

Optimizations of Aptamer-Gold Nanoparticle Nanoprobes Towards Lateral Flow Assays

Bilge Erkoçyiğit*, Ezgi Man, Ece Efecan, Serap Evran, Emine Güler Çelik
Ege University, İzmir, Türkiye

The aptamers were single-chain oligonucleotides obtained using the systematic evolution of ligands by exponential amplification (SELEX) method[1]. These aptamers have several advantages over other molecular recognition elements. One of the most important advantages of aptamers is their high affinity for target molecules, which makes them ideal for various applications. Furthermore, aptamers can be easily produced under in vitro conditions, making them highly cost-effective. This is in contrast to antibodies, which can be difficult and time-consuming to produce. Additionally, aptamers can be more stable than antibodies, particularly in harsh environments such as pH, high temperatures and high salt concentration[2]. This makes them ideal for use in stability critical applications. Furthermore, aptamers can be selected to recognize a wide range of targets, including small molecules, proteins, and whole cells. This versatility makes them valuable tools in a variety of fields, from diagnostics to drug discovery[3]. Gold nanoparticles (AuNPs) are often favored in the field of biosensors because of their stable physical structures and unique optical properties. Nanoprobes obtained by aptamer-AuNP conjugation offer high levels of sensitivity and specificity in biosensor applications. In addition, the simplicity and portability of lateral flow assays (LFA) coupled with the enhanced detection capabilities of nanoprobes make this approach highly suitable for in situ and point-of-care applications[4,5]. In this study, cocaine and methamphetamine aptamers were conjugated with AuNPs as models. Optimizations were performed for parameters such as AuNP size, aptamer concentration, and aptamer end modification. Consequently, the nanoprobes were characterized by spectroscopic and imaging techniques. Finally, we investigated the specificity and reproducibility of the LFAs against the target analytes.

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Keyword: *Biosensors, Lateral Flow Assay, Aptamer, Point of care, Gold nanoparticles*

DRAFT

ID: 115

Magnetic Graphene Field-Effect Transistor Biosensor for Ferritin Detection

Aleyna Akcay[*1], Phanish Chava[2], Zahra Fekri[2], Trang Anh Nguyen Le[3], Kalliopi Mavridou[4], Isli Cela[3], Hamza Cansever[5], Jürgen Lindner[5], Artur Erbe[2], Cumhur Gökhan Unlu[1]

[1] Pamukkale University-Department of Biomedical Engineering, 20160 Denizli, Türkiye
[2] Helmholtz-Zentrum Dresden-Rossendorf-Nanoelectronics,01328 Dresden, Germany
[3] Helmholtz-Zentrum Dresden-Rossendorf-Life Science Nanomicrosystems,01328 Dresden, Germany
[4] Helmholtz-Zentrum Dresden-Rossendorf-Spectroscopy,01328 Dresden, Germany
[5] Helmholtz-Zentrum Dresden-Rossendorf-Magnetism ,01328 Dresden, Germany

Early detection of diseases is extremely important for better treatment management and higher survival rates. For many diseases, biomarkers are typically present in ultra-low concentrations in various body fluids during the disease process or at the onset of the disease. Therefore, early detection of diseases is largely made by biochemical tests of biological fluids in the body, such as serum. To perform these tests, especially biochemical-based devices are required in laboratory environments. In addition, these tests are expensive and require trained personnel to interpret the results [1]. Graphene-Based Field Effect Transistor (GFET) Based Biosensors exhibit higher sensitivity due to the excellent properties and electronic conductivity brought by the two-dimensional structure of graphene, as well as requiring no expertise and fast detection time. GFET biosensors have additional advantages such as low detection limit (required for early detection), real-time analysis and less sample volume requirement [2]. A GFET basically consists of a conductive graphene channel positioned between two metal contacts, the drain and source electrodes, through which the current is transmitted. Graphene forming the conducting channel allows its chemical functionalization with receptor biomolecules that can selectively bind to target biomolecules in the analyte. The binding of target biomolecules to the graphene channel creates a change in charge or electric potential on the GFET surface, leading to a variation in charge carrier density and mobility on the graphene channel. Therefore, an electrical conductivity change that is directly related to the biomolecular takes place. Chemically modified GFET biosensors convert the biological signal into an electrical signal at the bioelectronic interface with each binding event [3]. Therefore, GFETs respond rapidly to gate voltage changes, providing a unique and powerful platform for detecting specific binding events. In this study, it is planned to design biosensor platforms with a magnetic GFET structure using Photolithography and Electron Beam Lithography (EBL) methods. GFET biosensor platforms were obtained by transferring 2-dimensional graphene obtained by Chemical Vapor Deposition (CVD) Method and Exfoliation Method to these electrode structures using various chemical methods. Structural and electrical characterizations of the obtained biosensor platforms were made in back-gate and liquid-gate configurations (dry and liquid ambient conditions). The GFET platform is functionalized with streptavidin-coated iron nanoparticles and ferritin receptor proteins, and studies are carried out to obtain a rapid diagnostic kit for ferritin detection.

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Keyword: *Biosensors, Ferritin, Graphene, Magnetic nanoparticles*

DRAFT

Production and Development of 3D Printed Working Electrodes for Electrochemical Biosensor Applications

Selen Gunden*, Pınar Kara, Ezgi Kivrak, Sezin Yuksel
Ege University, İzmir, Türkiye

3D printing is a computer-aided technology in which a design prepared in a digital file is produced as 3D solid objects. Although 3D printing technology is a fairly new field, 3D printers, which take up less space, are replacing the production areas created with high costs in the production of devices and customized products that are miniaturizing day by day. It also attracts a lot of attention due to its faster and cost-effective production. It has taken its place in many application areas such as biomedical applications, laboratory equipment manufacturing, laboratory-on-a-chip (LOC) and detection systems (1-2). In the direction of 3D printed biosensor research, it is aimed at fields such as optical, electronic, electrochemical electrodes and has various advantages such as reducing the production cost and increasing the production speed of electrochemical electrodes compared to traditional methods, as well as providing easier adjustment of important properties such as diversity, roughness and robustness in the surface geometry. By improving the properties of 3D Printed electrochemical biosensors produced by using 3D printing technologies in electrochemical measurements in terms of conductivity and analytical performance of the system, it helps to overcome these limitations and provides a highly efficient detection (3). The importance of 3D technologies is also increasing in biosensors and POC systems developed for clinical purposes (4) Compared to conventional electrodes used in electrochemical biosensor applications using 3D printing technology, more cost-effective, efficient and prototypical sensor surfaces have been developed and optimized in our laboratory using PLA/CB conductive filament (3DcbE). In this direction, fish sperm dsDNA and representing E. coli bacteria ssDNA oligonucleotide are biomodified into 3DcbE's (carbon black and PLA electrodes for label-free voltammetric detection). Differential pulse voltammetry technique is used for label-free bioelectric detection of hybridization. The nanostructure of the sensor surface was observed by SEM method. In the futher studies we are also planning to apply nano-modification in order to enlarge the electrode surface.

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Keyword: *biosensor, electrochemistry, 3D printing*

DRAFT

1D, 2D and 3D Carbon Nanomaterials and their use in Determination of Ions and Volatile Organic Compounds (VOCs).

Ahmet Önder[*1], **Dilce Özkendir İnanç**[2], **Ferit Begar**[1], **Onur Büyükçakır**[1], **Ümit Hakan Yıldız**[1]
[1] *Department of Chemistry, İzmir Institute of Technology, İzmir, Türkiye*
[2] *Department of Photonics, İzmir Institute of Technology, İzmir, Türkiye*

Carbon based materials are of an interest for sensing applications ranging from environmental, food safety and disease diagnosis as well as bioimaging [1,2]. The major advantages in sensing provided by carbon-based materials are high sensitivity, robustness, and easy-to-work with various type of samples [3-5]. We here described utilization of 1D carbon nanoparticles, vertically aligned carbon nanotube, 2D single and bi-layered graphene, and 3D graphene foam-based sensor platforms to monitor volatile organic compounds (VOCs), ions. Composite bioelectronic platforms formed with 1D carbon nanoparticles and molecular cages were prepared to sense ions. These electrodes were used as potentiometric sensors for NO_3^- ion. The electrode exhibited a linear response in the concentration range of 1.0×10^{-5} to 1.0×10^{-1} M. As next step we aimed to explore the use of vertically aligned carbon nanotubes as solid contacts in potentiometric sensors. The potentiometric performance characteristics of the developed NH_4^+ sensor are found to be promising (LOD = 7.5×10^{-6} M LRR = 1×10^{-5}–1×10^{-1} M.) 2D carbon material single layer and bilayer graphene were utilized to monitor lipid bilayer on solid substrates, it has been shown that lipid bilayer formation and ion transport are monitored with high sensitivity. Graphene foam (GF) was utilized as 3D carbon-based nanomaterial to discriminate low molecular weight volatile organic compounds. GF has high surface area which enabling efficient gas adsorption. The developed sensor platform exhibited unexpected discrimination between low molecular weight VOCs. It is concluded that adsorption and intercalation of VOCs were predominantly governed the selectivity. Overall we describe the novel methodologies used in fabrication of 1D, 2D and 3D carbon nanomaterials based sensors platforms that will be of an useful for wide range of applications such as disease diagnosis, environmental and food safety.

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Keyword: *carbon nanoparticles, vertically aligned carbon nanotube, graphene foam, volatile organic compounds sensing*

DRAFT

Cotton-like Scaffolds for Tissue Regeneration Applications

Saime Nur Karasu[*1], **Mostafa Awaid**[1], **Yavuz Nuri Ertaş**[1,2]
[1] *ERNAM-Nanotechnology Research and Application Center, Erciyes University, Kayseri, 38039, Türkiye*
[2] *Department of Biomedical Engineering, Erciyes University, Kayseri, 38039, Türkiye*

Adequate oxygen supply is crucial for the survival of cells, and its insufficiency can result in cell death as well as the activation of various angiogenic genes via the hypoxia-inducible factor (HIF) pathway. Furthermore, oxygen plays a vital role in the healing process, making it of utmost importance for long-term care considerations. Delivering a sustainable oxygen-release can support the cells residing, the proliferation and differentiation of the implanted cells[1], and the neovascularization to avoid cell death caused by the lack of oxygen[2]. However, guaranteeing a sufficient supply of O_2 to implanted tissue constructs is still considered one of the greatest obstacles in tissue engineering (TE)[3] and skin regeneration fields.
In this regard, electrospun scaffolds were developed, which can serve as an advanced support to offer structural integrity, maintain cell viability, guarantee a sustained oxygen release, and enhance mechanical properties. They can be developed by incorporating oxygen nanosources into biopolymers (FDA-approved) in the form of cotton-like microfibrous (or cotton candy) scaffolds. Microfibers-based scaffolds overcome structural integrity and mechanical property limitations of nanofibrous material-based scaffolds[4]. Furthermore, the microfibers-based scaffold offers significant advantages, including ample inter-fiber spaces that facilitate vascularization, cell penetration, and efficient transport of nutrients across the entire scaffold. Poly(lactic-co-glycolic acid) (PLGA) and synthesized calcium peroxide (CP) nanoparticles are being combined in a variety of CP concentrations (1, 3, 5, 7, and 10 wt.%) and spun via direct melt extrusion technique. Nano-CP has a good biocompatibility and rich oxygen content with a favorable O_2 release profile[5], which can improve the therapeutic effect. Alternatively, it acts as an excellent antimicrobial, antibacterial, and antitumor agent. Oxygen was generated from the decomposition of encapsulated CP in an aqueous environment. PLGA managed to secure a proper coating of CP. This system has successfully sustained oxygen release for several days, which is crucial for cell viability and proliferation. Moreover, the electrospun scaffolds have a fiber structure can produce an efficient amount of oxygen in a sustained release manner to maintain the survival of cells. The physical properties of scaffolds, including SEM for structural analysis, FTIR spectroscopy, and XRD for composition analysis, were characterized. Oxygen-release studies and optical images were carried out. Collectively, these results suggest that the developed system has promise for different tissue engineering applications, including soft tissue regeneration, and wound dressing.

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Keyword: *calcium peroxide nanoparticles, melt electrospinning, oxygen-release scaffold, tissue regeneration.*

DRAFT

ID: 162

Label-free Detection of Acute Leukemia from Blood Serum with the Combination of Surface-enhanced Raman Spectroscopy and Machine Learning

Munevver Akdeniz[*1,2], **Fatih Oktem**[3], **Zakarya Al-Shaebi**[1,2], **Muzaffer Keklik**[3], **Omer Aydin**[1,2,4,5]
[1] *Department of Biomedical Engineering, Erciyes University, Kayseri, 38039, Türkiye*
[2] *NanoThera Lab, ERFARMA-Drug Application and Research Center, Erciyes University, Kayseri, Türkiye*
[3] *Department of Hematology, Faculty of Medicine, Erciyes University, 38039 Kayseri, Türkiye*
[4] *ERNAM-Nanotechnology Research and Application Center, Erciyes University, Kayseri, 38039, Türkiye*
[5] *ERKAM-Clinical Engineering Research and Implementation Center, Erciyes University, Kayseri, Türkiye*

Acute leukemia (AL) is classified as acute myeloid leukemia (AML) and acute lymphocytic leukemia (ALL) is a hematologic malignancy caused by uncontrolled proliferation of leucocytes in bone marrow. Early detection of AL is very crucial for clinical treatment. Detection methods of AL are currently blood test, bone marrow test, imaging, and spinal fluid tests. However, these tests have some drawbacks like high-cost, time consuming. As an alternative method, Surface-enhanced Raman Spectroscopy (SERS) which enhanced Raman signals by interaction of plasmonic nanostructures with analyte, is proposed to overcome the drawbacks. In this study, we aimed to detect and investigate AML and ALL directly from blood serum with combination of label-free SERS and machine learning. Serum obtained from 79 blood samples which included AML, ALL, and healthy individuals were dropped onto the Ag-based SERS substrate and the spectra were collected using 785 nm laser. Healthy serum was used as a control group. In the peaks around 639, 726, 960, 1135, 1202, and 1329 cm^{-1} assigned to proteins, lipids, and nucleic acids were observed slightly difference on all groups. Furthermore, the groups were classified by machine learning algorithms including RF, kNN, and SVM. Based on these analyses, it has been shown that SERS and machine learning are methods that can be applied for the detection of both AML and ALL. Consequently, SERS and machine learning provide a rapid, low-cost, and promising tool for detection of AML and ALL from blood serum.

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Keyword: *SERS, AML, ALL, Blood serum, Machine Learning*

DRAFT

ID: 186

Development of Nano Fibrillar ECM-Based Scaffold for Neural Tissue Engineering

Hilal Deniz Yılmaz[*1], **Yavuz Emre Arslan**[2], **Ahu Arslan Yıldız**[1]
[1] *Izmir Institute of Technology, Department of Bioengineering, Türkiye*
[2] *Canakkale Onsekiz Mart University, Department of Bioengineering, Türkiye*

In terms of tissue engineering applications, nano fibrillar membranes are practical tools for cellular growth and association. They have a wide usage area in many applications, including conduit fabrication, drug delivery systems, biosensor design, and in vitro modeling studies. Hence, the polymer content of the nano fibrillar membrane directly affects the cellular hosting, organization, and regeneration capacity. Thus, incorporating bioactive elements within the nano fibrillar membrane can improve the recapitulation of the ECM structure. Herein, the hydrogel from the ECM of the spinal meninges tissue- the natural membrane of the central nervous system- is used to fabricate a nano fibrillar scaffold for neural tissue engineering application. The electrospinning technique was used for scaffold production, and a water-based electrospinning solvent system was introduced as an alternative to toxic solvents that are conventionally used for electrospinning of natural polymers. This study includes the optimization of electrospinning parameters to obtain uniform nano fibrillar electrospun scaffold for neural tissue engineering applications. For that, after the decellularization of natural spinal meninges tissue and obtaining the ECM hydrogel, the polymer to solvent concentration and crosslinking optimization steps for electrospinning was performed. Then, the biochemical, topographical, and surface characterizations of the electrospun membranes were performed using ATR-FTIR, SEM, protein adsorption, and swelling analyses. The optimized electrospun membranes revealed a uniform structure and nano-sized fiber thickness with high protein absorption capacity and at least 50% swelling behavior.

Keyword: *Nano fibrillar, Electrospinning, Spinal Meninges, ECM, Neural Tissue Engineering*

DRAFT

ID: 188

Electrochemical DNA biosensor applications with newly developed electrode surfaces based on ZIF-8 nanoparticles

Elifcan Emiroglu Bolukbas[*1], Dilsat Ozkan-Ariksoysal[1], Sabriye Yusan[2], Sule Aytas[2], Ikbal Gozde Kaptanoglu[3]

[1] Ege University Department of Analytical Chemistry, Faculity of Pharmacy, Erzene Mah., 35040 Bornova, İzmir, Türkiye

[2] Ege University Department of Nuclear Technology, Institute of Nuclear Sciences, Erzene Mah. 35040 Bornova, İzmir, Türkiye

[3] Ege University Department of Material Science and Engineering of Institute of Science Sciences, Erzene Mah. 35040 Bornova, İzmir, Türkiye

The effectiveness of the modified Pencil Graphite Electrode (PGE) with Zeolitic Imizadolate Framework (ZIF-8) nanomaterial for DNA Biosensor Applications was investigated in this study. The impact of nanomaterial use on signal enrichment has been investigated using differential pulse voltammetry (DPV) techniques based on the guanine signal. Electrochemical activation techniques were used on the electrode surfaces at various pH levels to obtain the best responses from each electrode modified with a ZIF-8 nanomaterial and it was determined that the activation method had an effect on the response, also it was tested to see if the biosensor could serve as a hybridization biosensor, using both probe and target DNA.
Here, the effectiveness of newly developed electrode surfaces containing nanomaterial is evaluated based on whether these surfaces can precisely detect the DNA signal. In comparison to the bare PGE electrode, the ZIF-8 nanomaterial modified biosensor demonstrated % 37 higher sensitivity performance in terms of guanine oxidation signal obtained at about 1.0V.

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Keyword: *nanobiosensor, ZIF-8 nanomaterial, electrochemistry*

DRAFT

Fabrication of 3D cellular structures via Mg-alginate based bio-patterning

Basak Coban*, Ahu Arslan Yildiz
Department of Bioengineering, Izmir Institute of Technology (IZTECH), 35430 Izmir, Türkiye

Alginate has been extensively used as a bio-ink due to its ability to form physical hydrogel via ionic crosslinking. This study aims to develop a Mg-alginate bio-ink based on contactless magnetic manipulation approach to fabricate patterned 3-dimensional (3D) cellular structures within. Mg-alginate has self-disassociation property and that provides an important advantage while obtaining patterned 3D cellular structures without applying any extra disassociation step and chemicals. In this study, patterned 3D cellular structures were obtained using HeLa, SaOS-2 and SH-SY5Y cells to investigate applicability of developed bio-patterning methodology. Then, long term cell viability and characterization was performed. Further, drug response of patterned cellular structures was evaluated for doxorubicin, and IC_{50} values were obtained as; 8.2, 7.8 and 2.1 μM for 3D, while 2D controls were 3.2, 4.4, and 0.2 μM for HeLa, SaOS-2 and SH-SY5Y cell lines, respectively. Significant difference was observed for the dose response of 3D cellular structures compared to conventional 2D cell culture, which confirms patterned 3D cellular structures more resistant to drug exposure. Finally, the results show that 3D cellular structures fabricated by Mg-alginate based bio-patterning method are promising experimental platforms for drug screening studies.

Keyword: *3D cell culture, magnesium-alginate, hydrogel, 3D tumor model, drug screening*

DRAFT

ID: 196

Synthesis and Characterization of a New Injectable Sericin-Like IPN Hydrogels

Ecem Önal*, Alper Ulubaş, Tuğçe Sakallı, Alper Şahin, Nur Başak Sürmeli, Volga Bulmuş
İzmir Institute of Technology, Department of Bioengineering, İzmir, Türkiye

Injectable hydrogels have widespread use in biomedical applications including tissue regeneration and engineering. Despite the demonstrated potential of sericin, a silk protein, in tissue regeneration and engineering applications, its widespread use is limited since it is not possible to obtain natural sericin in a reproducible manner. Sericin is often obtained from silkworm cocoons through processes utilizing high temperature and/or harsh chemicals which adversely results in the distribution of protein properties such as molecular weight, solubility, and crystallinity. Using recombinant sericin instead of sericin produced through unsustainable methods would allow optimizing the characteristics of the protein and its use as a biomaterial in tissue regeneration/engineering. For this aim, interpenetrating polymer networks (IPNs) of a new recombinant sericin together with poly((oligo ethylene glycol)diacrylate) were successfully prepared. The physicochemical and mechanical properties of the IPNs were determined via FT-IR spectroscopy, scanning electron microscopy, and rheometry. Injectable hydrogels displayed a large water retention capacity (2800%). Additionally, in vitro degradation experiments performed gravimetrically revealed that approx. 60% of the IPN structure could degrade both enzymatically and hydrolytically within 20 days. Preliminary in vitro cell culture evaluations demonstrated that the viability of the L929 fibroblast cell line was not affected after 24-hour incubation with IPNs.

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Keyword: *Tissue Regeneration, Injectable Hydrogel, IPN, Sericin*

DRAFT

A Portable Nanoplasmonic-Based Biosensor Measurable in Plate Reader

Ayşe Nur Gürler[*1], Yaşar Yurtsever[1], Elif Deniz Çalı[1], Zeynep Şahin[1], Dilara Dördüncü[1], Abdulhalim Kılıç[2]

[1] Molecular Biology and Genetics Department, Istanbul Technical University, Istanbul, Türkiye
[2] Molecular Biology, Genetics and Biotechnology Programme, Istanbul Technical University, Istanbul, Türkiye

Biosensors have evolved into a wide variety of forms, yet many of them still have significant limitations. The exponential development of nanobiotechnology has necessitated the construction of point-of-care (POC) devices that are inexpensive, easy to use, rapid, and reliable. The main objective of this project is to design and develop a portable, user-friendly, and economically viable framework for a nanoplasmonic biosensor. This approach, utilizing a spectrophotometer, aims to enable quantitative and simultaneous detection of multiple targets. To achieve this, we coated a multi-well plate with a positively charged polymer called poly-l-lysine (PLL) and immobilized negatively charged gold nanoparticles on it. By modifying several factors, including the buffering system, concentrations of PLL and gold nanoparticles, incubation durations of PLL and gold nanoparticles, and the size of gold nanoparticles, we were able to optimize the sensor system. The findings demonstrated varied characteristics based on the type of buffering system used (MilliQ water, PBS, and citrate buffer) to suspend the gold nanoparticles (AuNPs). The behavior observed was also influenced by the size and concentration of the nanoparticles. Finally, the research successfully established an experimental platform capable of producing distinct responses for different solutions and differentiating between varying concentrations of the same solution.

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Keyword: *nanoplasmonic biosensor platform, point-of-care devices*

DRAFT

ID: 199

In vitro Assessment of Interpenetrating Networks of a New Sericin-like Protein

Alper Ulubaş*, Ecem Önal, Tuğçe Sakallı, Alper Şahin, Nur Başak Sürmeli, Volga Bulmuş
Izmir Institute of Technology, İzmir, Türkiye

Interpenetrating polymer network (IPN) hydrogels are composed of two or more crosslinked polymer networks. They provide free volume space in the three-dimensional network structure, which are highly useful for a variety of applications including tissue engineering and controlled drug release. Sericin, a silk protein, has been shown to be non-immunogenic, mitogenic, promote cell proliferation and migration, and prevent cell death. Sericin is usually obtained by chemical treatments and enzymatic methods, which yields protein products with inconsistent structure and properties such as molecular weight, amino acid composition, crystal structure, solubility. The use of a sericin-like protein obtained through recombinant methods instead of sericin from natural sources potentially allows standardization in stucture and properties, thereby obtaining reproducible materials. We have recently produced a recombinant sericin-like protein (Bostan, F., & Surmeli, N. B., 2022) and prepared injectable IPN hydrogels. These IPN hydrogels made from a sericin-like protein and poly(oligo(etyhlene glycol)diacrylate) (PEGDA) were compared with IPN hydrogels of commercial sericin-PEGDA as well as hydrogels of PEGDA in terms of in vitro cytotoxicity, proliferation and immunogenicity. Cytotoxicity of hydrogels was investigated using L929 mouse fibroblast cell line via Alamar Blue assay. Proliferation of L929 cells on hydrogels was also investigated via Alamar Blue analysis and visualized with DAPI staining. Additionally, immunogenicity of hydrogels was determined using Raw 264.7 murine macrophage cell line via TNF-a ELISA assay. The results indicated that sericin-containing IPN hydrogels have higher cell viability and proliferation compared to PEGDA only hydrogels.

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Keyword: *IPN, Sericin, Biomaterial, Hydrogel*

DRAFT

Investigation of The Toxicity of Gold Nanoparticles in Mcf-7 Cell Line

Canan Çil[*1], Elif Mehveş Özer[2], Abdulhalim Kılıç[1]

[1] *Molecular Biology, Genetics and Biotechnology Programme, Istanbul Technical University, Istanbul, Türkiye*

[2] *Molecular Biology and Genetics Programme, Istanbul Technical University, Istanbul, Türkiye*

Gold nanoparticles (AuNPs) are highly important due to their modifiable optoelectronic and physicochemical characteristics, achieved by altering their size, shape, and coating material. They find utility in various fields with different purposes, including diagnostic tools, drug carriers, imaging and screening technologies involving the addition of contrast agents for the detection of viruses, bacteria, or tumors. AuNPs are extensively used in the field of immunology for cancer treatment. Since many cancers are often detected at late stages where chemotherapy or surgery alone may be insufficient, AuNPs provide new insights and treatment methods for cancer. Despite the widespread use of AuNPs, there is a controversial aspect in the literature regarding their potential to cause cellular toxicity. Numerous studies in the literature focus on investigating the cellular toxicity mechanisms of AuNPs in various cell lines. These studies indicate that the toxicity of AuNPs depends on several factors such as incubation time, cell type, size, shape, and coating material. The coating material itself can be modified and functionalized to achieve various properties, such as the addition of ligands, improved solubility, enhanced cellular uptake, and even altered circulation time in the blood.

In this study, we examined the effects of different concentrations of 60 nm-sized AuNPs, specifically $2.5x10^{10}$, $0.5x10^{10}$, $0.25x10^{10}$, and $0.05x10^{10}$ particles/mL, as well as biomimetic lipid bilayer-coated AuNPs, on the human breast cancer cell line MCF-7. The effects of AuNPs on cell viability were investigated after 24 hours. The results showed that there was no decrease in cell viability, except at the lowest concentration of AuNPs. Particularly, lipid bilayer-coated AuNPs exhibited the highest cell viability. The results of the study indicated that the concentrations of AuNPs tested did not exhibit antiproliferative or intrinsic toxic properties against the MCF-7 cell line.

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Keyword: *Gold nanoparticle toxicity, lipid bilayer-coated gold nanoparticle*

DRAFT

Implantable Scaffold Containing Radiosensitizer Nanoparticles Developed for Post-Surgical Use in Solid Tumors

Büşra Çolak[*1], **Yavuz Nuri Ertaş***[1,2]
[1] *ERNAM-Nanotechnology Research and Application Center, Erciyes University, Kayseri, Türkiye*
[2] *Department of Biomedical Engineering, Erciyes University, Kayseri, Türkiye*

Inefficient accumulation and systemic toxicity of nanoparticles intended to accumulate in the target tissue by active or passive targeting require the development of different targeting strategies [1]. Using implantable systems containing nanoparticles to improve nanoparticle accumulation in the target tissue, to limit repeated dose administration by increasing the applied concentration efficiency, is an effective strategy to completely eradicate residual cancer cells in the lesion area after surgery, especially in solid tumors [2-4].
In this study, an implantable scaffold loaded with radiotherapy-sensitive (radiosensitizer) nanoparticles was designed in order to both increase the accumulation of nanoparticles in the target tissue and increase the efficacy of radiotherapy, which is widely used in the therapy of solid tumors, by using low-dose X-ray. Bismuth sulfide nanoparticles with radiosensitizer properties were synthesized by bovine serum albumin (BSA)-mediated biomineralization process. Then implantable scaffolds with mechanical strength were fabricated using 3D printing by mixing radiosensitizer nanoparticles and polymer solution for local delivery of radiosensitizer nanoparticles to the tumor site. The microscope images obtained show that the nanoparticles are homogeneously dispersed in the scaffold. The ability of nanoparticle-loaded scaffolds to improve radiotherapy efficacy on cancer cells under X-ray irradiation was evaluated different assays such as reactive oxygen species generation, colony and live/dead staining assay. The results obtained support that scaffolds may have effective therapeutic efficacy and high anticancer activity, especially when implanted in solid tumor sites requiring post-surgical radiotherapy.

Acknowledgement
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Keyword: *postsurgery, implantation, scaffold, nanoparticle, X-ray*

DRAFT

ID: 253

Magnetic nanoparticle-based biosensor system for SARS-CoV-2 antibody response following vaccination

Simge Balaban Hanoglu[*1], **Duygu Harmanci**[2], **Gözde Akkus**[3], **Evrim Durgunlu**[1], **Nursima Ucar**[1], **Candan Cicek**[3], **Suna Timur**[1]

[1] *Department of Biochemistry, Faculty of Science, Ege University, 35100, Bornova, Izmir, Türkiye*

[2] *Central Research Test and Analysis Laboratory Application and Research Center, Ege University, 35100, Bornova, Izmir, Türkiye*

[3] *Department of Infectious Diseases and Clinical Microbiology, Faculty of Medicine, Ege University, 35100, Bornova, Izmir, Türkiye*

A novel coronavirus first appeared in Wuhan, China, in December 2019, spreading rapidly and causing a pandemic. Knowing that herd immunity takes time, researchers have accelerated their efforts to develop a vaccine against COVID-19. The first vaccine to be used was CoronoVac or Sinovac. After this vaccine, the BNT162b2 vaccine (Pfizer-BioNTech) has proven to be more effective. These vaccines are accepted worldwide, were added to the regime in Turkey. Detection of SARS-CoV-2 is as important as it is in humoral immunity after infection or vaccination. It is important parameters how long the antibodies produced remain in the body or whether the presence of antibodies provides protective immunity. There is also a difference between the production of antibodies when a person is infected and the production of antibodies when they have been vaccinated. Therefore, it is necessary to consider the different reactions to different vaccines and adjust the vaccination schedule. Although it is difficult and costly to check the antibody level of each individual before vaccination, there is a need for a rapid and sensitive testing system that is easy to use. In this study, we developed magnetic nanoparticle-based biosensor platforms for rapid detection of SARS-CoV-2 antibody responses in human serum. The use of a magnetic nanoparticle-based electrochemical system enabled the detection of anti-SARS-CoV-2 spike (S) and nucleocapsid (N) antibodies at a concentration of ng/ml in both buffer and 100-fold diluted serum. In particular, the protocol for detection of anti S and N Abs, which is considered an indicator of innate immunity after vaccination or post infection, can be used to evaluate antibody response. Therefore, we included total 48 volunteers who had COVID-19 but were not vaccinated and who had COVID-19 and were vaccinated with Coronovac or Biontech. In this study, which was planned as a cohort, serum samples were examined from the time the volunteers' showed symptoms of COVID-19 at 3, 6, and 12 months with respect to antibody response in the developed system. The developed platforms were able to detect anti-S Ab and anti-N Ab with a limit of detection of 0.978 and 0.894 ng/mL, respectively. The results of anti-S Ab and anti-N Ab biosensors were confirmed with the corresponding commercial ECLIA assays. Compared with ECLIA, more regular results were obtained, particularly for samples collected after month 6, when antibody responses decreased. The results of this study will be useful for exploring the dynamics of the immune response, and the proposed system has translational use potential for the clinic. In conclusion, the MNP-based biosensor platform proposed in this study, together with its counterparts in previous studies, is a candidate for determining natural immunity and post-vaccination antibody response, as well as reducing the workload of medical personnel and paving the way for screening studies of vaccine efficacy.

Keyword: *SARS-CoV-2, COVID-19 vaccine, immunoassay, biosensor, anti-S-antibody*

DRAFT

Development of Aptasensor for the Diagnosis of Covid-19

Nursima Uçar*[1], Duygu Harmancı Karagülle[2], Simge Balaban Hanoğlu[1], Ezgi Man[1], Figen Zihnioglu[1], Serap Evran[1], Candan Çiçek[3], Ruchan Sertoz[3], Bilgin Arda[3], Tuncay Göksel[4], Kutsal Turhan[4], Suna Timur[1]

[1] Ege University, Institute of Science and Technology, Izmir, Türkiye
[2] Ege University, Central Research Test and Analysis Laboratory Application and Research Center, Izmir, Türkiye
[3] Ege University, Faculty of Medicine, Department of Medical Microbiology, Izmir, Türkiye
[4] Ege University, Faculty of Medicine, Department of Thoracic Surgery, Izmir, Türkiye

Aptamers are single-stranded DNA or RNA oligonucleotides that can bind specifically to a variety of targets with high affinity, selectivity, and sensitivity. Because of these advantages over antibodies, aptamers are a promising alternative for most applications. In this study, we have developed a basic system using aptamers that can translate the pandemic process that began with COVID -19 to later emerging diseases. In this project, we develop a low-cost, rapid, and portable aptasensor platform that can be used without an expert to diagnose COVID -19, a public health problem. To this end, amino-terminated aptamers were synthesized using the SELEX method and the interaction of the aptamers with the S1 protein of SARS-CoV-2 was studied by isothermal titration calorimetry (ITC). Gold electrodes were used to design the biosensor platform. After the electrode surface was functionalized with cysteamine, the amino-terminated aptamer was conjugated to the surface via a glutaraldehyde crosslinker. Subsequently, the surface characterization and analytical parameters of the developed sensor platform were determined by adding commercial S1 proteins on the surface using differential pulse voltammetry (DPV), cyclic voltammetry (CV), and impedance spectroscopy (EIS). Based on the obtained EIS and CV measurements, the surface characterization of the developed biosensor platform was performed and it was found that the modification was completed. In addition, the DPV results and analytical parameters of the sensor platform (calibration diagram, detection limit, repeatability, coefficient of variation) were determined and the working performance of the developed system was evaluated. Experiments with real samples were then performed. Experiments with interferences provided information on the specificity of the aptamer. The appropriate concentrations and quantities were determined by optimizing all studies.

Keyword: *aptamer, aptasensor, biosensor, electrochemical biosensor, COVID_19*

DRAFT

Rapid and cost-effective gelatin/dye paper based colorimetric chemo responsive sensor for monitoring biogenic amines

Fırat Ali Beyaz*, **Faezeh Ghorbanizamani, Figen Zihnioğlu**
Department of Biochemistry, Faculty of Science, Ege University, Bornova, Izmir, Türkiye

Biogenic amines which are ubiquitous in living organisms play an important role in many biological processes. However, their excessive production or intake can induce undesired toxicological effects. They have attracted increasing attention due to their significance in food safety and quality and are generally accepted as indicators for the freshness of food. In this context improvement of sensitive and cost-effective detection techniques is of crucial importance in food safety. Several methods have been developed for determination of biogenic amines in food such as gas chromatography, capillary electrophoresis, high-performance liquid chromatography, chemo and biosensors and etc. Among these methods, colorimetric platforms have advantages such as good environmental tolerance, high selectivity, simple sampling methods, visual detection mechanism, fast and reliable.

This work presents the preparation of pH sensitive gelatin/bromophenol blue paper-based platform for rapid, inexpensive, environmentally friendly, and sensitive screening tool for instantaneous detection of biogenic amines at a micro-/ nano level. The detection principle is based on a color change upon biogenic amine exposure to a gelatine/dye containing paper, which can be recorded simply via a smartphone and evaluation is made with freeware ImageJ to obtain data for quantitative analysis. The colors of the obtained paper platforms are yellow, and the paper incorporated with dye/gelatin showed considerable sensitivity against pH changes and, their color changed from yellow to green/blue by the increase of pH due to amine concentration. Putrescine was used as sample biogenic amine on test platforms. A linear relationship was observed between the intensity of blue color formed using ImageJ software and different biogenic amine concentration ranges. As the prepared paper platforms are suitable for calibration at different concentration ranges, they allow the determination of biogenic amines at both low and high concentrations. The limit of detection (LOD) for putrescine concentrations ranging from 0 - 100 ng/mL and 0 -100 ug/mL was found as 28.5 ng/mL (r2 = 0.9934) and 53.1 µg/mL (r2 = 0.979), respectively. The results were compared with spectrophotometric scanning method and found to be compatible. Moreover, the paper sensor was used for monitoring the freshness of the selected foods such as chicken and fish spoilage which presented visible color changes due to biogenic amines formed over time. The obtained results showed that the prepared paper platforms could be used as an effective method for the monitoring of food freshness.

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Keyword: *Biogenic amines, Paper based colorimetric sensor, Food spoilage, Gelatin/bromophenol blue*

DRAFT

Optical Imaging System for CdTe Quantum Dot-Based Lateral Flow Immunoassay: Quantitative Concentration and PL Analysis

Ilgim Efeturk[*1], Ege Gokce Savas[2], Ekrem Tinaz[3], Hakan Bozkurt[1], Hulya Ayar Kayali[2,3,4], Canan Varlikli[1,5]

[1] Department of Photonics, İzmir Institute of Technology, Urla, 35430 İzmir, Türkiye
[2] İzmir International Biomedicine and Genome Institute, Dokuz Eylul University, 35340 İzmir, Türkiye
[3] Izmir Biomedicine and Genome Center, 35430 İzmir, Türkiye
[4] Department of Chemistry, Division of Biochemistry, Faculty of Science, Dokuz Eylul University, 35160 İzmir, Türkiye
[5] Department of Photonics Science and Engineering, The Graduate School, İzmir Institute of Technology, Urla, 35430 İzmir, Türkiye

Lateral flow immunoassay is a point-of-care, easy-to-use, cost-effective and rapid diagnostic method to detect the target analytes in samples including whole blood, plasma, serum, sweat, or urine[1,2]. Analyzing the analyte under laboratory conditions is time-consuming and expensive, whereas immunochromatographic analyzes are affordable, provide results in minutes, and do not require any professional during analysis. An optical system for immunochromatography can indicate the stage of a certain disease in addition to presence/absence binary detection. In this study, the optical imaging system for LFIAs is developed based on CdTe quantum dots (QD) which were selected due to their niche properties for bioimaging including water solubility, high photoluminescence (PL) quantum yield (QYs), longer decay times[3] and photostability.
Observed samples were classified into 2 categories: (1) aqueous forms of 1:1, 1:2, 1:10, and 1:100 dilutions of CdTe QD with a stock concentration of 3.5 mg/ml diluted with borate buffer at pH 7.5, and (2) dry forms embedded in conjugate pads with a volume of 4 µl at the same dilutions. In the setup consisting of a 405-nm LED source, sample holder, 490-nm LP dichroic-mirror, and spectrometer, comparative analysis reveals a significant reduction of the QD emission in the glass fiber medium, by a factor of 21.27 (aqueous: 0.3106 a.u., dry: 0.0146 a.u.) when compared to CdTe QD_{aq}. Nevertheless, the usage of a more intense 405-nm laser light source has resulted in 967.8% increase in the intensity observed for QD_{dry} (0.1558 a.u.). As QD concentration increases, aggregation-induced emission is observed, which may play an important role in determining the level of disease in the body. The half-life of the strips was determined as 13 days. Data those could not be obtained in XRD and in the spectrofluorometer measurements due to the sample size of pads, could be obtained by the use of introduced setup. This study offers promising potential for next-generation rapid diagnosis and diagnostics.

Acknowledgements:
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Keyword: *Lateral Flow Immunoassay, Optical Imaging, Quantitative Concentration Detection, Quantum Dot Fluorescence, Cadmium Telluride*

DRAFT

Breast Cancer Cell Recognition with Polytyrosine Modified Nanoelectrode

Mustafa Ali Güngör[1], Sencer Karaca[1], Vildan Şanko[* 1], Sezin Eren Demirbüken[2], Bora Garipcan[2], Filiz Kuralay[1], Mustafa Ali Güngör[3]

[1] Department of Chemistry, Faculty of Science, Hacettepe University, Ankara 06800, Türkiye
[2] Institute of Biomedical Engineering, Bogazici University, 34684 Istanbul, Türkiye
[3] Department of Chemistry, Polatlı Faculty of Arts and Sciences, Ankara Hacı Bayram Veli University, Ankara, Polatlı 06900, Türkiye

Electrochemical systems enable qualitative/quantitative determination of the analytes with good sensitivity, selectivity, and stability. In these systems, electrode modification is highly desired to improve analytical performance. Among many modifiers, carbon-based materials such as graphene and carbon nanotubes are preferred in composite electrodes because of their large surface areas and high conductivity in the nanoscale. Additionally, polymeric layers are widely used to provide functionality [1,2]. In this context, electrochemistry offers advanced analytical tools for biomedical applications. Cancer is a type of disease in which certain cells in the body grow uncontrollably and as a result of this uncontrolled growth, serious health problems can occur [3]. This fatal disease and its treatments can also cause a variety of side effects. In this case, the importance of early diagnosis of cancer disease comes forward [4]. Breast cancer is a type of malignant tumor that appears in the inner lining of the milk ducts, epithelial tissues, or lobules with varying degrees of spread [5]. Various biomarkers can be used for clinical diagnosis of breast cancer, including estrogen and progesterone receptors, carbohydrate antigen 15-3 (CA15-3), carcinoembryonic antigen (CEA), and human epidermal growth factor receptor 2 (HER2).

In this study, we propose a disposable, simple electrochemical platform for the recognition of MCF-7 cells (human breast cancer cell line). After modifying the pencil graphite electrode (PGE) with graphene and carbon nanotubes, polytyrosine was created over this electrode electrochemically. The characterization studies were followed by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). In order to probe the recognition ability of the nanoelectrode for MCF-7 cells, antiHER2 antibody immobilization was performed on the functionalized surface to interact with the receptors due to overexpressing HER2 antigen on the cells. These interaction studies were monitored by using the EIS technique. Our results demonstrated that the prepared modified electrodes were successfully used to recognize the breast cancer cell line. As a result, a practical, effective and promising electrode design was introduced for cancer cell-based studies.

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Keyword: *Breast cancer, Electrochemical recognition, Carbon-based materials, Polytyrosine*

DRAFT

Cloning, expression, and purification of MPT64 proteins which is immunogenic protein of Mycobacterium tuberculosis

Muhammed Yusuf Yılmaz[*1], Gizem Kılıç[1], Burcu Saygıner[1], Ayça Tan[2], Neda Tatlıoğlu[3], Bilge Suyolcu[3], Ali Tufan[3], Tuna Havuz[1], Ceyda Demirtaş[1], Mehmet Burak Taşkaya[3], Rüzgar Çiçek[1], Nihan Ünübol[4], Tanıl Kocagöz[1], Erkan Mozioğlu[1]

[1] Department of Medical Biotechnology, Institute of Health Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

[2] Department of Biomedical Engineering, Faculty of Engineering and Natural Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

[3] Department of Molecular Biology and Genetics, Faculty of Engineering and Natural Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

[4] Department of Medical Microbiology, School of Medicine, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

Tuberculosis is a very important infectious disease all over the world. Rapid diagnosis is the top priority in the fight against this disease. For this purpose, biomolecules specific to Mycobacterium tuberculosis bacteria causing tuberculosis are important targets. For the characterisation of biomolecules identified as targets and for their use as substrates of new diagnostic products, their synthetic production and purification on an industrial scale is a major necessity. However, there are serious difficulties in their production in rapidly cultivable bacteria such as Escherichia coli instead of slow-growing mycobacteria. In this study, the cloning, expression and purification experiments required for the recombinant production of immunogenic MPT64 proteins of M.tuberculosis in E.coli were performed.

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Keyword: *Design of synthetic biomolecules, recombinant protein production, Mycobacterium tuberculosis, diagnosis, biosensors*

DRAFT

ID: 302

Optimisation studies of biofilm culture media to be used in the development of new generation antimicrobial surfaces

Tuna Havuz*, Burcu Saygıner, Erkan Mozioğlu
Department of Medical Biotechnology, Institute of Health Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

Unlike the individual life forms of microorganisms, their specialized forms called biofilms increase their stability. Biofilm formations are a significant problem not only in the field of health but also in almost every field of industry. Therefore, the production of new generation nanotechnological materials exhibiting antimicrobial and antibiofilm properties is becoming important. Development of suitable microbial culture media to form biofilms for use in testing different types of surface materials is critical. In this study, optimisation studies of biofilm culture media were performed.

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Keyword: *Design of synthetic biomolecules, recombinant protein production, Mycobacterium tuberculosis, diagnosis, biosensors*

DRAFT

ID: 303

Gene block design and cloning for recombinant production of glucose oxidase enzyme the in E.coli

Burcu Saygıner[*1], **Tuna Havuz**[2], **Erkan Mozioğlu**[1]

[1] *Department of Medical Biotechnology, Institute of Health Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye*

[2] *Department of Molecular Biology and Genetics, Faculty of Science and Letters, Istanbul Technical University, Istanbul, Türkiye*

Glucose oxidase (GOx) catalyses the oxidation of glucose and produced hydrogen peroxide and δ-gluconolactone. Due to its stabilities and rapid turnover, GOx has a wide range of applications in medicine, pharmacy, food industry, and textile. Recombinant DNA technology is used to produce this enzyme on an industrial scale. In this study, it was firstly aimed to design gene blocks from gene sequences of glucose oxidase enzyme of Aspergillus niger by codon optimization with bioinformatics tools and then to clone these synthetic genes into expression vectors by ligand independent cloning (LIC) method and recombinant production in Eshericiha coli.

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Keyword: *Design of synthetic biomolecules,, recombinant protein production, Mycobacterium tuberculosis, diagnosis, biosensors*

DRAFT

ID: 304

Fluorescent bacterial biosensors for investigating auto-induction parameters to increase the efficiency of recombinant protein production

Ali Tufan[*1], Muhammed Yusuf Yılmaz[2], Erkan Mozioğlu[2]

[1] Department of Molecular Biology and Genetics, Faculty of Engineering and Natural Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

[2] Department of Medical Biotechnology, Institute of Health Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

Protein production using recombinant DNA technology is one of the most widely used areas of nanobiotechnology. However, the production of recombinant proteins in organisms different from their natural hosts has some challenges, such as low yields or inclusion body production. Therefore, optimization experiments are required for each protein and each host separately and many different parameters need to be tested. In addition, IPTG-induced recombinant protein production sometimes results in low or no yields due to the increased load on the microorganisms. Auto-induction may be preferred instead. In this study, the aim was to use fluorescent bacterial biosensors to investigate auto induction parameters.

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Keyword: *Design of synthetic biomolecules, Recombinant protein production, Mycobacterium tuberculosis, diagnosis, biosensors*

DRAFT

ID: 305

In vitro selection DNA aptazymes specific to MPT64 proteins

Gizem Kılıç*, Erkan Mozioğlu
Department of Medical Biotechnology, Institute of Health Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Türkiye

As a major global health problem, tuberculosis causes of death more than 10 million people each year worldwide. The development of point of care (POC) diagnostic tools are among the urgent requirements. Aptamer-based biosensors may be alternatives for them. Aptazymes have recently been receiving increasing interest in the development of a new generation of POC diagnostic tools because they both recognize the target and generate signals with catalytic activity. In this study, an aptazyme library was designed and new fluorogenic aptazyme molecules specific to MPT64 proteins of Mycobacterium tuberculosis were selected to develop new tuberculosis aptasensors.

Acknowledgents: This study was supported by a grant from the Scientific and Technological Research Council of Türkiye (TÜBİTAK), No: 121Z220. Also thank to Acıbadem Mehmet Ali Aydınlar University for research infrastructure and opportunities.

Keyword: *Aptazymes, aptasensors, Mycobacterium tuberculosis, diagnosis, biosensors*

DRAFT

Development of Donepezil Loading Lipid Nanoparticles for Using the Treatment of Alzheimer's disease

Öykü Genç[1], Aycan Coşkun[1], R.Hilal Şenay-Tekeşin[1], Esra Feyzioğlu-Demir[*2]
[1] Nanotechnology and Biomaterial Laboratory, Cakabey Schools, Çiğli, Izmir, Türkiye
[2] Department of Medical Laboratory Techniques, Vocational School of Health Services, Izmir University of Economics, Balçova, Izmir, Türkiye

Alzheimer's disease is one of the most common neurodegenerative disease concerned with the structure and functioning of the nervous system. It can lead to memory problems, social dysfunctions, and symptoms that can cause death. Frequent and high-dose drug intake is required in the treatment of Alzheimer's disease. This is very difficult for patients who have difficulties in memory and body control. For this reason, there is a need for drug delivery systems that will reduce frequent drug intake, and ensure drugs are delivered in specific doses [1,2]. Nanoparticles, which are very small particles (1–1000 nm), are widely used in many medical fields, such as diagnosis and treatment. Especially, these have great potential in the treatment of many diseases such as neurodegenerative diseases [2]. Among the different form of nanoparticles that can be used for this purpose are liposome, polymeric nanoparticles, gold nanoparticles, dendrimer, and lipid nanoparticles.
In this study, lipid and protein derived nanoparticles were prepared to investigate their potential as delivery systems in the treatment of Alzheimer's disease. Lipid nanoparticles (LNP) were synthesized by pH-driven method using zein and rhamnolipid, which are used as proteins and lipids respectively. Lipid nanoparticles were characterized with SEM, FTIR and Zeta sizer analyses, and were determined to have a spherical morphology and 142.2 nm particle size. Donepezil was chosen as a model for drugs and drug loading, and drug release studies were carried out. The proportions of donepezil released from 400 µg/mL drug-loaded LNP after 150 minutes were found to be 97.15% and 84.29 % in the pH 5.5 and pH 7.4 release medium respectively. The release behavior of donepezil from LNP were also analyzed using five different kinetic models, and the release of donepezil was determined to be compatible with the Korsmeyer-Peppas model and Higuchi release model in the pH 5.5and pH 7.4 release medium, respectively. The resulting controlled drug release system was found to be compatible with controlled drug release by different administration routes, easy to synthesize, environmentally friendly, biodegradable, and possessing high loading capacity and encapsulation power due to nano-sizes.

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Keyword: *Lipid nanoparticles, drug release, donepezil, zein, rhamnolipid*

DRAFT

Layer-by-Layer Coated Custom-Made 2D Printed Contact Lenses as Personalized Dual-Drug Delivery Systems for the Treatment of Ocular Diseases

Burcu Ökmen Altaş*, Barış Sürmelioğlu, Nihal Aydoğan, Gökçe Dicle Kalaycıoğlu
Hacettepe Üniversitesi, Kimya Mühendisliği Bölümü, Çankaya, Ankara, Türkiye

Today, many people are suffering from various ocular diseases [1]. The approaches developed by the researchers have demonstrated the application of contact lenses to treat different eye diseases [2]. p-HEMA is widely used for the preparation of hydrogels as a lens material to treat ocular diseases. In our study, to deliver ciprofloxacin and ketotifen drugs simultaneously from p-Hema based contact lens at a therapeutically relevant doses without significant burst release, the surface of p-HEMA based contact lens was coated with the hyaluronic acid, chitosan and alginate – $CaCl_2$ by using the "Layer by Layer'' deposition technique. This approach has been used to improve the surface properties of hydrogel, as well as to load different drug molecules at different locations and also allow control of multidrug delivery kinetics to the eye. On the other hand, a top layer of the contact lens composed of drug free alginate – $CaCl_2$ to avoid chitosan degradation by tear fluid protein. In this way, adjustable delay times can be obtained by controlling the thickness of the drug-free chitosan and alginate – $CaCl_2$ layers. Thus, a drug delivery system capable of controlled drug release without burst release was obtained. The results of our study demonstrated that the concept of incorporating the LbL coated contact lenses can be evaluated as personalized dual-drug delivery systems for the simultaneous loading and sustained release of antibiotic and anti-allergic ocular drugs to treat and manage various ocular allergic conditions.

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Keyword: *Contact lens, multiple drug delivery, Layer by layer*

DRAFT

The potential of wound dressing of agarose/chitosan nanoparticle-loaded natural plant extract based film

Şeyma Karagül[*1], Fatma Yurt[1,2]

[1] *Ege University, Department of Biomedical Technologies, The Institute of Natural and Applied Sciences, Bornova, Türkiye*

[2] *Ege University, Department of Nuclear Applications, Institute Nuclear Science, Bornova, Türkiye*

Wound dressing materials have been created to speed up the healing process of chronic wounds by providing a moist environment. In this study, the effect of chitosan nanoparticles loaded with Hypericum Perforatum and the possible modification of agarose gel to produce wound healing films were investigated. This research aims to create a film using herbal medicine technology to heal chronic wounds. To achieve these goals, it is aimed to reduce the time required for chronic wounds to heal, to eliminate the length of hospital stay, or to develop films that allow self-treatment. Hypericum Perforatum has antiviral, antibacterial, anti-inflammatory, and antioxidant properties [1]. Chitosan, a natural polymer, is commonly used in drug delivery systems due to its biocompatibility, low toxicity, and high hydrophilic properties [2]. Agarose gel supplies create unique films with their high surface wettability, controlled swelling, and high biocompatibility [3].

Chitosan nanoparticles and nanoparticles loaded Hypericum Perforatum were synthesized by the ionic gelation method [4]. The synthesized Hypericum Perforatum-loaded nanoparticles were modified to the gel matrix. Then the matrix was dried to make films. The loading efficiency of Hypericum Perforatum was calculated using UV-Vis spectrophotometry. The characterization of nanoparticles was done using Dynamic Light Scattering (DLS), Fourier Transform Infrared Spectroscopy (FT-IR), and Scanning Electron Microscopy (SEM) techniques. According to the results, it was shown that Hypericum Perforatum' extract was loaded on chitosan nanoparticles with 87±11% yield, and a high yield of Hypericum Perforatum loading was observed. The sizes of chitosan nanoparticles and nanoparticles loaded Hypericum Perforatum were measured to be 69±4,2 and 124 ±5,7 nm, respectively. The film designed in our study might be used as a film with antibacterial effects for wound healing.

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Keyword: *Bioactivity, Hypericum perforatum, Wound dressing, Herbal biotechnology, Chitosan nanoparticles*

DRAFT

Investigation of Drug Loading Properties of Carbon Coated La1-xSrxMnO3 Structures as Drug Delivery Nanosystems for Cancer Combine-Treatment

Derya Özel[*1], Buse Sert[2], Gül Kaya[2], Şeyma Karagül[3], Ersan Harputlu[2], Fatma Yurt[1,3], Cumhur Gökhan Ünlü[4], Kasım Ocakoğlu[2]

[1] Ege University, Department of Nuclear Applications, Institute Nuclear Science, 35100, Bornova, Izmir, Türkiye

[2] Tarsus University, Faculty of Engineering, Department of Engineering Fundamental Sciences, 33400 Tarsus, Türkiye

[3] Ege University, Department of Biomedical Technologies, The Institute of Natural and Applied Sciences,35100, Bornova, Izmir, Türkiye

[4] Pamukkale University, Faculty of Technology, Department of Biomedical Engineering, 20070, Denizli, Türkiye

Magnetic hyperthermia treatment aims to conduct maximum heat to cancerous tissues while preserving normal tissues by monitoring the temperature of the tumor structure and stopping the application when it reaches the appropriate temperature [1]. Otherwise, normal tissues might also be harmed by high temperatures. In hyperthermia treatment, if the Curie temperature of the material used is in the range of 40-42 °C, heat generation will cease above this temperature, thereby protecting healthy tissues [2]. For this purpose, perovskite compounds with an ABO_3 (A: large metal ion, B: small metal ion) structure, whose Curie temperatures can be easily adjusted, have been employed in hyperthermia research [3,4]. In this study, uniform carbon-coated $La_{1-x}Sr_xMnO_3$ perovskite structures containing carboxylic acid groups on their surfaces, which can be used in hyperthermia studies, were synthesized and their drug loading properties were investigated. The carbon-coated MNPs with a uniform structure were thoroughly examined, and their morphology was confirmed through SEM, TEM, XRD, FTIR, and XPS analyses. Afterward, the chemotherapy drug Temozolomide (TMZ) for Glioblastoma Multiforme (GBM) was loaded into nanoparticles [5]. The antibody Panitumumab which is to target the deletion mutant (EGFRvIII) pathway to the epidermal growth factor receptor (EGFR) found in human GBM cells was integrated for in vitro studies, and the drug loading properties were investigated.

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Keyword: *Glioblastoma Multiforme cancer, Temozolomide, Panitumumab, Combine treatment*

DRAFT

Preparation of Silane Coated Perovskite Structures as Drug Delivery Nanosystems for Hyperthermia Studies

Buse Sert[1], Derya Özel[*2], Gül Kaya[1], Alparslan Oral[3], Ersan Harputlu[1], Fatma Yurt[2], Çiğdem Yener[4], Sinem Çiçek[4], Aleyna Akçay[4], Hatice Dilay Yazıcı[4], Telem Şimşek[5], Cumhur Gökhan Ünlü[4], Kasım Ocakoğlu[1]

[1] Tarsus University, Faculty of Engineering, Department of Engineering Fundamental Sciences, Tarsus, Türkiye

[2] Ege University, Department of Nuclear Applications, Institute of Nuclear Science, Bornova, Izmir, Türkiye.

[3] Ege University, Department of Nuclear Technology, Institute of Nuclear Science, Bornova, Izmir, Türkiye.

[4] Pamukkale University, Faculty of Technology, Department of Biomedical Engineering, Denizli, Türkiye.

[5] Hacettepe University, Department of Nanotechnology and Nanomedicine, Graduate School of Science and Engineering, Ankara, Türkiye

In recent years, significant research has been conducted to discover effective approaches to reducing or eliminating the side effects associated with traditional cancer treatment [1]. As a result, magnetic nanoparticles (MNPs) have garnered considerable interest due to their unique physical properties, magnetic sensitivity, biocompatibility, and stability. MNPs represent an important class of nanoscale materials with potential applications in biomedical fields, such as hyperthermia therapy, controlled drug release, and magnetic resonance imaging of cancer cells, owing to their distinctive physical properties and their ability to interact at the cellular and molecular levels [2]. The selection of MNPs is associated with their high magnetic sensitivity, biocompatibility, stability, and the availability of various preparation methods. Additionally, MNPs can be easily controlled by the application of an external magnetic field, enabling the controlled release of anticancer agents at a specific rate and in a specific region. These important features can contribute to overcoming the difficulties in traditional treatment. In self-controlled hyperthermia, the magnetic phase transition of the particle should occur within the range of 41-46 °C [3]. Numerous studies have been conducted to date towards achieving this goal, and it is evident that compounds belonging to the perovskite family, such as $LaSrMnO_3$, exhibit the most suitable structures for these properties [4]. In this study, silane-coated $LaSrMnO_3$ perovskite structures with various doping rates were successfully synthesized and characterized. Then, Temozolomide, which is used in brain tumor treatment, was loaded onto this nanostructure. The resulting nanostructure was evaluated to be useful for drug delivery and combined therapy (chemotherapy and hyperthermia).

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Keyword: *Hyperthermia, Silane Coated Perovskite Structures, Combine-therapy*

DRAFT

Synthesis of MXene/Mo2C-Fucoidan Nanohybrid and Investigation of Drug Loading Efficiency

Gul Kaya*[1], Buse Sert[1], Ayca Tuncel[2], Ersan Harputlu[1], Cumhur Gokhan Unlu[3], Kasim Ocakoglu[1], Fatma Yurt[2]

[1] *Tarsus University, Faculty of Engineering, Department of Engineering Fundamental Sciences, 33400 Tarsus, Türkiye*

[2] *Ege University, Department of Nuclear Applications, Institute Nuclear Science, 35100, Bornova, Izmir, Türkiye*

[3] *Pamukkale University, Faculty of Technology, Department of Biomedical Engineering, 20070, Denizli, Türkiye*

Studies on the synthesis of new organic-inorganic hybrid materials are continuing in energy, medicine, biomedical, environment and many other fields [1]. In comparison to existing two-dimensional (2D) analogs, MXene, a newly created material family, has several advantages, particularly the variable surface terminal groups (-O, -OH, etc.) that provide an almost limitless range of options for controlling the physicochemical properties of the surface [2]. However, the interface compatibility of MXene-organic hybrids is still less focused and continues to be investigated. In this study, Mo_2CT_x-MXene/Mo_2C@C synthesis was carried out; the synthesized hybrid structure was coated with poly (allylamine hydrochloride) (PAH) and fucoidan (Fuc), respectively. One of the reasons for integrating Mo_2C@C nanospheres into MXene layers is that the conductive carbon shell and matrix effectively prevent the aggregation of Mo_2C nanocrystals and facilitate electron transport. In addition, the abundance of Mo_2C nanocrystals in the carbon shell/matrix provides highly active sites catalytically. The nanoporous structure allows the active sites to be exposed and mass transferred effectively.

In the first stage, Mo_2CT_x-MXene structures with a layer thickness of 1 nm were synthesized with high purity and efficiency from the MAX phase using the hydrothermal technique. Then, the synthesized Mo_2C@C nanospheres with an average diameter of 50 nm were integrated into Mo_2CT_x-MXene structures. In the last step, surface modification was provided with fucoidan, a natural polysaccharide derivative, in order to increase the biocompatibility of the hybrid structure obtained by using equal amounts of MXene and Mo_2C@C structures (Mo_2CT_x-MXene/Mo_2C@C-Fuc). MXene derivatives are known to be negatively charged over a wide pH range, due to their surface functional groups, designated T_x. In this way, firstly, positively charged PAH and then negatively charged Fucoidan were coated on the surface [3]. In this method, polymer derivatives are electrostatically coated on surfaces in a layered formation. All nanostructures obtained in the study were characterized by techniques such as FE-SEM, TEM, XRD, XPS, and Zeta potential. Paclitaxel, which is known as an anti-cancer drug for triple-negative breast cancer (TNBC), was loaded to Mo_2CT_x-MXene/Mo_2C@C-Fuc hybrid structures [4,5]. The combination therapy potential of the newly synthesized MXene derivatives was evaluated on TNBC by in vitro experiments.

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Keyword: *MXene/Mo2C, poly(allylamine hydrochloride), fucoidan, paclitaxel, breast cancer*

DRAFT

ID: 127

Development of Polymeric Nanoparticle for the Treatment of Triple Negative Breast Cancer

Berrin Chatzi Memet[*1,2], **Ummugulsum Yildiz**[1,2], **Omer Aydin**[1,2,3,4]

[1] *Department of Biomedical Engineering, Faculty of Engineering, Erciyes University, Kayseri 38039, Türkiye*

[2] *NanoThera Lab, ERFARMA-Drug Application and Research Center, Erciyes University, 38280, Kayseri, Türkiye*

[3] *ERNAM-Nanotechnology Research and Application Center, Erciyes University, Kayseri 38039, Türkiye*

[4] *ERKAM-Clinical Engineering Research and Implementation Center, Erciyes University, Kayseri 38030, Türkiye*

Triple-negative breast cancer (TNBC) is a specific form of breast cancer where the tumor lacks the presence of estrogen receptors (ER), progesterone receptors (PR), and human epidermal growth factor-2 (HER-2) receptors. Triple-negative breast cancer (TNBC) is a highly aggressive form of breast cancer that exhibits early resistance to chemotherapy. Its significant drawback lies in its unfavorable prognosis, characterized by low overall survival rates, frequent relapse, and higher mortality rates when compared to other subtypes of breast cancer. Doxorubicin (DOX) is still the primary chemotherapeutic drug used in the conventional treatment of triple-negative breast cancer (TNBC). However, their clinical application is unsatisfactory due to drug resistance, nonselective distribution, and limited penetration. Therefore, developing a drug delivery system with improved penetration is crucial for effective TNBC therapy. Polymeric nanoparticles will be used as a carrier system to overcome these challenges.In our study, we successfully synthesized a novel negatively charged SPMA/PMMA polymer through RAFT polymerization. Nanoparticles were formed using the nanoprecipitation method. To achieve a nanoparticle-DOX complex, we employed electrostatic bonding. According to Dynamic Light Scattering (DLS) and ζ-potential analysis, the size of our nanoparticles was 180.8 ± 1 nm, and the surface load -41.2 ± 3mV. These measurements allowed us to assess the size distribution and stability of the nanoparticle-DOX complex, as well as determine the surface charge characteristics through ζ-potential measurements. As a result of complexes prepared at different nanoparticle ratios, it was the 1:30 (DOX:Nanoparticle) ratio that gave the highest encapsulation efficiency with %82.47 ± 15.51 EE. The IC_{50} value of Dox in 4T1 cells has been calculated as 0.61 μM. Therapeutic effect of the engineered polymeric nanoparticles is being currently under investigation.

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Keyword: *Polymer nanoparticles, RAFT Polymerization, Nanoprecipitation, Triple Negative Breast Cancer*

DRAFT

ID: 130

The Influence of Gold Nanoparticles on Cell Viability and on the Release of Exosomes in an In vitro Alzheimer's Disease Model

Mohammed Dabbour*, **Sultan Alnamri, Ozan Akdoğan, Canan Canan Bağcı**
Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353 Istanbul, Türkiye

Neurodegenerative disorders (NDs) involve the progressive impairment or deterioration of neurons essential for cognitive processes. Exosomes released by brain or neuron cells may play a vital part in the pathology of NDs, including Alzheimer's disease (AD), marked by memory loss and cognitive decline (1-3). Exosomes can be employed as AD biomarkers and can function as AD drug delivery vehicles in the central nervous system (2). Moreover, gold nanoparticles (AuNPs) possess extraordinary attributes, which include enclosing therapeutic molecules, facilitating drug delivery across the blood brain barrier, displaying antioxidant, anti-inflammatory, and anti-amyloidosis effects, and exhibiting nanoscale chirality and distinctive optical features, that render them valuable for ND diagnosis and treatment (4). Numerous AD-based studies have priorly explored the diagnostic and treatment potential of AuNPs.

In our study, we aimed to investigate the impact of green synthesized AuNPs on cell viability and exosome release in an in vitro AD model. AuNPs were successfully synthesized via a bay leaf-based green synthesis method, and were characterized by a UV-VIS spectrophotometer, which revealed a 564 nm AuNP absorbance peak that corresponds to the UV-VIS peak of nano-sized gold (green-synthesized) absorbance that was reported by Ipek et al. (2023) (5). Subsequently, the AuNPs will be further characterized via SEM and XRD for their shape and crystalline structure. To examine the influence of the generated AuNPs in vitro on human SH-SY5Y neuroblastoma cells, an AD model will be established by using beta amyloid toxicity, and the biocompatibility of the synthesized AuNPs will be determined using the MTT assay on normal and AD model cells. Thereafter, the effect of AuNPs on exosome release will be determined by comparing the relative amounts of exosome marker proteins in normal and AD model cells pre- and post-AuNP administration.

This study is hypothesized to contribute to research on AD treatment via uncovering an additional therapeutic utility of AuNPs to AD in vitro. Additionally, the study is expected to contribute to our comprehension of exosome behavior in response to AuNP exposure in vitro, thereby granting significant contribution to AD biomarker studies.

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Keyword: *Gold Nanoparticles, Nanomedicine, Exosomes, Alzheimer's Disease*

DRAFT

The effect of copper oxide nanoparticles on the oxidative metabolism and exosomal release in in-vitro Parkinson disease model

Asia Alnaseri*[1], Dalya Al-Zehhawi[1], Marwa Agha Kassab[1], İbrahim Ertuğrul Yalçın[1], Bestenur Yalçın[2], Canan Bağcı[1]

[1] Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353 Istanbul, Türkiye
[2] Bahcesehir University, Vocational School of Health Services, Department of Medical Laboratory Techniques, 34353, Istanbul, Türkiye

Parkinson's disease (PD) is a progressive age-related debilitating motor disorder and the second most common neurodegenerative disease after Alzheimer's disease. PD is characterized by loss of dopaminergic neurons in the substantia nigra compact (SNc) and accumulation of Lewy bodies[1], and is diagnosed mainly based on clinical symptoms. Numerous acute and long-term neurodegenerative disorders are associated with oxidative stress including PD as it is considered to be playing a significant role in the development of Parkinson's disease (PD). The use of artificial nanoparticles is growing, and as the use of these materials grows, it becomes increasingly vital to investigate their potential negative impacts on human health and the environment. Nanoparticle toxicity includes oxidative DNA damage, DNA lesions, nonviable cells, and intracellular ROS[2].
Copper oxide nanoparticles (CuO NPs) are a type of nanoparticles that have gained attention due to their unique physicochemical properties and potential applications in various fields. However, the potential toxicity of CuO NPs has raised concerns, particularly regarding their impact on cellular processes and their association with neurodegenerative diseases including Parkinson's.
Green synthesis of NPs utilizing microorganisms such as algae, fungi, bacteria, and plant leaf extracts has been proposed as an ecofriendly alternative to chemical synthesis because these processes are low cost, energy efficient, and nontoxic. The use of plant extracts for NP synthesis may be preferable to other ecologically friendly biological techniques since it eliminates the time-consuming procedure of maintaining a cell culture[3].
Exosomes, tiny cell-secreted vesicles found in almost all biological fluids, are known to carry RNAs and other molecules such as proteins and lipids. Thus, they have the potential to be used for early disease diagnosis marker for a number of neurodegenerative diseases, such as PD[4,5].
This project focuses on the green synthesizing of CuO NPs using green synthesis method, characterizing the NPs, then applying them on in SH-SY5Y cell line mimicking Parkinson's to determine whether this exposure to CuO NPs alters the oxidative metabolism of the cells. We successfully synthesized CuO NPs by using aloe vera plant as the reducing agent. The CuO NPs will be characterized by different nanoparticle characterization methods such as scanning electron microscope (SEM), X-ray diffraction analysis (XRD), and dynamic light scattering (DLS). Another focus of this study is to determine the effects of CuO NPs on the release of exosomes in the SH-SY5Y neuroblastoma cell line and a PD model which will be established on these cells.
These findings would contribute to understanding the potential impact of nanoparticles on the progress of PD, provide insights into the underlying mechanisms of nanoparticle-induced cellular effects, an it could also have implications for the development and safe use of copper oxide nanoparticles in nanomedicine.

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Keyword: *copper oxide nanoparticles, nanomedicine, oxidative stress, exosomes, Parkinson's disease*

DRAFT

Development of a Novel Liposomal Formulation for Targeted Treatment of Triple-Negative Breast Cancer

Orhan Burak Ekşi[*1], **Ömer Aydın**[2,3,4]

[1] *Nanotechnology Research and Application Center (ERNAM), Erciyes University, 38039, Kayseri, Türkiye*

[2] *Biomedical Engineering, Erciyes University, 38039, Kayseri, Türkiye*

[3] *NanoThera Lab, Drug Application and Research Center (ERFARMA), Erciyes University, 38039, Kayseri, Türkiye*

[4] *Clinical Engineering Research and Implementation Center (ERKAM), Erciyes University, 38030, Kayseri, Türkiye*

Triple-negative breast cancer (TNBC) represents a challenging subtype with limited treatment options. In this study, we aimed to develop a novel approach for the treatment of TNBC by synthesizing a liposomal formulation using sunflower lecithin, cholesterol, and quercetin molecules.

The liposomes were characterized using various techniques. Spherical morphology of the liposomes was confirmed through scanning transmission electron microscopy (STEM) imaging. Nanoparticle tracking analysis (NTA) revealed a size range of 100-110 nm, indicating the suitability of the liposomes for targeted drug delivery. The surface potential of the liposomes was determined to be approximately -22 mV using a Zeta sizer, suggesting good stability and colloidal dispersion properties.

To evaluate the efficacy of the liposomal formulation, a cell viability assay was performed using TNBC cell lines. Encouraging results were obtained, demonstrating a significant reduction in cell viability upon treatment with the liposomes. These findings indicate the potential of our liposomal formulation as an effective therapeutic strategy for TNBC.

Overall, our study presents a promising approach for the treatment of TNBC, utilizing a liposomal formulation composed of sunflower lecithin, cholesterol, and quercetin molecules. Further investigations are warranted to elucidate the underlying mechanisms and optimize the formulation for eventual clinical translation.

Keyword: *Breast cancer, Liposome, Sunflower lecithin, Quercetin, Drug delivery*

DRAFT

Development of Smart Nanoparticles for Efficient Therapy in Chordoma: Overcoming Treatment Resistance through Nanomedicine

Aybuke Ulku Kutlu[*1,2], Gizem Kursunluoglu[2], Merve Ercan Ayra[3], Cansu Umran Tunc[4], Esra Aydemir[5], Yasemin Yuksel Durmaz[3], Omer Aydin[1,2,6,7]

[1] Biomedical Engineering, Erciyes University, 38039, Kayseri, Türkiye

[2] NanoTheraLab, Drug Application and Research Center (ERFARMA), Erciyes University, 38039, Kayseri, Türkiye

[3] Biomedical Engineering, Istanbul Medipol University, Istanbul, 34810, Türkiye

[4] Utah Center for Nanomedicine, University of Utah, Salt Lake City, UT, USA,

[5] Biomedical Engineering, Biruni University, Istanbul,34010, Türkiye

[6] Clinical Engineering Research and Implementation Center (ERKAM), Erciyes University, 38030, Kayseri, Türkiye

[7] Nanotechnology Research and Application Center (ERNAM), Erciyes University, 38039, Kayseri, Türkiye

Chordoma, a rare malignant bone tumor with high recurrence rates and limited treatment success, poses significant challenges in current therapeutic approaches. However, the emerging field of nanomedicine offers a promising solution through the utilization of nanoparticles as effective carriers for gene and plasmid delivery. Among these nanoparticles, polymer-based carriers have garnered significant attention for their potential in overcoming the barriers associated with gene therapy. In this study, we aimed to develop an innovative treatment strategy for chordoma by exploiting the advantages of smart polymer nanoparticles as gene carriers. By utilizing FDA-approved β-cyclodextrin (β-CD) as the core material, we formed a complex with plasmid DNA (pDNA) and a positively charged peptide sequence containing a nuclear localization signal (NLS) feature. This approach resulted in the generation of pH-sensitive, hydrophobic, and cationic nanoparticles with enhanced biocompatibility through the grafting of polyethylene glycol (PEG). Our experimental findings demonstrated the remarkable non-toxicity of the designed smart gene carrier nanoparticles on the chordoma cell line CH22. Additionally, gel electrophoresis experiments confirmed the successful formation of a complex between the NLS+β-CD structure and CRISPR/Cas9 pDNA. DLS has been utilized in measuring the particle sizes and zeta potentials of "smart" NPs at different N/P ratios. All "smart" NPs with varying N/P ratios had particle sizes of less than 200 nm. The charge of "smart" NP and NLS peptide is positive, whereas the charge of CRISPR/cas9 plasmid is negative, while all complexes had a positive surface charge. Importantly, fluorescence imaging revealed efficient nuclear entry of the NLS peptide-containing pDNA+β-CD complex group within 6 hours, whereas the group lacking the NLS peptide showed no nuclear entry. Notably, the delivery of the plasmid to the nucleus and subsequent activation were confirmed by GFP transfection 48 hours after the application of the NLS+β-CD+pDNA complex to the chordoma cell line. Collectively, our study underscores the crucial role of polymer nanoparticles in facilitating gene therapy against the rare chordoma cancer, highlighting their potential in improving treatment outcomes for this challenging disease.

Acknowledgments:
This study was supported by the Scientific and Technological Research Council of Türkiye (TUBITAK) 1001 Scientific and Technological Research Projects Support Program (120S938). Aybuke Ulku KUTLU is supported by both TUBITAK 120S938 and Higher Education Council (YOK) 100/2000 Doctoral Scholarship Program.

Keyword: *CRISPR/cas9,chordoma, gene delivery, rare disease, smart nanoparticles*

DRAFT

Development of Polymeric miRNA Delivery Tools for the Treatment of Breast Cancer

Kübra Yumuk[*1], Zuhal Hamurcu[2,1], Ömer Aydın[3,4,5]

[1] Genome and Stem Cell (GENKOK), Erciyes University, 38039, Kayseri, Türkiye

[2] Faculty of Medicine, Basic Medical Sciences, Medical Biology, Erciyes University, 38030, Kayseri, Türkiye

[3] Biomedical Engineering, Erciyes University, 38039, Kayseri, Türkiye

[4] NanoThera Lab, Drug Application and Research Center (ERFARMA), Erciyes University, 38039, Kayseri, Türkiye

[5] Clinical Engineering Research and Implementation Center (ERKAM), Erciyes University, 38030, Kayseri, Türkiye

Breast cancer is an important health problem worldwide, accounting for 30% of all female cancer cases and 15% of cancer-related deaths in women. Standard treatment of breast cancers; surgery, radiotherapy, chemotherapy, hormone therapy, anti-Her2-targeted monoclonal antibody therapies, either individually or in combination. Although there are standard treatments, some breast cancer cells can become resistant to standard treatments. This resistance can arise due to genetic mutations or changes in tumor microenvironment, making cancer cells less susceptible to effects of treatment. That's why standard treatment does not enough for the cure of breast cancers. Gene therapy has great potential solve for these challenges. MicroRNAs (miRNAs) have emerged as potential therapeutic agents for cancer treatment due to their ability to regulate gene expression. However, efficient delivery of miRNA to breast cancer cells remains a challenge. Because the molecular structure of miRNAs is unstable in the physiological environment, and poor cellular uptake due to their negative charge and size are barriers for their use. It is known that miRNAs need carrier systems to fully perform their activities, to pass through the cell membrane and reach the appropriate intracellular region, and they gain the ability to provide higher molecular stability and effective protection against degradation by nucleases. Nanocarriers offer a promising solution for targeted delivery of miRNAs. In this study, we develop β-CD-based nanocarriers to encapsulate and deliver miRNA to breast cancer cells. The nanocarriers are designed to protect miRNA from degradation and facilitate its efficient cellular uptake. Our engineered delivery system is around 200 nm according to DSL measurement. And also, our nanocarriers has positive charge. The physicochemical properties of the β-CD nanocarriers, including size, surface charge, and stability, are optimized to ensure effective delivery and controlled release of miRNA. Our inhibitor miRNA and β-CD-based nanocarriers can be complexed around at 2/1 N/P ratio. And our mimic miRNA can be complex with β-CD-based nanocarriers in 8/1 ratio. Finally, negative miRNA and β-CD-based nanocarriers can be complex around at 8/1 N/P ratio. This well characterized polymer system currently being tested in vitro conditions.

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This study has been supported by the Erciyes University Scientific Research Projects (BAP) under Grant No: TSAÜ-2022-11895.

Keyword: *miRNA, Gene Therapy, Breast cancer, Nanocarriers*

DRAFT

Antioxidant, Anti-inflammatory and Antifungal Activities of Silver Nanoparticles Biosynthesized from Ammoides verticillata Aqueous Extract

Sarra Abbad[*1], Fatima Zohra Gana[1], Nadia Aissaoui[2]
[1] Department of Pharmacy, Faculty of Medicine, Abou Bekr Belkaid University, Tlemcen, Algeria
[2] Laboratory for Sustainable Management of Natural Resources in Arid and Semi-arid Areas, Salhi Ahmed University Center, Naâma, Algeria

Nowadays, biogenic silver nanoparticles (AgNPs) are arousing immense interest for their remarkable biological properties, offering hope in the fight against different ailments. The present work deals with the green synthesis of silver nanoparticles (AgNPs) using the dry aqueous extract from the aerial parts of Ammoides verticillata and the evaluation of their antioxidant, anti-inflammatory, and antifungal activity.
The formation of AgNPs was confirmed by visual color changes and by the appearance of the surface plasmon resonance (SPR) peak at 420 nm in the UV-Visible spectra. Dynamic light scattering (DLS) analysis demonstrated that the synthesized AgNPs had an average size of 34.58 nm. Antioxidant activity was determined using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay. AgNPs, aqueous extract, and ascorbic acid exhibited dose-dependent free radical scavenging ability, with half-maximal inhibitory concentration (IC50) values of 17.64±1.23 µg/mL, 83.61±3.43 µg/mL, and 46.73±2.54 µg/mL, respectively, thus confirming that AgNPs have a higher antioxidant activity than ascorbic acid. The in vitro anti-inflammatory activity of AgNPs was assessed by albumin denaturation assay. At a 500 µg/mL concentration, AgNPs exerted 86.77 % of an inhibitory effect on protein denaturation, while diclofenac sodium, used as a reference drug, exhibited 91.33 % of protein protection. These findings demonstrate the ability of AgNPs to control protein denaturation involved in the inflammatory process. The antifungal susceptibility testing revealed that the biosynthesized AgNPs inhibited fungal growth in a dose-dependent manner. Furthermore, AgNPs exerted fungicidal action against Candida albicans strains with low minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC) values. These findings suggest that plant-based AgNPs have great biological potential for safe biomedical applications.

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Keyword: *green synthesis, silver nanoparticles, Ammoides verticillata, biological activities*

DRAFT

Investigation of Antibiotic-Membrane Interactions using Different Biomimetic Lipid Membrane Models

Şebnem Seherler*, Abdulhalim Kılıç
Molecular Biology, Genetics and Biotechnology Programme, İstanbul Technical University, İstanbul, Türkiye

Biomimetic lipid membranes offer a versatile platform for studying the structure and function of biological membranes and their interactions with various molecules such as nanoparticles, antibiotics, proteins, and drugs. These lipid membrane models are extensively researched as they provide a simplified approach compared to direct investigation of native membranes, which can be complex. In these systems, well-characterized antibiotics, such as Gramicidin-D, which serves as an ion channel protein can be introduced into the lipid membranes to investigate the interactions between the membrane and antibiotics. The integration of Gramicidin-D into lipid bilayer of liposomes can be evaluated through endpoint analysis using fluorescent probes loaded liposomes.

In this study, liposomes containing a neutral phospholipid molecule (1,2-Dioleoyl-sn-glycero-3-phosphocholine or DOPC) and a negatively charged one (1,2-dioleoyl-sn-glycero-3-phospho-L-serine or DOPS) in a ratio of 92:08 were produced as a biomimetic lipid membrane model using thin-lipid film hydration methods. The liposomes were then loaded with a fluorescent probe, 8-Hydroxypyrene-1,3,6-trisulfonic acid trisodium salt (Pyranine) using either extrusion or bath sonication. Excess dye was removed through dialysis over a 24-hour period. The encapsulation efficiencies of both extrusion and sonication methods were calculated for each liposome composition. Following the encapsulation process, the dye-loaded liposomes were treated with Gramicidin-D to investigate the interactions between model cellular membranes and membrane proteins by monitoring dye leakage/liposome stability caused by the insertion of the channel protein

Keyword: *Biomimetic Lipid Membranes, Dye Loaded Liposomes, Gramicidin-D antibiotics, Pyranine*

DRAFT

Design of Upconverting Nanoparticle (UCNP) Integrated Chitosan Microparticles for Controlled and Sustained Intravitreal Delivery of Anti-Vascular Endothelial Growth Factor (VEGF) Antagonist Peptide

Zehra Canbulat[*1], Zeynep Özörnek[2], Zafer Eroglu[3], Murat Hasanreisoglu[4], Önder Metin[3], Seda Kızılel[5]

[1] Research Center for Translational Medicine, Koc University, Istanbul, Türkiye
[2] Department of Biomedical Sciences and Engineering, Koc University, Istanbul, Türkiye
[3] Department of Chemistry, Koc University, Istanbul, Türkiye
[4] Department of Ophthalmology, Koc University School of Medicine, Istanbul, Türkiye
[5] Department of Chemical and Biological Engineering, Istanbul, Türkiye

Ocular angiogenesis is one of the most encountered diseases in the eye and it results in complications such as retinal detachment, macular edema which later leads to vision loss and blindness. The primary biological component controlling the angiogenesis of the eye is vascular endothelial growth factor (VEGF). In clinical treatment, the anti-VEGF antibody is the primary drug with drawbacks such as short-half life, burden on both patient and clinicians. Since it is administered through intravitreal injection, there is a risk of infection. Here, we report an intravitreal controlled drug delivery system which includes the upconverting nanoparticles encapsulated in chitosan microgels which is conjugated with an anti VEGF peptide. Chitosan microgels will be stimulated by near infrared (NIR) light to release anti-VEGF under controlled conditions. The NIR light will subsequently be upconverted into UV light by the nanoparticles in the microgel. To do so, UCNPs with the ability to up-convert NIR light to 365 nm are synthesized and their characterization is done via PL spectra and TEM. In addition, methacrylated chitosan is produced and they are photopolymerized into chitosan microgels so that UCNPs are integrated. These microgels will be characterized through FTIR spectra, NMR and SEM. In further experiments, the anti VEGF peptide will be conjugated to chitosan microgels through ortho-nitrobenzyl bond and in vitro tests will be performed through MTT test and their biocompatibility will be assessed. It is expected to prevent angiogenesis in the retina. Through the administration of an anti-VEGF peptide regulated by UCNP integrated chitosan methacrylate microgel, this project provides a novel approach to problems related to intraocular anti-VEGF drug therapies.

Keyword: *Angiogenesis, Ocular diseases, Upconverting nanoparticles, Biomaterials, Hydrogel*

DRAFT

ID: 243

Nanoencapsulation of natural products extracts for viability improvement as potential anticancer drugs

Kholis Abdurachim Audah[*1], **Nasser Mohamed Ghassan Mohamed Adnan Shaikho**[1], **Garry Ian**[1], **Angeli Verdiansin**[1], **Norma Nur Azizah**[2], **Ade Arsianti**[2]

[1] *Swiss German University, Banten, Indonesia*

[2] *University of Indonesia, Indonesia*

Natural products in different forms, either as single compounds, fractions or extracts have been utilized as drug sources. Despite the ongoing debate about their usage as medicines, the utilization of natural products in the form of extracts, especially those that have been empirically proven and used traditionally as medicines n different parts of the world, show an increasing demand.

One of the main problems of natural product extracts is their bioavailability which eventually affects their viability. In this study, nanoencapsulation of mangrove extracts was performed to improve their viability as potential anticancer drugs. The results showed that nanoencapsulation had improved the viability of the extracts approximately two folds than non-encapsulated ones against two different cancer cell lines MCF-7 and HT-29 with only around 16 percent encapsulation efficiency.

Keyword: *natural products, mangroves, anticancer, bioavailability, nanoencapsulation*

DRAFT

Design Of Light-Sensitive Mesoporous Silica Nanoparticles As Carriers For Bee Venom In The Treatment Of Breast Cancer Cells

Özlem Yıldız*[1], Ayşenur Pamukçu[1], Emel Bakay[2], Didem Şen Karaman[1], Nermin Tapoloğlu[1]
[1] *Biomedical Engineering Program Graduate School of Natural and Applied Sciences, Izmir Katip Celebi University, İzmir, Türkiye*
[2] *Abo Akademi University, Turku, Finland*

Breast cancer is the most common malignant type of cancer with a high mortality rate. Surgery, chemotherapy, radiotherapy, immunotherapy, gene therapy, and hormonal therapy have been employed for the treatment of breast cancer [1,4]. In recent research; combinatory therapy modalities such as Photodynamic therapy (PDT) the application of light with certain wavelengths absorbed by light-sensitive agents is an advantageous therapeutic approach and is being immensely investigated in breast cancer treatments [1]. In addition, the anticancer activity of bee venom as an alternative treatment against breast cancer attracted a lot of attention in the recent year [2-3]. Besides that, nanomedicine-aided strategies have the potential to overcome the limitations in the treatment of breast cancer [5]. With the aid of flexible nanoparticle designs concomitant anti-cancer strategies could be facilitated such as combining light-sensitive agents for PDT and bee venom in the same nanoparticle design. Among the employed nanoparticle designs mesoporous silica nanoparticles (MSN) are beneficial due to tunable silica chemistry, high loading capacity, chemical, and biological stability, and ability to reach the tumor cells efficiently [4]. In this study; we aim to combine bee venom and the light-sensitive agents in the same silica scaffold and to investigate their anticancer effect on breast cancer cells by in vitro studies. Within the scope of these studies, photosensitizer incorporated MSN was synthesized to respond to PDT, and loading of bee venom was performed in MSN structure and physicochemical characterization of designed nanoparticles was achieved to ensure their anticancer activity. The anticancer activity of venom-loaded MSNs was examined against the MCF-7 breast cancer cell line. In addition, the activity of the designed nanoparticles on breast cancer cells was examined with laser irradiation simultaneously. In conclusion: two different innovative treatment methods could be combined in the same MSNs design with the potential to offer combinatory cancer treatments, thanks to the tunable physicochemical properties of MSN. Our experimental results revealed MSN design could provide a scaffold for combinatory treatments with bee venom and PDT have the anti-cancer potential for breast cancer.

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Keyword: *Bee Venom, Mesoporous Silica Nanoparticles (MSN), Photodynamic Therapy (PDT), Breast Cancer, Drug Delivery Systems*

DRAFT

Root Canal Irrigation Agents Integrated Polyvinyl alcohol /Chitosan Hydrogels and Their Physical Characteristics

Batuhan Göç[1], Nadir Kiraz[2], Seda Demirel Topel[*3], Deniz Yanık[4]

[1] Antalya Bilim University, Faculty of Engineering and Natural Sciences, Department of Mechanical Engineering, Döşemealtı, Antalya, Türkiye

[2] Akdeniz University, Faculty of Sciences, Department of Chemistry, Antalya, Türkiye

[3] Antalya Bilim University, Faculty of Engineering and Natural Sciences, Department of Electrical and Electronics Engineering, Döşemealtı, Antalya, Türkiye

[4] Antalya Bilim University, Faculty of Dentistry, Department of Endodontics, Döşemealtı, Antalya, Türkiye

Polyvinyl alcohol (PVA) and chitosan hydrogels have garnered significant attention in the field of biomaterials due to their unique properties and potential applications in various biomedical fields. PVA and chitosan hydrogels have gained popularity in the field of endodontics due to their biocompatible nature and favorable mechanical properties, which allow for effective adaptation to pulp anatomy. PVA hydrogels are highly biocompatible, exhibit excellent mechanical strength, and possess good water absorption capacity. On the other hand, chitosan hydrogels are derived from chitin, a naturally occurring biopolymer. Chitosan hydrogels offer exceptional biocompatibility, biodegradability, and antimicrobial properties, making them suitable for wound healing, tissue engineering, and drug delivery applications. Furthermore, the combination of PVA and chitosan in composite hydrogels has shown promise in synergistically enhancing their mechanical and biological properties. In endodontics, the pursuit of the ideal irrigation agent, especially from the perspective of mechanical properties, continues depending on the drawbacks or deficiencies of the available solutions. Sodium hypochlorite (NaOCl), the most common irrigation solution in endodontics, is capable of dissolving organic tissue and is a strong antibacterial agent. Ethylenediamine tetraacetic acid (EDTA) is a chelation agent and is used to remove the smear layer that consisted of both inorganic and organic components. Chlorhexidine gluconate (CHX), a cationic molecule, is an antibacterial irrigation solution and is known for its antibacterial effect, especially on Enterococcus faecalis, and substantivity. In this study, PVA and chitosan hydrogels were used as base materials to improve the mechanical properties of irrigation solutions. EDTA, NaOCI, and CHX irrigation agents were mixed at different ratios to the PVA/chitosan hydrogels, and investigated their swelling ratios, wettability, viscosity, and contact angles. EDTA and CHX resulted to a stable gel solution after they mixed with the composite hydrogel solution over a week. On the other hand, NaOCl displays as a crosslinker resulted to a viscous hybrid hydrogel. This study emphasizes the utilization of PVA/chitosan hydrogels when combined to proper irrigats as innovative medicaments in endodontics.

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Keyword: *PVA, chitosan, endodontics, EDTA, irrigation agent*

DRAFT

ID: 129

Dynamic Plasmonic Hotspot Engineering with Cilia-Inspired Magnetic Soft Actuators

Gorkem Liman[*1], Emre Ergene[1,2], Emrecan Yıldız[1,3], Kubra Ozkan Hukum[1], Pinar Yılgor Huri[2], Arif Engin Cetin[4], Hakan Usta[5], Gokhan Demirel[1]

[1] Gazi University, Faculty of Science, Department of Chemistry, Teknikokullar Ankara, Türkiye
[2] Ankara University, Engineering Faculty, Biomedical Engineering Department, Golbasi Ankara, Türkiye
[3] Hacettepe University, Faculty of Science, Department of Chemistry, Beytepe Ankara, Türkiye
[4] Izmir Biomedicine and Genome Center, Cetin Laboratory, Balcova Izmir, Türkiye
[5] Kayseri Abdullah Gul University, Engineering Faculty, Nanotechnology Engineering, Kayseri, Türkiye

Surface-enhanced Raman spectroscopy (SERS) is a powerful analytical tool to detect molecular species at ultralow concentrations. Raman signal enhancement in SERS mainly originates from two theories; electromagnetic and chemical enhancement. Chemical enhancement (CE), which mainly relies on the charge-transfer processes between the chemisorbed analyte molecules and the SERS-active material, can provide unique enhancement and possibilities to design new SERS platforms. Today, electromagnetic enhancement (EM) mechanism is considered to be the most important effect for Raman signal enhancement in plasmonic SERS substrates, which relies on the excitation of localized surface plasmon resonances (LSPRs) leading to the localization and magnification of the incident electromagnetic field in regions called hot-spots. However, considering current approaches, controlling and tuning plasmonic hot-spot formations where the Raman signal enhancements maximize are still challenging due to high process cost, complexity, and inability of large-area fabrication. Many studies are now being carried out to solve these problems.

In this study, we propose a simple but very effective method using soft actuators as a solution to traditional hotspot formation problems. Soft actuators in different geometries were produced by adding silicon and magnetic micro parts to the molds designed using a 3D printer. We demonstrate a strategy based on plasmonic nanoparticles decorated cilia-inspired magnetic actuators that enable highly accessible millimeter-sized hot-spot generation via bending motion under a magnetic field. The fabricated platforms were then decorated with gold nanoparticles. Hot-spot generation performances of the platforms were evaluated by SERS using different Raman reporter molecules. The hot-spot generation performances of the new actuator platforms were evaluated via SERS using varied reporter molecules and also by employing 2D and 3D confocal Raman mapping techniques. The hot-spot formation is shown to be reversible and tunable, and leads to excellent Raman signal enhancements of up to ≈120 folds compared to the unactuated platforms. Accessible electromagnetic field magnification in the platforms can be manipulated by controlling different magnetic field strength, which is further supported by finite difference time domain (FDTD) simulations. Finally, we produced a centipede-inspired robotic platform to demonstrate the potential of our proposed strategy. Then, SERS enhancements were examined by performing analyte capture from the target environment.

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Keyword: *SERS, Raman Spectroscopy, Soft Actuators, Hot-Spot Engineering*

DRAFT

Polystyrene Based Actuator for Hot-spot Generation in SERS

Emrecan Yıldız[*1,2], **Münire Derebaşı**[2], **Görkem Liman**[2], **Kübra Özkan Hüküm**[2], **Gökhan Demirel**[2]
[1] *Hacettepe University, Faculty of Science, Department of Chemistry, Ankara, Türkiye*
[2] *Gazi University, Faculty of Science, Department of Chemistry, Teknikokullar Ankara, Türkiye*

Surface-Enhanced Raman Spectroscopy (SERS) is a vibrational spectroscopy technique that allows for highly sensitive structural detection of low-concentration analytes. One of the enhancement mechanisms in Raman spectroscopy is electromagnetic field enhancement. In this enhancement, the resonance of surface plasmons possessed by SERS-active metal particles with the wavelength of the incident light results in a significant amplification of the electromagnetic field. The regions where the enhancement is maximum are referred to as "hotspots." The abundance of hotspots enables a much higher level of enhancement in SERS. Further enhancement with increased sharpness and roughness could be achieved by developing nanorod, nanostar, and other structures with higher curvature. The dense and enhanced plasmonic hot spots in sharp edges and nanogaps drastically increase the surrounding electrical field, enabling even a single molecule level detection. In this study, the formation of hotspots was manipulated by controlling the nanoscale inter-particle distance using light-responsive soft robotic systems, leading to substantial improvements in SERS applications. Soft platforms were modified with gold nanosphere, gold nanorod, and gold nanourchins. Hot-spot generation performances of the platforms were evaluated by SERS using different Raman reporter molecules. Using this technique, we also introduced an ability for polymeric platforms to control their motion with a simple modification, which could dramatically facilitate the sampling and analysis of target molecules in the desired environment.

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Keyword: *SERS, Hot-Spot Engineering, Soft Actuators*

DRAFT

Tip-enhanced Raman Spectroscopy with Epi-illumination and Collection

Özge Demirtaş[1], Batuhan Balkan[*2], Alpan Bek[2,1]
[1] Middle East Technical University Micro and Nanotechnology Program, Ankara, Türkiye
[2] Middle East Technical University Department of Physics, Türkiye

A combination of Raman spectroscopy and scanning probe microscopy, either atomic force microscopy (AFM) or scanning tunneling microscopy, seemed particularly promising as a nanoscale resolved detection tool called tip-enhanced Raman spectroscopy[1]. The morphology and size of the tips, surrounding medium, wavelength, and polarization of the laser light are important parameters affecting the spectral response of the tips[2]. Plasmon nanofocusing[3] provides efficient coupling of far-field radiation to the near-field zone by propagation of surface plasmon polariton through the end of the tip. In this study, we aim to achieve plasmon nanofocusing by modifying AFM tips using femtosecond (fs) pulses. To determine the optimal parameters, we investigated ripple formation on flat substrates and tips under varying power of fs pulsed laser, as well as different velocities and hatch distances of the galvoscanner head. Figure 1a depicts the design of our TERS device, while Figure 1b illustrates the epi-illumination and collection configuration, which allows characterization of both opaque and transparent samples. This configuration eliminates the residual background signal that arises from side illumination.

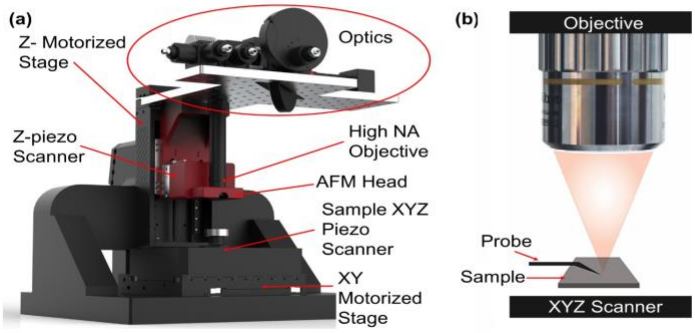

Figure 1: (a) 3D drawing of the integrated system consisting of AFM and Raman spectroscopy and **(b)** schematic of the illumination and collection configuration.

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Keyword: *Atomic force microscopy, Raman Spectroscopy, TERS, Scaning Probe Microscopy, Plasmon Nanofocusing*

ID: 242

Multi-Au capped Si nanoislands as a novel saturable absorber with a high modulation depth

Ali Karatutlu, Umut Taylan, Zehra Gizem Mutlay*, Bülend Ortaç
Bilkent University UNAM, Ankara, Türkiye

We demonstrate the synthesis and characterization of multi-Au capped amorphous Si nanoislands using the subsequent use of laser ablation and plasma-enhanced chemical vapor deposition techniques. It is the first study in the fabrication of multi-Au caps on one Si nanoislands using a vapor-liquid-solid mechanism and their use as a saturable absorber with a high modulation depth of around 15%. The fabricated multi-Au-capped Si nanoislands were initially characterized using UV-Vis-NIR absorption and reflection spectroscopy, scanning electron microscopy, and transmission electron microscopy studies. For the determination of their non-linear saturable absorption properties, a power-dependent transmission measurement of a femtosecond light sent from a commercial Titanium-Sapphire laser source operating at 800 nm was utilized. The hybrid saturable absorber consisting of metallic and semiconductor structures yielded around 15% modulation-depth as a promising mode-locker.

Keyword: *saturable absorber, non-linear optics, nanoislands, vapor-liquid-solid mechanism, silicon*

DRAFT

ID: 294

Application of Photodynamic Therapy of Prostate Cancer with MoO3_x-Based Nanomaterial

Hande Ugras[*1], Ozgur Tabakoglu[1], Huseyin Umit Kaynar[1], Aymila Cin[1], Nermin Topaloglu Avsar[2], Busra Sirek[2]

[1] Izmir Bakırcay University, İzmir, Türkiye

[2] Izmir Katip Celebi University, İzmir, Türkiye

Photodynamic therapy (PDT) has been investigated in several research studies as a potential treatment for prostate cancer. In this study, molybdenum trioxide (MoO_3) and rare earth elements are used in combination with PDT. In this method, $MoO_3$was doped with neodymium (Nd), erbium (Er), and ytterbium (Yb) in specific amounts. As a result, 2.8mM of all elements were obtained. After the nanomaterials were obtained, X-ray diffraction analysis (XRD), scanning electron microscopy (SEM), and Energy Dispersive X-Ray Analysis (EDX) tests were done and the materials' size, purification, and morphology were determined. In addition to these tests, absorbance test was performed. It has been observed that materials have absorbance of approximately 950–1000 nm, so 980 nm is chosen for PDT applications. Prostate cancer cell line (PC3) was prepared from stock. Materials' singlet oxygen (ROS) capacity was checked by using a specific chemical agent called 1,1′-bis (diphenylphosphine) ferrocene (DPPF). One of the important parameter for PDT applications is energy density. Energy density (J/cm^2) refers to how much energy cells will be exposed to per cm^2.Thus, $50J/cm^2$, $100J/cm^2$ and $200J/cm^2$ irradiations were tried in the experiments in order to compare ROS production capacities of nanomaterials. The results show that Nd and Yb have the potential for ROS production at $200J/cm^2$. Afterward, the materials' cytotoxicity was controlled using the MTT assay. MTT results showed that MoO_3-Nd and MoO_3-Yb have toxic effects in 0.1mg/mL and 0.2mg/mL respectively. On the other hand, their lower concentrations, 0.05mg/mL, 0.025mg/mL, showed that they had an anticancer effect without cytotoxicity. The aim of this research is to synthesize new potential materials for PDT, the results of which are promising for cancer research. In future experiments, we will investigate the cell uptake activity, cytotoxic effects, and photothermal therapy (PTT) potential of the compound.

Keyword: *MoO3, rare earth elements, PDT, anticancer*

DRAFT

A one-step hydrothermal method-based QDs synthesis and their use in electrochemical sensor design for Cu(II) determination

Mustafa Ali Güngör[*1,2], **Seyide Nur Bahçe**[1], **Cem Erkmen**[1], **Vildan Şanko**[1], **Filiz Kuralay***[1]
[1] *Department of Chemistry, Faculty of Science, Hacettepe University, Ankara 06800, Türkiye*
[2] *Department of Chemistry, Polatlı Faculty of Arts and Sciences, Ankara Hacı Bayram Veli University, Ankara, Polatlı 06900, Türkiye*

An important metal, copper is critical for the health of people, plants, and animals. Due to its qualities, including electrical and thermal conductivity, flexibility, sustainability, and antibacterial activity, copper is widely employed in a variety of industries. Therefore, it is crucial to offer a fast, sensitive, and validated method for determining trace copper levels. In the literature, several analytical methods such as electrochemical, atomic fluorescence spectrometry, high-inductively coupled plasma, and chromatographic methods are frequently used to detect copper (1-2). Whereas the majority of these methods are expensive and time-consuming, electrochemical methods offer high sensitivity, are easy to use, and respond quickly. Quantum dots (QDs) are zero-dimensional nanocrystals utilized in nanoscience and nanotechnology that have outstanding optical, electrical, chemical, physical and semiconductor capabilities as well as strong biocompatibility and biodegradability. They are frequently utilized for a variety of possible applications, including electrochemical sensors, biosensors, and potential targeting agents for viruses and cancer cells (3). In this study, an electrochemical Cu(II) sensor was developed using a pencil graphite electrode (PGE) modified with QDs synthesized using citric acid and l-cysteine precursors. The QDs nanoparticles were synthesized by a one-step hydrothermal method. The characterization of the QDs nanoparticles was investigated by ultraviolet-visible (UV-vis) spectroscopy and the results showed successful synthesis of QDs structures. The electrochemical behavior of Cu(II) at the PGE modified with QDs was deeply explored by cyclic voltammetry (CV) and anodic stripping voltammetry (ASV). Electrochemical experiments presented that the QDs-modified sensor exhibited good electrochemical performance. After determining the experimental conditions for the electrodeposition of QDs, the linear range of Cu(II) on the modified electrode was 5.0-150.0 nM. Moreover, the suggested sensor demonstrated good stability, repeatability, and it was effectively used to detect Cu(II) in water samples.

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Keyword: *Nanosensor, Copper, Quantum dots, Electrochemical sensor*

DRAFT

ID: 313

Single-walled carbon nanotubes mediated linear DNA vector delivery into the squash leaves

Melike Çokol Çakmak* **, Ravzanur Yazıcıoğlu , Gülnur Şener , Stuart J. Lucas , Nihal Öztolan Erol**
Sabancı University Nanotechnology Research and Application Center, İstanbul, Türkiye

Gene delivery into plant leaf tissue remains a challenge because of the presence of the plant cell wall. Using carbon nanotubes (CNTs) as a carrier is an exciting approach aiming to deliver a 'gene of interest' into plant tissues (Demirer et al., 2019). Herein, we demonstrated CNT-mediated gene delivery in Cucurbita pepo (squash) leaves using a GFP-expressing linear DNA vector. For this, carboxylated single-walled CNTs (COOH-SWCNTs) were covalently functionalized with positively charged polyethyleneimine (PEI), which electrostatically interacted with the negatively charged GFP vector. They were characterized by zeta potential measurement, Raman spectroscopy, Fourier transform infrared (FT-IR) spectroscopy, and thermogravimetric analysis (TGA) which prove the success of functionalization. The zeta potential values of COOH-SWCNTs changed from -77.56±0.7488 mV to 64.36±1.586 mV with the addition of PEI, and subsequently decrease to 4.013±1.285 mV after binding with the GFP vector, confirming the attachments. Then, PEI-functionalized COOH-SWCNTs were infiltrated into the abaxial interveinal surface of squash leaves at various concentrations ranging between 1.25 ng/ul and 10 ng/ul, and their potential cytotoxic effects on the leaves were evaluated. Leaves infiltrated with the lowest concentration of PEI-functionalized COOH-SWCNTs showed slight leaf chlorosis indicating that the concentration at 1.25 ng/ul is less toxic to the plant. Then, PEI-functionalized COOH-SWCNTs were associated with the GFP vector in a 1:1 ratio and infiltrated in squash leaves. The expression of GFP was confirmed using a confocal microscope at 96 h post-infiltration. These results indicate that PEI-functionalized COOH-SWCNTs are capable of delivering DNA vectors into squash leaves, and may therefore be considered as a gene delivery tool for squash functional genetics and disease treatment.

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Keyword: *Single-walled carbon nanotubes, Linear DNA vector delivery, Cucurbita pepo, Abaxial interveinal surface of leaf infiltration, GFP expression*

DRAFT

ID: 317

Comparison of ZnO Nanoparts Synthesized with *Vitis Vinifera* L. cv. Öküzgözü by Thermogravimetric Analysis (TGA) According to Drying Temperatures

Nesrin Karaca Sanyürek* **, Burcu Aydoğdu**
Munzur University, Tunceli, Türkiye

In this study, *Vitis vinifera* L. cv. Öküzgözü was mixed with distilled water at 40°C with a magnetic stirrer for 24 hours. The extract was filtered and the phytochemicals, antioxidant and phenolic substances in the filtrate were used as stabilizers for ZnO nanoparticle synthesis. ZnO nanoparticles were synthesized by the precipitation approach. In order to investigate the effect of grape extract on ZnO nanoparticle synthesis, the structural stabilization of ZnO nanoparticles by drying at different drying temperatures was investigated by Thermogravimetric analysis method (TGA). According to the results found in TGA analysis, ZnO nanoparticles dried at 600°C did not show any mass loss, but ZnO nanoparticles dried at 60°C also showed mass loss. This is due to organic compounds known to come from grape extract during synthesis.

Keyword: *ZnO Nanoparticles, Termogravimetrik, Vitis vinifera L.*

DRAFT

Investigation of Hole Transport Layer Effects on Stability of Quantum Dot Red-Light Emitting Diodes Fabricated via Ink-Jet Printing Technique

Halide Diker[*1], Seçil Sevim Ünlütürk[2], Serdar Özçelik[3], Canan Varlıklı[4]
[1] *Solar Energy Institute, Ege University, Izmir, Türkiye*
[2] *Kansai Altan Paint Industry and Trade Inc., Izmir, Türkiye*
[3] *Department of Chemistry, Izmir Institute of Technology, Izmir, Türkiye*
[4] *Department of Photonics, Izmir Institute of Technology, Izmir, Türkiye*

Quantum dot light-emitting diodes (QLEDs) get attraction in next-generation display technologies regarding the unique properties of quantum dots (QDs) such as narrow emission bandwidth, high material stability high color purity, and cost-effective solution-based processibility [1]. Among various fabrication techniques, the inkjet printing method is considered the most promising method to fabricate cost-effective, large-area and/or flexible QLED displays [2]. As well as its material-saving benefit, it provides to generate individual QD patterns to achieve high-resolution pixelated displays due to its mask-free coating ability [3]. Along with the jetting parameters of the inkjet printer, the coating operation is necessary to achieve high QLED performance as well. In addition, while the inkjet printing technique is used to fabricate QLEDs, investigating the interface phenomena between the QD layer and polymeric hole transport layer (HTL) is crucial to identify the resistivity of the HTL against to solvents included in inkjet-printed QD layer [4]. Rigid HTL is known to be increased the QLED stability to a great extent due to preventing the interlayer mixing and HTL erosion caused by the QD ink solvent system [5].

In this study, red-light emitting QDs (CdSSe/ZnS) were synthesized by hot injection method and utilized as an emissive layer in the QLED with the device structure of ITO/PEDOT:PSS/**PVK(or p-TPD)**/QD/ZnO/LiF/Al. Ink-jet printing technique was used for the QD emissive layer by "one-layer-coating (1-Layer QD)" and "two-layer-coating (2-Layer QD)" approach to fabricate the device. The two different HTL materials, i.e., PVK and p-TPD were utilized to determine their interaction with the ink-jet printed QD emissive layer. Different device performances were obtained based on the kind of HTL and the number of QD layers. 1-Layer QD on the PVK and on the p-TPD layers exhibited approximately the same external quantum efficiencies whereas 2-Layer QD exhibited ~3-fold higher efficiencies on the PVK layer than that of on the p-TPD layer at the lower current density region. However, compared to the PVK layer, the p-TPD layer provided higher device stability regardless of the number of QD layers at the higher current density regions. The durability of p-TPD based devices was determined to be more than 10-fold higher than that of the PVK based devices.

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Keyword: *Quantum Dots, Red QLED, Inkjet Printing, Hole Transport Layer Erosion*

DRAFT

A study on the conformation-dependent colorimetric response of Polydiacetylene supramolecules to external triggers

Emine Hande Cingil Tan[*1], **Gizem Beliktay**[2], **Eric Tan**[1]
[1] *Sabanci University Nanotechnology Research and Application Center, İstanbul, Türkiye*
[2] *Sabancı University, İstanbul, Türkiye*

Polydiacetylene (PDA) supramolecules exhibit a conformation-dependent colorimetric response to external triggers. They transition from the blue phase, the planar backbone conformation, to the red phase, which exhibits a twisted nonplanar conformation. Therefore, PDAs act as sensors for the changes in their chain conformations caused by external triggers. Here we demonstrate how the colorimetric response of PDA vesicles to triggers is affected by having an initial purple phase, an intermediate phase with a twisted ribbon-like conformation, instead of blue. We obtained stable purple PDA vesicles at room temperature in aqueous conditions. Once exposed to external triggers, these vesicles gave a colorimetric response at lower exposure levels than blue phase PDA vesicles. Their already nonplanar conformation makes the complete conformational transition easier. Additionally, we report the supramolecular interactions which govern the conformation transition in the PDA vesicle system by using various PDA vesicles and external triggers. Within the scope investigated, we show that inter- and intra-chain interactions play a crucial part in causing chain distortions and structural rearrangements of the PDA backbone, in addition to the repulsive-ionic head group interactions. These results broaden the understanding of supramolecular interactions that make PDAs such interesting systems for research and also highlight the possibility of utilizing PDAs prepared at intermediate phases for customized sensing applications.

Keyword: *Polydiacetylene, Supramolecular interactions, Self-assembly, conformational transition*

DRAFT

ID: 278

Synthesis and characterization of organic molecules for Optoelectronic application

Gülenay Tunc*, Ayşe Gül Gürek
Gebze Technical University, Kocaeli, Türkiye

Organic semiconductors have considerable interest because of their growing performance in optical and electronic device.Different types of organic materials have worked by scientists on electronics.These materials include small molecules, polymers,phthalocyanine,porphyrin, fullerenes and other carbon-based molecular structures; ensembles of molecules and hybrid materials.Organic materials are being studied and developed for their potential to build devices with a flexibility.
In this study,organic molecules designed and synthesized which consist of different type of functional groups. These molecules were synthesized by sonogashira coupling reactions and statistical condensation reaction between two different phthalonitrile derivatives. The effect of substituted groups will be investigated on photophysical, photochemical properties and on point of view optoelectronic performance.

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Keyword: *organic electronic, semiconductors, small molecules, phthalocyanine*

DRAFT

The Optimization of the Electrical Conductivity of Pedot:Pss Films by Secondary Doping Using Polar Organic Solvents As a Preliminary Study for Efficient Thermoelectric Textiles

Bahar Şölen Akdemir Yılmaz[*1], **Nuray Kızıldağ**[1], **Ahmet Yavuz Oral**[2]
[1] *Institute of Nanotechnology, Gebze Technical University, Kocaeli, Türkiye*
[2] *Department of Material Science and Engineering, Gebze Technical University, Kocaeli, Türkiye*

Poly (3,4-ethylenedioxythiophene) (PEDOT) is a conjugated and electrically conductive polymer, which makes it attractive for many applications. However, PEDOT is insoluble in many solvents and therefore blended with poly (styrene sulfonate) (PSS), which acts as a non-conductive surfactant for easy processability[1]. While blending with PSS improves the processability, it disrupts the electrical conductivity of the PEDOT. Some polar organic solvents are used in secondary doping process to increase the electrical conductivity of PEDOT:PSS films. In this study, the PEDOT:PSS was treated with ethylene glycol (EG), dimethyl sulfoxide (DMSO), and their combination. Two samples were treated with 5 vol% EG and one of them washed with DMSO afterwards. Another two samples were treated with 5 vol% DMSO and one of them washed with EG afterwards. The last sample was treated with 2.5 vol% EG and 2.5 vol% DMSO mixture. The total solvent concentration was kept as 5 vol% for all samples. AFM and SEM/EDS were used to determine the conformational change of polymer chains and the distribution of the atoms of the elements, respectively. For the determination of absorption behavior of the samples, UV-Vis-NIR measurements were conducted in the wavelength range of 200-350 nm. The change in the PSS content was determined by XPS analysis. The film thickness was obtained with profilometer and the electrical conductivities of the films were measured by using LCR meter. The optimum conformational changes were observed with the sample treated with EG and washed with DMSO. It had a smoother surface and thus a more linear chain alignment[2]. The decrease in the PSS content was higher for the sample treated with DMSO and then washed with EG, which resulted in higher electrical conductivity[3]. The thermoelectric ink process which resulted in the highest electrical conductivity will be used for the high efficient thermoelectric textile prototyping.

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Keyword: *PEDOT:PSS, secondary doping, electrical conductivity, ethylene glycol, dimethyl sulfoxide*

DRAFT

ID: 39

One-Pot Synthesis of Magnetic Reduced Graphene Oxide as a Support of Pd/PdO Nanoparticles for Hydrogen Generation from Formic Acid

Mina Hadidi*, Morteza Bahram, Sajjad Keshipour
Urmia University, Iran

Deposition of Fe_3O_4 is considered as a common strategy to magnetization of material, which is normally carried out by a chemical oxidation reaction of iron cations under restricted conditions like temperature adjusting under nitrogen atmosphere. Herein, a protocol was developed to perch Fe_3O_4 nanoparticles on RGO via simply thermal treatment of citric acid, Fe(II), and Fe(III) as a one-pot reaction at 160 ºC for 1 h. Self-condensation reaction of citric acid was promoted to give RGO along with the oxidation reactions of iron cations to Fe_3O_4. This report offers adding Fe(II), and Fe(III) to the reaction vessel of GO synthesis from citric acid surprisingly leads to the one-pot single-step constructing magnetic RGO (MRGO). To evaluate the efficiency of the synthesized MRGO, Pd/PdO were deposited on MRGO to be employed as a magnetic photocatalyst of hydrogen generation from formic acid. The Pd/PdO supported on MRGO gave the turnover frequency of 371 h^{-1} at room temperature.

Keyword: *Magnetic, Reduced graphene oxide, One-pot Magnetization, Hydrogen generation, Formic acid*

DRAFT

Fabrication Of Shungite Enriched Ag/Cu Nano catalyts Integrated To Catalytic Converters and Investigation Of Their Efficiencies

Batuhan Göç*[1], Seda Demirel Topel[2]

[1] *Antalya Bilim University, Faculty of Engineering and Natural Sciences, Department of Mechanical Engineering, Döşemealtı, Antalya, Türkiye*

[2] *Antalya Bilim University, Faculty of Engineering and Natural Sciences, Department of Electrical and Electronics Engineering, Döşemealtı, Antalya, Türkiye*

The problem of air pollution caused by motor vehicles, which accounts for 50% of total urban air pollution, persists despite efforts to adopt greener fuels. Catalytic converters play a vital role in reducing exhaust emissions, but their prices have been rising due to global raw material supply challenges. Furthermore, the valuable metals, such as Platinum (Pt), Palladium (Pd), and Rhodium (Rh) present in catalytic converters make them attractive targets for theft. Enhancing the efficiency of catalytic converters is essential to mitigate the damaging effects on the ozone layer and reduce harmful gas emissions. In this study, a sustainable and cost-effective catalytic converter was developed to address the increasing demand for efficient and environmentally friendly emission control systems. This research investigates the utilization of Shungite, a natural mineral with high carbon content and catalytic activity, along with Ag-Cu nanoparticles (NPs) to produce a high-efficiency and low-cost catalytic converter.

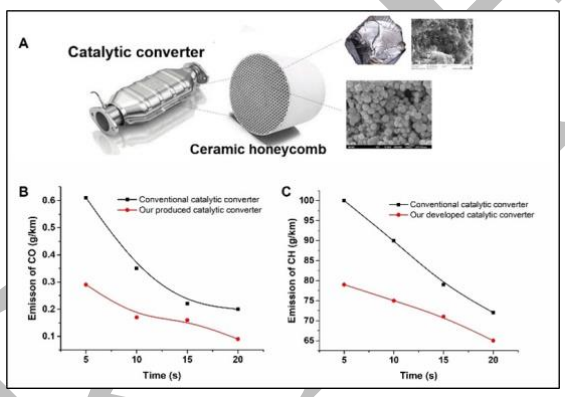

Figure 1. Schematic representation of the catalytic converter (**A**), Emission value for CO (g/km) (**B**) and Emission value for CH (g/km) (**C**)

The synthesis method involved the stirring of a mixture containing $AgNO_3$ and $CuSO_4.5H_2O$ in a N_2 gas atmosphere, followed by the gradual addition of $NaBH_4$ solution as a reducing agent. After further stirring, the resulting Ag/Cu nanoparticles were mixed with Shungite dust in 1:2 ratio, respectively. The catalytic converter was prepared by cutting open a second-hand unit, and the ceramic honeycombs were cleaned using acid solutions. Finally, the ceramic honeycombs were coated with the shungite enriched Ag/Cu nanocatalyts using the dip coating method. The coating widths were imaged using an electron microscope and the particle size were evaluated with dynamic light scattering (DLS) analysis in solution. The results revealed that the Shungite-enriched Ag and Cu nanoparticles had sizes of 20.16 nm and 98.20 nm, respectively. The catalytic converter incorporating these nanoparticles exhibited a 55.56 % decrease in CO and a 20.45% decrease in HC emissions compared to a standard converter. Ongoing development of this project aims to optimize the design and emission reduction capabilities, making it an attractive choice for future automotive manufacturers due to its economic viability and low emission rates.

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Keyword: *Catalytic converters, Efficiency, Shungite, Ag-Cu nanoparticles, Nanotechnology*

DRAFT

Modified Buoy Based Triboelectric Nanogerator for Blue Wave Energy Harvesting

Onur Demircioglu[*1], Melih Ogeday Cicek[1], Doga Doganay[1], Gunay Gazaloglu[2], Ahmet Cevdet Yalciner[2], Simge Cinar[1], Husnu Emrah Unalan[1]

[1] Department of Metallurgical and Materials Engineering, Middle East Technical University (METU), 06800, Ankara, Türkiye

[2] Department of Civil Engineering, Middle East Technical University (METU), 06800, Ankara, Türkiye

Triboelectric nanogenerators (TENGs) have been of great interest since they were proposed. Power is generated by static electricity caused by the contact of two separate surfaces. Therefore, any place where there is motion can be an effective workplace for TENGs to be used as both self-powered sensors and energy harvesting units. Given situations like these, water waves are one of the best places to get most out of TENGs to harness waste energy. In this study a commercial buoy used by sailors and marine workers for an alarm or guidance system was modified to work as a TENG device. TENG is prepared by coating inside of a buoy with polyurethane (PU) foam and hiring a pendulum mechanism as a counter triboelectric layer by coating an aluminum ball with poly (dimethyl siloxane) attached to a spring in the buoy. As a result of contact-separation, triboelectrification is provided. Real sea waves are simulated in Coastal and Ocean Engineering Laboratory of METU and fabricated buoy based TENG generated an open circuit voltage (Voc) of 145 V and short circuit current (Isc) of 8.9 μA. In addition, a power of 1.1 W/m^2 is obtained under a wave frequency of 1 Hz and a wave height of 11.8 cm at an impedance match of 300 MΩ.

Keyword: *Blue Energy Harvesting, Triboelectric Nanogenerators*

DRAFT

ID: 105

Energy Harvesting Using Lubricated Ball Bearing Triboelectric Nanogenerator

Murathan Çuğunlular*, Onur Demircioğlu, Melih Ögeday Çiçek, Mete Batuhan Durukan, Doğa Doğanay, Hüsnü Emrah Ünalan

Department of Metallurgical and Materials Engineering, Middle East Technical University (METU), 06800, Ankara, Türkiye

Triboelectric nanogenerators (TENGs) offer unique properties such as low weight, simple-structure, high power density and integrability to modern devices. TENGs utilize contact electrification and electrostatic induction to convert mechanical energy into electricity. Generally, for TENG systems the breakdown voltage of the air is a limiting factor for high power density; however, recent studies suggested that using lubricants could increase this breakdown voltage between the electrodes and increase efficiency. Ball bearings are components that are used with lubricants to reduce friction during rotational motion. Integrating TENG with ball bearings to convert rotational mechanical energy to electrical energy offers untapped potential. Given the widespread use of ball bearings in every level of mechanical systems, the ball bearing TENG can be implemented to variety of applications. In this study, ball bearings integrated with free standing TENG electrodes are tested from 200-1500 RPM with different ball and bearing dielectric materials under the presence of a variety of lubricants. The effect of material couples and lubricants are separately investigated. POM bearing and glass ball is found to be the best performing ball bearing TENG and a peak power of 2.2 μW was obtained at 500 RPM. The best performing lubricant is found to be polyethylene glycol, which increased power by 28% compared to dry conditions.

Keyword: *Nanogenerator*

DRAFT

ID: 109

cZIF-67/MXene Nanocomposite as a Sulfur Host Material for High-Performance Li-S Batteries

Recep Yuksel
Department of Chemistry, Faculty of Science, Eskisehir Osmangazi University (ESOGU), 26040 Eskisehir, Türkiye

Lithium-sulfur (Li-S) batteries are considered as one of the most promising electrochemical energy storage systems because of their high energy density (2600 Wh/kg), and theoretical capacity (1675 mAh/g). Although Li-S batteries possess high capacity, the performance of Li-S batteries is limited because of the polysulfide shuttling effect and the insulating nature of S. To overcome these problems, we report a nanocomposite host material using the metal organic framework derived porous carbon and two-dimensional Ti_3C_2 for S cathode in the Li−S batteries. The fabricated cZIF-67/Ti_3C_2 nanocomposite is a promising cathode host material due to its lightweight, high conductivity, and good electrochemical stability. cZIF-67/MXene nanocomposite achieves high S loading (>4 mg/cm^2) using melt S fusion. Thus, S/cZIF-67/Ti_3C_2 cathodes show a remarkable specific capacity of 1100 mAh g^{-1} at 0.1 C-rate and a good capacity retention of % 80 after 200 galvanostatic charge-discharge cycles at 1.0 C-rate. We will present a detailed analysis of electrochemical properties of the fabricated Li-S batteries to underline their charge storage behavior.

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Keyword: *Nanocomposite, MXene, MOF, Li-S Battery*

DRAFT

1T-TiS_2 Embedded Core-shell Fibers for Triboelectric Nanogenerator Applications

Onur Demircioglu, Sumeyye Kandur*, Ali Deniz Ucar, Mete Batuhan Durukan, Doga Doganay, Melih Ogeday Cicek, Husnu Emrah Unalan

Department of Metallurgical and Materials Engineering, Middle East Technical University (METU), Ankara, Türkiye

Triboelectric nanogenerators (TENGs) convert mechanical energy into electrical energy by frictional electrification. The easiness of the triboelectrification mechanism with relatively high-power output, and easy-to-build fabrication techniques makes these devices readily applicable for many applications. Among them, textile-based triboelectric applications have additional advantages compared to their conventional counterparts because of their flexibility and stretchability. Their applicability to wearable, communications, and health monitoring systems makes them suitable for utilization in Internet of thing (IoT) environments. In this study, a core-shell fiber is fabricated by the wet-spinning method. 1T-TiS_2 nanosheet added core fiber, which is working as a current collecting electrode, is conducting and consisting of TPU/1T-TiS_2-nanosheet/CB. On the other hand, the shell layer is a dielectric and consists only of TPU/TiO_2. TiO_2 is obtained through the oxidization of TiS_2 nanosheets in deionized water. From a parametric study regarding the composition of the core-shell fibers, conductivities of core were measured as 3.6, 0.67 and 0.6 S/m, respectively. From triboelectric measurements of the core layer against aluminum at different compositions open circuit voltages (Voc) of 2.7, 3.5, 5 V, and short circuit currents (Isc) of 350, 120, and 100 nA are recorded.

Keyword: *Triboelectric nanogenerator, 2D nanomaterials, titanium disulfide*

DRAFT

ID: 142

Bio-derived carbonaceous coating to control dendrite formation in aqueous zinc ion batteries

Maryam Abouali*, Recep Yuksel
Department of Chemistry, Faculty of Science, Eskisehir Osmangazi University (ESOGU), 26040 Eskisehir, Türkiye

Electrochemical energy storage, one of the cleanest and safest ways of converting and storing energy, is considered as an alternative to fossil fuels. Lithium-ion batteries domain an important part of the market being applied in portable electronic devices such as smartphones and laptops. However, drawbacks related to these kinds of batteries in terms of safety problems and manufacturing costs direct researchers to design more efficient energy storage systems. Aqueous zinc ion batteries (AZIBs) have attracted huge attention as promising electrochemical energy storage devices which are safe, low-cost, and applicable to large-scale production. The main challenge associated with these batteries is dendrite formation on the zinc anode surface during plating/stripping which leads to short circuit and thus affect battery performance. One possible solution to tackle this problem and to extend the life cycle of AZIBs is to modify the zinc anode surface by coating carbonaceous materials which enables controlled charge flux and uniform ion distribution. In this work, we report a new Zn anode design with poly lactic acid (PLA), a bio-derived environmentally friendly polymer as a porous layer on the zinc anode. By carbonizing this polymer using a high-power nanosecond laser, a carbon-coated zinc foil is prepared which can be directly utilized as the anode in zinc ion batteries. The fabricated PLA-derived carbon-coated zinc anode demonstrates significant improvements in terms of stability and cycling performance. We will present a detailed analysis of the electrochemical properties of the fabricated batteries to underline their charge storage behavior.

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Keyword: *Polymers, Energy Storage, AZIBs, Sustainable Materials, Vanadium Pentoxide*

DRAFT

Single Noble Metal Atom Doping: Boosting Photocatalytic CO2 Reduction on 2D Layered Perovskites

Bengisu Yılmaz[*1], **Uğur Ünal**[2]
[1] *Department of Materials Science and Engineering, Koc University, 34450, İstanbul, Türkiye*
[2] *Koç University Surface Science and Technology Center (KUYTAM), 34450, İstanbul, Türkiye*

The increasing use of fossil fuels and the subsequent rise in atmospheric CO2 levels due to industrial development and population growth have led to environmental challenges, including global warming. To mitigate these issues, it is imperative to reduce CO2 emissions and convert them into valuable chemicals. Perovskite oxides, known for their unique properties, have emerged as promising semiconductors for CO2 reduction. Notably, two-dimensional (2D) layered perovskites have some advantages over bulk ones. 2D layered structures facilitate electron transfer reactions, separation of electron-hole pairs, and shortening of charge carrier diffusion pathways. This study investigates the photocatalytic CO2 reduction performance of ultrathin 2D layered perovskite oxide KCa2Nb3O10 doped with a single-site noble metal, Ruthenium. In the literature, there are studies in which the co-catalysts are on the surface of the perovskite oxide. However, this study will be pioneering due to the contribution of noble metals into the crystal structure. 2D nanolayers with single atomic catalysts will be used for the first time for CO2 reduction performances. Furthermore, the influence of the ratio of dopant metal on photocatalytic activities is thoroughly examined. Methanol and ethanol were obtained as the main products from the synthesized materials due to CO2 reduction in the pure water medium. Using 2D nanolayers with single atomic catalysts contributes to advancing sustainable energy conversion technologies and addressing the pressing global challenge of CO2 reduction.

Keyword: *Photocatalytic CO2 reduction, Layered Perovskites, Single site noble metal atom doping, Photoelectrochemistry*

DRAFT

Development of Cathode Electrode for Large-Area Li-Ion Capacitors bye Ultrasonic Spray Coating

Sirin Siyahjani Gultekin[*1], Alper Ekici[2], Sermet Koyuncu[1]
[1] *Çanakkale Onsekiz Mart University, Çanakkale, Türkiye*
[2] *Ege University Solar Energy Institute, İzmir, Türkiye*

Lithium-ion supercapacitors have gained significant attention as promising energy storage devices due to their high-power density and long cycling stability[1]. This study focuses on the preparation and characterization of RGO:$Li3V_2(PO_4)_3$ (RGO/LVP) cathode composite materials, followed by the optimization of ultrasonic spray coating parameters such as spraying rate, frequency, substrate temperature, distance, etc. for the fabrication of high-performance large-area lithium-ion supercapacitors[2]. The composites were prepared using the sol-gel method with varying ratios of graphene oxide (GO) ranging from 10% to 50% (w/w). We aimed to enhance the electrochemical performance and stability of the supercapacitor electrodes by combining the unique properties of $Li_3V_2(PO_4)_3$ and reduced graphene oxide (RGO)[3]. The prepared composite materials and the prepared electrodes were extensively characterized using XRD, FT-IR, Raman, XPS, and SEM techniques to evaluate their structural and morphological properties. In conclusion, SEM, XRD, and XPS analyses confirmed the homogeneous formation of LPV/rGO composite structure. Additionally, in the composite electrode studies, the lowest resistance of $21.00x10^4$ Ω was achieved using 50% rGO/LVP.

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Keyword: *Li-ion capacitor, Utrasonic spray coating*

DRAFT

Synthesis and characterization of novel ethylene scavenger system to extend shelf life fruits and vegetables

Aygül Yurtay[*1,2], İstem Özkan[1], Büşra Daştan[1]
[1] BSH Home Appliances GmbH, BSH Street 59501, Cerkezkoy Factory, Türkiye
[2] Eskisehir Technical University, Chemical Engineering Department, 26555 Eskisehir, Türkiye

The aim of this study was developed novel porous carbon/polypropylene composite which is used in the refrigerator drawer in order to extend the shelf life of fruits and vegetables. For this purpose, walnut shells and oak wood chips were chosen as precursors to produce activated carbon via physical activation method, and oak wood chips were used to produce biochar. Carbon samples and polypropylene were utilized to obtain porous composite without any binder agent. It was determined that the composite samples formed by adding 0.1% to 10% activated carbon to the polymer matrix showed similar mechanical properties compared to the pure PP drawer. This finding suggests that the shelf life of fruits and vegetables in the porous drawer will increase at least 1.5 to 2 times compared to the PP drawer, as a result of the reduced ethylene concentration as a result of the ethylene gas adsorption onto activated carbon. The activated carbon/polypropylene porous composite production process which was explained in this study and the implementation of the refrigerator drawer was patented (Application Number: 2021/013472) by Bosch-Siemens Home Appliances.

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Keyword: *Freshness, Activated carbon, Ethylene Scavenger, Carbon/Polymer composites*

DRAFT

Synthesis and Characterizations of Organo-Rare-Earth-Metal Complexes for Organic Light Emitting Diode Applications

Cem Maraşlıoğlu[*1], **Şevki Can Cevher**[2], **Betül Canımkurbey**[3], **Merve Taner Camcı**[1], **Ali Çırpan**[4]

[1] *Turkish Energy, Nuclear and Mineral Research Agency – Rare Earth Elements Research Institute Ankara, Türkiye*

[2] *Zurich University of Applied Sciences ZHAW, Institute of Computational Physics, 8401, Winterthur, Switzerland*

[3] *Amasya University Research Central Laboratory, Amasya, Türkiye*

[4] *Middle East Technical University, Department of Chemistry, 06800, Ankara, Türkiye*

Lighting technologies are an indispensable part of this era and cover a wide area in many fields such as primary lighting and lighting in imaging sectors. Among these lighting technologies, organic light emitting diodes (OLEDs) attract attention due to their low potential operation, easy application to large areas, flexibility, lightness and high resolution. On the other hand, it is seen in the literature that organometallic complexes synthesized by using transition metals and some rare earth metals operate with high efficiency. This study is initiated by the motivation to increase the diversity in OLED applications and to synthesize applicable electroluminescent organometallic materials with high performance criterias. While imidazole derivatives, which are known to emit blue light are easy to synthesize and derivatize, were chosen as organic components, Europium (Eu) and Lanthanium (La) metals were preferred as metals to be used in organometallic complexes. Imidazole-derivatives, which have electroluminescence alone, are expected to have high-intensity and narrow emission band possessing emission in their metal complexes taking advantage of the shielding properties of electrons in the outer orbit of rare earth metals (REMs) and inhibition of f-f electron transition. In addition, it is aimed to coat the emissive layer by using the solution coating method as well as thermal evaporation, thanks to the modified alkyl chains on the structures of imidazoles. Structural characterizations are done by using infrared (IR) spectroscopy, ^{1}H-NMR and ^{13}C-NMR, optical characterizations are performed by UV-Vis spectroscopy (UV) and photoluminescence (PL) spectroscopy, electronical characterizations are completed by Cyclic Voltammetry (CV). Finally, the OLED applications will be completed as future work. External quantum efficiencies (EQEs), photoluminescence quantum yields (PLQYs), turn-on voltages and current density-voltage curves of the devices will be examined.

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Keyword: *Organic Light Emitting Diode, Organometallic Complex, Rare Earth Metals, Imidazoles*

DRAFT

ID: 232

Investigation of Biological Activities of Silver-Graphene Nanoparticles Synthesized by Green Synthesis Method

Büşra Dalgıç[*1], Sultan Sücü[2], İrem Akyol[2], Neslihan Ddemir[3]

[1] Çanakkale Onsekiz Mart University, School of Graduate Studies, Department of Biology, Çanakkale, Türkiye

[2] Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Molecular Biology and Genetic, Çanakkale, Türkiye

[3] Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye

Obtaining nanoparticles biologically with the green synthesis method provides a wide range of production and energy savings as well as being environmentally friendly, avoiding toxic chemicals and being biocompatible. Plant-mediated synthesis has become a more preferred method by researchers as it allows the formation of stable nanoparticles in a shorter time compared to other synthesis methods and makes synthesis easier. Quercus infectoria Olivier is one of the popular medicinal plants belonging to the Fagaceae family which is also used to treat various ailments. It is known that the gall structure of Q. infecoria is used by the local people in the treatment of burns, as well as in the content of ointments used as wound healing. In addition to these medicinal properties, Q. infectoria is known that it is frequently used as a pigment and for dyeing textile fibers since ancient times.

In our study, silver nanoparticles (AgNPs) were synthesized with Q. infectoria galls using the biological synthesis method and graphene-AgNP (GAgNP) composites were formed. Characterization was carried out using Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) methods. The biological activity of the nanoparticles was examined using the Ames/Salmonella test and the photocatalytic activity test. Mutagenic activity of nanoparticles was investigated against Salmonella typhimurium TA98 and TA100 strains by Ames/Salmonella test. The mutagenicity results confirmed that GAgNPs did not show mutagenic activity against either strains. Photocatalytic activities of nanoparticles were investigated against methylene blue and congo red dyes. At the end of the study, the methylene blue of GAgNPs was determined at 90 minutes. It was found that the congo red dye was completely degraded in the 180 minutes. We suggest that it is possible to use the nanoparticles synthesized within the scope of this study as a potential industrial product, as they do not show mutagenic activity and exhibit excellent dye degradation.

Keyword: *Quercus infectoria Olivier, Green Synthesis, Silver Nanoparticles, Characterization, Biological Activity*

DRAFT

Epilobium angustifolium L. Leaf Extract used Silver Nanoparticles and Their Biological Activities

İrem Akyol[*] [1] , Neslihan Demir[2]

[1] *Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Molecular Biology and Genetics, Çanakkale, Türkiye*

[2] *Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye*

Nanotechnology has the capacity to profoundly transform multiple industries, presenting vast opportunities for advancements in critical areas like drug delivery, miniaturization of electronics, renewable energy technologies, environmental remediation, and beyond. Nanoparticles have found widespread applications across these fields. Green synthesis of nanoparticles using microorganisms or plants offers a cost-effective, eco-friendly alternative to physical and chemical methods, which have disadvantages like high energy consumption, low yield, high costs, and environmental hazard.

Silver nanoparticles (AgNPs), derived from metal nanoparticles are widely utilized in various product designs owing to their unique antimicrobial properties. Silver nanoparticles are utilized in drug production, harnessing their antimicrobial and anticancer properties to create a convenient and enduring impact against a range of human pathogens, including viruses, bacteria, and fungi.

Epilobium angustifolium L. also known as fireweed or willowherb has a long history of traditional use as a remedy in folk medicine. In traditional usage, the infusion of fireweed leaves has been regarded as beneficial for alleviating headaches, colds, and gastrointestinal disorders. The abundance of polyphenolic compounds in the leaves and flowers of E. angustifolium has garnered attention for its diverse properties. E. angustifolium extracts display a range of beneficial activities, including anti-androgenic, antiproliferative, cytotoxic, immunomodulatory, anticancer, and antimicrobial properties.

In this study, the antibacterial and antioxidant properties of silver nanoparticles investigated which were synthesized with E. angustifolium leaf extract. The broth microdilution method was employed to determine the Minimum Inhibition Concentration (MIC) value. Antioxidant activities were determined by 1,1-diphenyl-2-picrylhydrazil ($DPPH^{\bullet}$) Free Radical Scavenging Activity and 2,2'-Azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) ($ABTS^{\bullet+}$) Cation Radical Scavenging Activity. The results revealed that both the extract and the silver nanoparticles showed remarkable antibacterial activity. Both samples exhibited noteworthy radical scavenging activity, indicating their potential as effective antioxidants. We observed a substantial increase in the biological activities of AgNPs when synthesized using E. angustifolium leaf extract. This suggests the potential utilization of nanomaterials in the healthcare sector, subject to future in vivo and in vitro testing.

Keyword: *Epilobium angustifolium L., Silver Nanoparticles, Antibacterial Activity, Antioxidant Activity*

DRAFT

Antibacterial Activity of Silver Nanoparticles Synthesized Green Synthesis Method Using Aqueous Extract of Plant *Lycopodium clavatum* L.

Sultan Sücü[*1], Büşra Dalgıç[2], Neslihan Demir[3]

[1] *Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Molecular Biology and Genetic, Çanakkale, Türkiye*

[2] *Çanakkale Onsekiz Mart University, School of Graduate Studies, Department of Biology, Çanakkale, Türkiye*

[3] *Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye*

Processing, extracting, and combining materials from a molecule or atom is what the term "nanotechnology" refers to. With the use of nanotechnology, the fundamental compositions of materials at the molecular or atomic level can be rearranged, the size of a nanoscale, and given new qualities. The shape, size, interatomic organization, and method of synthesis of nanoparticles can all differ. Metallic nanoparticles can be created through physical, chemical, and biological processes. The manufacture of nanoparticles on a large scale through biological means conserves energy, does not involve the use of hazardous chemicals, and has a low mistake rate. Living sources including yeast, algae, and bacteria are employed in biological synthesis, commonly referred to as "green synthesis" in addition to plants. Plants that are producers in the ecosystem are preferred because they can be found more easily and they form target nanoparticles. Lycopodium clavatum L., which is a type of moss and known as club moss, is popularly used for constipation, chronic aeration, and where is good for exhaust gas output. It has benefits for mental expressions such as forgetfulness and anxiety and also it is good for the stomach and digestion system. L. clavatum plant has anticancer, antioxidant, and wound properties.

Microorganisms that have become resistant to antibiotics become a problem to the world. This global problem reveals the organism to new antibiotics and agents. Researchers are investigating bioaccumulation, high alternative therapies, and ingredients. Green synthesis attracts the attention of researchers because it is a biological method and is environmentally friendly. In this study, silver nanoparticles synthesized with L. clavatum aqueous extract. Characterization of nanoparticles determined with UV-Vis spectrophotometer. The antibacterial effects of extract and AgNP were investigated with the Minimum Inhibition Concentration (MIC) method. It has been observed that club moss have a bacterial effect against microorganisms used by AgNPs synthesized from extract.

Keyword: *Green Synthesis, Lycopodium clavatum L., AgNP, Characterization, Antibacterial Activity*

DRAFT

Green Synthesis of Silver Nanoparticles Using Senna alexandrina var. alexandrina, Characterization and Investigation of Biological Activities

Gökçe Örüntaş[*1], Neslihan Demir[2], Büşra Dalgıç[3]

[1] Çanakkale Onsekiz Mart University, Faculty of Science and Arts, Department of Molecular Biology and Genetic, Çanakkale, Türkiye

[2] Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye

[3] Çanakkale Onsekiz Mart University, School of Graduate Studies, Department of Biology, Çanakkale, Türkiye

Nanoparticles (NPs) have extremely small size compared to normal sized materials, their high surface area/volume ratios, have added unique physicochemical, magnetic and optical properties to them and have attracted the attention of the scientific world with these properties. Substances with nano size have significant activities compared to their counterparts without this size. The biological synthesis of NPs is environmentally friendly, large-scale production and energy saving, no toxic chemicals are used, and it is biocompatible. Nanoparticles can be synthesized by the green synthesis method using many different organisms; however, they are often preferred because of their high stability when synthesized with plants. Our country has a rich flora in terms of both medicinal and aromatic plants. The use of plants in the synthesis of nanoparticles has gained importance in recent years. A wide variety of parts of plants such as roots, stems, leaves, seeds, fruits, flowers, latex, bark, biomass and essential oil can be used in the synthesis. Senna alexandrina var. alexandrina is a plant belonging to the Fabaceae family. The dried fruit peels of S. alexandrina are used in alternative medicine for the treatment of many diseases. It is known to be used for antipyretic, hepatoprotective, therapeutic purposes in wounds and burns.

In the study, S. alexandrina var. alexandrina pods was extracted and silver nanoparticles were synthesized by green synthesis method. UV-Vis spectrophotometer analyzes were performed for the characterization process. The biological activities of the extract and nanoparticles were examined by antioxidant and DNA cleavage activity analyses. Antioxidant activity was determined with $DPPH^{\bullet}$ and $ABTS^{\bullet+}$ free radical scavenging tests; DNA cleavage activity was investigated by agarose gel electrophoresis method. Results we obtained showed that both samples had good biological activity.

Keyword: *Silver nanoparticles, Senna alexandrina var. alexandrina, Green Synthesis, DNA Cleavage Activity, Antioxidant Activity*

DRAFT

Genotoxicity of Copper Oxide Nanoparticles Synthesized from *Persea americana* L. Leaves by *Allium cepa* L. Test

Ecem Kuru[*1], **Neslihan Demir**[2]

[1] *Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Molecular Biology and Genetics, Çanakkale, Türkiye*

[2] *Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye*

Toxic substances are known to cause DNA damage, resulting in effects such as chromosomal aberrations, micronuclei, somatic mutations, or apoptosis. One of the most commonly used tests to determine genotoxicity is the *Allium cepa* L. test. The A. cepa test enables the determination of chromosomal aberrations in mitotic cells with easy application and low cost. The synthesis of nanoparticles with plant extracts by green synthesis, which has no toxic effect on the environment, is increasing the use of nanotechnology in the medical field. The green synthesis method is also becoming widespread in metal nanoparticles used in many biotechnological applications. Plant extracts used in metal nanoparticle synthesis contain reducing components with antioxidant, antimicrobial or antibacterial properties.

Persea americana L. leaves, are known to have anti-inflammatory properties. In this study, the anomalies of the extract obtained from P. americana leaves synthesized with this extract were investigated by A. cepa test. Root tips were treated in P. americana extracts and P. americana CuO nanoparticles at concentrations of 250, 500 and 1000 mg/mL. Samples were taken from the tips of the roots at 12, 24 and 48 hours. The mitotic stages and chromosome abnormalities of each of the samples were examined under the microscope. Chromosomal anomalies and mitotic index were determined by calculating the percentage of abnormalities in the counts. The results show that the genotoxic effect of nanoparticles higher in A. cepa root tips than the extract. With future studies, the genotoxic activity of plant leaves and copper nanoparticles can be further investigated.

Keyword: *Allium cepa L., Persea americana L., Copper Oxide Nanoparticles, Genotoxicity, Green Synthesis*

DRAFT

The Green Synthesis of Silver Nanoparticles Using Garden Angelica (*Angelica archangelica* L.) Extract, Investigation of Antibacterial Activity and Interactions with DNA

Akın Akyel[*1], Neslihan Demir[2]

[1] *Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Department of Molecular Biology and Genetics, Çanakkale, Türkiye*

[2] *Çanakkale Onsekiz Mart University, Faculty of Science, Department of Biology, Çanakkale, Türkiye*

Nanoparticles attract attention due to their different physical and chemical properties. They are significant because they possess important activities and can be produced through natural formations as well as chemical, physical, and biological methods. The biological synthesis of nanoparticles is preferred due to its lower cost and environmentally friendly nature compared to physical and chemical methods. Among the biological synthesis methods, synthesis using plants appears to be a suitable method as it leads to the formation of stable nanoparticles in a shorter time and facilitates stable synthesis. Angelica archangelica L., commonly known as angelica or garden angelica, is a medicinal plant belonging to the Apiaceae family. A. archangelica is not only used as a medicinal plant but also finds applications in the cosmetic industry. The volatile oils and coumarins are the most active components of A. archangelica. It is known for its antioxidant, anti-inflammatory, antimicrobial, analgesic, and anticancer properties. In this study, silver nanoparticles were synthesized using A. archangelica through a green synthesis method.

The characterization of the nanoparticles obtained in this study was performed using UV-Vis spectrometry, and the visualization was obtained in the range of 200-800 nm. The biological activities of the nanoparticles were investigated by agarose gel electrophoresis method, examining their hydrolytic and oxidative interactions with pBR322 plasmid DNA in the presence of A. archangelica extract and silver nanoparticle. The minimum inhibitory concentration (MIC) values were determined using the broth microdilution method.

In the obtained results, it was observed that both sample had the ability to oxidatively cleave DNA in experiments conducted using pBR322 plasmid DNA. It can also say that both the extract and the silver nanoparticle have antibacterial effect. With future in vitro and in vivo studies, along with broader research, promising products are expected to emerge.

Keyword: *Angelica archangelica L., Green Synthesis, Silver Nanoparticles, DNA Cleavage Activity, Antibacterial Activity*

DRAFT

Investigating The Phonon Spectra of Twisted Bilayer Structures with Computational Methods

Dilara Ickecan[*1], **Yunus Emre Okyayli**[2], **Erdi Ata Bleda**[1], **Dogan Erbahar**[3]
[1] *Marmara University, Dept. of Physics, 34724, Ziverbey, Istanbul, Türkiye*
[2] *Gebze Technical University, Dept. of Physics, 41400, Gebze, Kocaeli Türkiye*
[3] *Dogus University, Faculty of Engineering, Dept. of Mechanical Engineering, Umraniye, 34775, İstanbul, Türkiye*

The discovery of superconductivity in twisted bilayer graphene (TBLG) has been a breakthrough in the field of 2D materials (1,2). TBLG is a two-dimensional material made up of two graphene layers stacked on top of each other and rotated at a certain angle. When this angle is just 1.1º (also known as the "magic angle") TBLG becomes a superconductor. Theoretical explanations compete for this odd behavior. Some studies have suggested that electron-phonon coupling might be important as in the conventional Bardeen-Cooper-Schrieffer (BCS) theory (3). In any case a general understanding of the effect of twisting on the vibrational behavior is lacking and important. In this study, we tackle this issue by a novel computational approach. The local environment of atoms have been used as a generic classification scheme and the properties of phonon spectrum of twisted bilayer graphene have been investigated as a function of rotation angle by molecular dynamics simulations. The relationship between the lattice parameters and the rotation angle is chaotic and the emergent complexity observed in these structures introduces modelling difficulties. In this work, we also show that the classification scheme we propose might be used in machine learning (4) (ML) applications for understanding and predicting the phonon spectra of twisted structures. As an application of this method, we have characterized about one thousand TBLG structures to train a model for predicting the phonon spectra of TBLG and will be presenting our preliminary results.

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Keyword: *Graphene, Twisted bilayer graphene, Moire patterns, Machine learning, Vibrational spectra*

DRAFT

Edge-up Oriented Self Assembly of CdSe/CdZnS Colloidal Quantum Wells for Amplified Spontaneous Emission and Random Lasing

Zeynep Dikmen[*1], Ahmet Tarık Işık[2], İklim Bozkaya[2], Betül Canımkurbey[2], Farzan Shabani[2], Hilmi Volkan Demir[2]

[1] Eskisehir Osmangazi University, Eskişehir, Türkiye

[2] Department of Electrical and Electronics Engineering, Department of Physics, UNAM − Institute of Materials Science and Nanotechnology, Bilkent University, Ankara 06800, Türkiye

Self-assembly of Colloidal Quantum Wells (CQWs) may result in a dramatic change in their collective properties [1-4]. Highly- ordered new artificial solids as promising candidates for optoelectronic applications can be prepared via self-assembly of CQWs requiring critical orientation control. For example, oriented self-assembly of CQWs allows for strongly polarized emission from the stacks of CQWs assembled in solution [5, 6], long-range energy transfer through edge-up-oriented CQW chains [7], and control of the transition dipole moment orientation of laterally-oriented CQWs enhancing their light outcoupling efficiency [5].

In this study, we demonstrate edge-up-oriented self-assembled monolayer (SAM) film formation of CdSe/CdZnS CQWs by adjusting the hydrophilicity/lipophilicity balance of the subphase with binary subphase usage. Moreover, surfactant addition into the substrate is also shown to be highly effective in the orientation control over the self-assembly process of these CQWs. The resulting non-close-packed CdSe/CdZnS CQW stacks with different thicknesses are used to determine their optical gain behavior. The roughness of non-close-packed assembled CQW stack films results in random lasing, while thick samples exhibit ASE despite their larger roughness. The ASE threshold of these non-close-packed stacks produced by sequencing five layers of CdSe/CdZnS CQW SAM is determined as 75 μJ/cm^2 [8].

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Keyword: *colloidal quantum wells, CdSe/CdZnS, self-assembly, amplified spontaneous emission, random lasing*

DRAFT

Electrochemical Determination of Antifibrotic Drug Based on Molecularly Imprinted Polymer and Diamond Nanoparticle Composite

Ozge Selcuk[*1], **Bengi Uslu**[2]
[1] *Department of Analytical Chemistry, Faculty of Pharmacy, Mersin University, 33169, Mersin, Türkiye*
[2] *Department of Analytical Chemistry, Faculty of Pharmacy, Ankara University, 06560, Ankara, Türkiye*

Idiopathic pulmonary fibrosis (IPF), a chronic, progressive disease with no known cause, has an impact on patients' physical and mental health. Fibrosis is what distinguishes the disease, which causes an irreversible loss of lung function, resulting in worsening cough and shortness of breath, as well as reduced quality of life [1]. Patients with idiopathic pulmonary fibrosis who take the antifibrotic and anti-inflammatory drug pirfenidone experience less deterioration in lung function [2]. Thus, in the present work, an electrochemical sensor was developed using a poly(o-phenylenediamine)(o−PD) based molecularly imprinted polymer (MIP) for the detection of pirfenidone, using differential pulse voltammetry (DPV) for the first time. While fabricated the electrochemical sensor, firstly a nanocomposite suspension mixture of chitosan (CIT), ionic liquid (IL) and diamond nanoparticle (Dia) was coated on bare glassy carbon electrode (GCE) by drop-casting method and secondly the surface of modified electrode CIT@IL@DiaNPs/GCE covered with molecularly imprinted polymer film was obtained at the electropolymerization stage with cyclic voltammetry. Two steps were applied to perform the imprinting process: (1) adsorption of PIR to the o−PD surface during polymerization of o−PD monomer onto GCE, and (2) PIR extraction from the designed template. Under optimal conditions, the sensor exhibited good sensitivity for pirfenidone with a linear range of 30.0 pM− 1.0 nM and detection limit of 9.29 nM. In order to demonstrate the applicability of the developed sensors to real samples, the determination was made from Pirfect® tablet and human serum.

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Keyword: *molecular imprinted polymer, nanocomposite, antifibrotic drug, pirfenidone, nanosensor*

DRAFT

ID: 328

Design of a green electrochemical nanosensor platform for the detection of mexiletine

Didem Nur Unal[*1], **Ipek Kucuk**[1], **Cigdem Kanbes-Dindar**[2], **Burcin Bozal-Palabiyik**[2], **Bengi Uslu**[2]

[1] *Ankara University, Faculty of Pharmacy, Department of Analytical Chemistry, 06560, Ankara, Türkiye and Ankara University, The Graduate School of Health Sciences, 06110, Ankara, Türkiye*

[2] *Ankara University, Faculty of Pharmacy, Department of Analytical Chemistry, 06560, Ankara, Türkiye*

The synthesis of nanoparticles via a green technique is acknowledged as a widely utilized, safe, dependable, economical, and efficient technology. In this work, carbon quantum dots (CQDs) and iron nanoparticles (FeNPs) were easily and quickly created from the Citrus reticulata fruit shells. The glassy carbon electrode (GCE) surface was modified with the produced FeNPs and CQDs in a straightforward manner to create the nanosensor platform. The nanomaterials were thoroughly analyzed using scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), and cyclic voltammetry (CV). Using a modified electrode (CQDs/FeNPs/GCE), mexiletine was analyzed using differential pulse voltammetry (DPV). It has been noted that the electron transfer and electrocatalytic performance of mexiletine were greatly enhanced by the use of green nanomaterials in the modification of electrochemical nanosensors. CQDs/FeNPs/GCE showed intense activity for the electro-oxidation of mexiletine, boosting the peak current by almost 18 times above bare GCE. Considering the optimum experimental conditions, mexiletine response is linear in the range from 1.0×10^{-7} M to 1.0×10^{-6} M and from 1.0×10^{-7} M to 8.0×10^{-7} M for standard and serum, respectively. The detection limits were also determined to be 2.45×10^{-8} M and 1.84×10^{-8} M for standard and serum respectively. Finally, with an average of 99% good recoveries, the developed sensor effectively identified mexiletine in human serum samples. Long-term stability and excellent reproducibility are also displayed.

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Keyword: *green synthesis, Citrus reticulata peels, mexiletine, electrochemical nanosensor*

DRAFT

ID: 17

Improvement of dielectric properties of $BaSrTiO_3$-based ceramics by adding Ag

Mahdi Ghasemifard*, Misagh Ghamari
Esfarayen University of Technology, Esfarayen, Iran

In this study, the effects of Ag as a dopant on $BaSrTiO_3$ nanopowders (NPs) were synthesized by an auto-combustion method. Using the optimal ratio of citric acid and nitric acid as the polymerization agent and fuel the structural properties were investigated. The X-ray diffraction (XRD) results revealed that the samples grow in cubic and tetragonal structures. The particle aggregation state and electrical properties were characterized by transmission electron microscopy (TEM) and ultraviolet–visible (UV–VIS) were studied, respectively. Using the X-ray peak broadening and size–strain plot (SSP) method the crystallite sizes and lattice strain of the samples were investigated. The UV–Vis absorption spectra revealed that the band gap of the BSTO-based has a strong absorption peak which lies in the UV region.

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Keyword: *Auto-combustion, Nanopowder, X-ray diffraction, BSTO*

DRAFT

Thermal Synthesis Routes of ZnO Nanofibers Matter for the Photocatalytic Activity and Adsorbent Efficiency

Tuğba Isık[*1], **Mohamed Hilal Elhousseini**[2], **Özlem Kap**[3], **Francis Verpoort**[4], **Nesrin Horzum Polat**[3]
[1] *Department of Mineral Analysis and Technologies General Directorate of Mineral Research and Exploration, Ankara, Türkiye*
[2] *Hong Kong Centre for Cerebro-Cardiovascular Health Engineering (COCHE), Hong Kong, China*
[3] *Engineering Sciences Department, Izmir Katip Çelebi University, Izmir, Türkiye*
[4] *State Key Laboratory of Advanced Technology for Materials Synthesis and Processing, Wuhan University of Technology, Wuhan, PR China*

Water pollution is one of the most significant ecological problems because of the growing industrialization and urbanization. Genotoxic organic and inorganic pollutants such as dyes and heavy metals possess a high risk even at low concentrations, which require efficient purification methods and materials [1]. Chemical oxidation, coagulation, photocatalysis, and adsorption are widely used techniques for wastewater treatment. Metal-Organic Frameworks (MOFs) and porous organic polymers have been used for dye degradation, but they're challenging due to their low stability [2, 3]. Among them, metal oxides are recognized as the most versatile materials, and they show promising results in various applications due to their photocatalytic, antibacterial, electromagnetic, and optical properties. Zinc oxide nanostructures are low-cost, non-toxic, and biocompatible. Moreover, they exhibit photocatalytic properties. In addition to these, ZnO nanofibers offer a high surface-to-volume ratio, improved stability, continuous structure, and a larger contact surface.
In this study, we fabricated polyvinyl alcohol–zinc acetate composite nanofibers via electrospinning. The fibers were calcined at 300, 500, and 700 °C in a muffle furnace for 6 hours to remove the polymer matrix and induce direct calcination resulting in high-yield ZnO synthesis without special equipment or organic solvent. The optimal calcination temperatures were determined through thermogravimetric analysis, considering the stability of the ZnO nanofibers. Following the calcination, two different cooling routes were followed: free cooling in the furnace slowly and rapid cooling by immersion in a cold-water bath right after the 6-hour calcination. The photocatalytic activity of fibers was examined via a model reaction, which employs the treatment of ZnO nanofibers with methylene blue solution under UV irradiation. The rapid cooling process results in higher surface area, enhanced porosity, and conductivity of ZnO nanofibers which improves the photodegradation of the methylene blue and increases the chromium (VI) adsorption in acidic solution. The results reveal that the improved porous structure of ZnO fibers has an impact on the enhanced photocatalytic activity and chromium adsorption capacity. These tailored ZnO nanofibers could be very useful for photocatalysis and heavy metal removal from wastewater.

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Keyword: *zinc oxide, water pollution, chromium, photodegradation*

DRAFT

ID: 66

Surface Texturing of Panel Glasses for Anti-reflective and Anti-soiling Properties

Zeynep Cantürk[*1], Mersiye Karakaş[2], Serena Erkızan[1], Nasim S. Esmaeilzad[3], Deniz Avcı[4], Gizem Aydın[4], Nahide Özben[4], Refika Budakoğlu[4], Talat Özden[3], Alpan Bek[1]

[1] Physics Department, ODTÜ, 06800 Ankara, Türkiye

[2] Micro and Nanotechnology Program, ODTÜ, 06800 Ankara, Türkiye

[3] ODTÜ-GÜNAM, 06800 Ankara, Türkiye

[4] Şişecam Science, Technology and Design Center, 41420 Kocaeli, Türkiye

An alternative approach to anti-reflection coating of solar panel glass for minimizing reflective losses is texturing of the panel glass surface at micro- and nano-scales. Texturing does not only reduce back-reflection but it also redirects the normally incident rays to more oblique inclinations which may be beneficial for extending the optical path length of the rays in the underlying solar cells. In addition to improved light management properties, micro- and nano-texturing of glass surface also has the potential to lend anti-soiling properties by minimizing contact area between dust and glass surface and exhibiting super-hydrophobic property. As the soiling of the solar panels is the major cause behind under-performance of the solar plants in warm climates where water is a scarce resource, forced-cleaning procedures should be avoided as much as possible. We propose micro- and nano-texturing of the panel glass top surface as an agent to facilitate self-cleaning of panel glasses from soiling. In this work we use 2 mm thick flat soda-lime panel glasses fabricated by Şişecam Science, Technology and Design Center. The glass samples are surface textured using 2 methods. The first method is metal assisted chemical etching (MACE) using an aqueous solution of HF as etchant and Ag and Al as catalysts. The second method is reactive ion etching (RIE). In that case, firstly the samples will be masked with ZnO:Al and after etched wetly RIE etched will be done until removing ZnO:Al mask. Also, the second way to etch masked samples is to use initially Cl_2, SF_6, Ar and O_2 gases. The resulting glass surface textures are characterized using dark-field optical and scanning electron microscopies. Optical properties are characterized using spectrally resolved optical transmission and haze measurements and the results are presented and compared. This work is supported by TÜBİTAK under grant nr 20AG002

Keyword: *Glass Texturing, RIE, MACE, Anti-reflective, Anti- soiling*

DRAFT

Compositional Evolution of Raman, XRD Pattern, and Optical Transmission for Thin Film CdS_xSe_{1-x}

Sultan Sefa Sukuti[*1], Mehmet Hikmet Yükselici[1], Birsel Can Ömür[1], Fatma Melda Patan[2]
[1] *Yildiz Technical University, Istanbul, Türkiye*
[2] *Yeditepe University, Istanbul, Türkiye*

Thin film ternary CdS_xSe_{1-x} structures were grown by physical vapor deposition (PVD) on glass slides. The powders of binary group II-VI semiconductors CdSe and CdS were evaporated separately in the same vacuum chamber. We were able to adjust S to Se ratio by controlling the deposition speed depending on the current passing thru two cuvettes in which CdSe and CdS powders are kept respectively. The thin film samples with different thickness increasing linearly with time were characterized by optical transmission measurements, x ray diffraction (XRD) and Raman scattering. The analysis of XRD results indicate that the strain is on the order of 10^{-4} Raman spectra display CdSe like and CdS like vibrational modes at around 200 and 300 cm^{-1} respectively. We report evolution of Raman spectra with composition (x) which varies between 0 (CdSe) and 1 (CdS). We discuss evolution of XRD pattern and long wavelength optical absorption tail by employing Williamson Hall model and Urbach theory.

Keyword: *Raman, Xrd, CdS, CdSe*

DRAFT

Investigation of Effet the Mechanical Parameters of the Glioma and Keratinocyte Cells by using Finite Element Methods

Kübra Kelleci*[1], Burak Aslancan Pak[2], Sevil Özer[2]
[1] *Yildiz Technical University, İstanbul, Türkiye*
[2] *İstanbul Yeni Yuzyil University, İstanbul, Türkiye*

Nowadays, the biomechanics of living cells has been the focus of attention, as high-resolution techniques such as atomic force microscopy (AFM) allow the properties of living cells to be studied with nanoscale and precision. There are a lot of results showing that the mechanical changes in the cell or its extracellular matrix (ECM) are used as a biomarker of pathological changes [1]. Therefore, cell stiffness is an index that evaluates the status of cell cultures.

In this study, 2D axial biomechanical models of keratinocyte and glioma cells were made using the Finite Element Method (FEM modeling), and their mechanical properties were calculated. The keratinocyte cells modeled in the study are epidermal cells that make keratin, and glioma is a group of tumor cells formed in glial cells, the supporting tissue of the brain. The force-indentation curve was calculated using the Hertz model. Young's Modulus (E) values are compared with simulation outputs (Elasticity Value: Glioma, $\approx 10^4$ Pa, Keratinocyte $\approx 10^5$ Pa) at the same indentation depth, as well as cell-indentation studies given in the literature (Elasticity Value: Glioma, 11.4-33.1 kPa [2], Keratinocyte 1.1-210 kPa [3]). The simulation outputs are in good agreement with the Hertz model at low indentation depths, it is seen that the agreement decreases as the depth increases (Figure 1). The reason for this is understood to be caused by the stress (von Misses Stress) in the cell that occurs when the indenter presses on the cell surface in the 2D axial AFM indentation model. As the indentation increases in the model, the created mesh cannot dynamically follow the correctness of the solution.

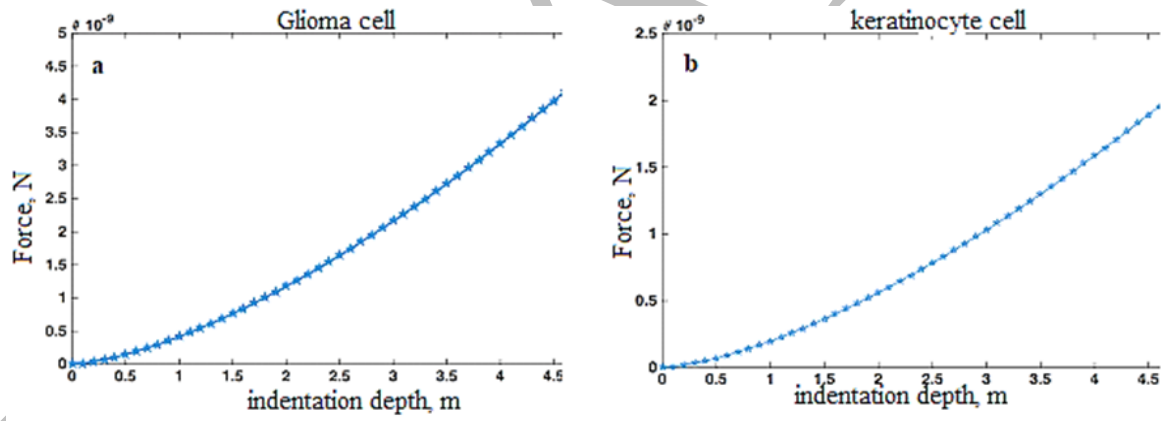

Figure 1. Force-indentation curves for (a) Glioma cell and (b) Keratinocyte cell

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Keyword: *atomic force microscopy, finite element method, biomechanics, Hertz model, cell mechanics*

DRAFT

Harnessing Natural Products for Unlocking the Potential of Nanostructured Carriers for Aging-Related Diseases

Hichem Moulahoum*, **Faezeh Ghorbanizamani, Figen Zihnioglu**
Biochemistry Department, Faculty of Sciences, Ege University, Izmir, Türkiye

Aging-related diseases, including diabetes, Alzheimer's disease, and liver diseases, are characterized by complex pathophysiological mechanisms and pose significant health challenges globally. The process of protein modification, including aggregation, glycation, and oxidation, plays a critical role in the pathogenesis of aging-related diseases. Natural plant extracts have emerged as valuable therapeutic agents for aging-related diseases due to their rich bioactive components and their ability to modulate protein modifications as well as other mechanisms, offering potential therapeutic benefits. However, some of the bioactive compounds found in plant extracts are generally non-soluble in water making them poorly exploited for therapeutic purposes. From this, the concept of drug delivery systems explore the development of nanostructured carriers with a focus on harnessing the therapeutic benefits of natural products to create efficient forms of therapeutic approaches. By combining the advantages of nanostructured carriers and natural plant extracts, personalized and effective treatment strategies for aging-related diseases can be developed. Nanostructured carriers, such as liposomes, niosomes, and polymersomes, offer numerous advantages in targeted therapy. These carriers can be tailored to encapsulate natural plant extracts and other therapeutics that are usually insoluble, thereby protecting them from degradation, improving their stability, and facilitating transport and controlled release at the desired site of action. Furthermore, the surface modifications of nanocarriers with targeting ligands, such as peptides, enable specific delivery to diseased tissues or cells resulting in improved treatment efficacy. The utilization of nanostructured carriers, in conjunction with natural plant extracts, holds significant promise for therapy in aging-related diseases. The encapsulation of bioactive compounds within nanocarriers enhances the stability and bioavailability of natural plant extracts, leading to improved treatment outcomes. Moreover, the specific targeting of disease-related mechanisms, such as protein modification, provides additional opportunities for managing aging-related diseases effectively. The integration of nanostructured carriers and natural plant extracts represents a scientific approach to develop personalized treatment strategies, ultimately contributing to improved patient outcomes and lowering the economic burden seen for specific agents.

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Keyword: *nanostructured carriers, aging-related diseases, natural plant extracts, protein modification, drug delivery*

DRAFT

ID: 306

Medical uses of montmorillonite nanoclay

Shahriyar Karimdoust
Atatürk University, Erzurum, Türkiye

Medical uses of montmorillonite nanoclay Bentonite clay mineral is a natural phyllosilicate with a layered crystal structure. Montmorillonite is the main mineral forming bentonite [1,2] and is a mineral with unique properties, such as swelling and absorption. These properties have made montmorillonite widely used in medical and industrial applications [3]. Montmorillonite nanoclay is an abundant and valuable material that is in at least one dimension of nanometers. This unique clay mineral with a specific surface area of about 750 square meters per gram has taken a very valuable position in nanotechnology. The placement of drug molecules in the nanoscale interlayer spaces of clay minerals can change their properties for biological applications. Good suspension, diffusion and dispersion properties, drug protection from degradation, increasing drug distribution from the intestinal membrane are among the positive features of montmorillonite nanoclays, which have distinguished them in the use of nanomedicine drug [4]. One of the most important uses of montmorillonite is its use in the production of nanoclays, so that it is the most widely used clay mineral in the nanotechnology and pharmaceutical industries [5] Montmorillonite has adsorbent properties to remove toxic heavy metals and can be used as a therapeutic agent. Natural clays, such as montmorillonite, can absorb metals, and this nanoclay has the ability to detoxify and be anti-viral. Clay materials, including sodium montmorillonite, have the ability to adsorb rotaviruses and bovine coronaviruses [6]. Another important medical application of montmorillonite is its use in the drug delivery system inside the body. The high absorption capacity of montmorillonite helps to increase drug entrapment and continuous drug release. Montmorillonite generally causes the release of the drug in many formulations by being highly absorbed into the drug. In addition, montmorillonite increases the dissolution rate and bioavailability of hydrophobic drugs.

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Keyword: *Nanoclay, Montmorillonite, Nanomedicine, Mineral Drugs*

DRAFT

Integral Imaging and Acoustic Trapping

Kooshan Mohsenvand[*1], Artur Carnicer[2], Benedetta Marmiroli[3], Ali-Reza Moradi[1]
[1] Department of Physics, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan 45137-66731, Iran
[2] Departament de F´ısica Aplicada, Universitat de Barcelona (UB), 08028 Barcelona, Spain
[3] Institute of Inorganic Chemistry, Graz University of Technology, 8010 Graz, Austria

3D imaging provides crucial details about the objects and scenes that may not be obtained via 2D imaging methods. For several 3D imaging applications, the object requires immobilization. For nanometer to millimeter scale size, we introduce integral imaging and acoustic trapping integrated systems for mesoscopic and beyond objects. Acoustic trapping is suitable for micron to millimeter samples, and Integral imaging is suitable for nano to millimeter samples so with the combination of these two methods we can report detail in the nanoscale of the surface of the sample in the acoustic trap. This method can be compared with digital holography and optical trapping.

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Keyword: *Acoustic Trapping*

DRAFT

ID: 217

Elaboration and characterization of iron oxide nanoparticles by green chemistry

Souad Brick Chaouche
1. University of Science and Technology Houari Boumediene, BP 32 El Alia 16111 Bab Ezzouar, Algiers, Algeria

In this work, magnetic iron oxide nanoparticles Fe_3O_4 were developed greenly using extract of Artemisia herba-alba. The characterized by techniques, XRD, EDX, and SEM have shown that these iron nanoparticles made by green synthesis are crystalline and porous magnetite-type, whose size is between 29 and 55 nm. The analysis of the essential oil of Artemisia herba-alba was carried out by the FTIR AND (GC/MS) techniques, and showed the presence of phenolic compounds necessary in the nanoparticle manufacturing protocol. The application of magnetic iron oxide nanoparticles to dye adsorption (Methylene Blue) using two different protocols (with and without ultrasonic irradiation) showed that the adsorbent power of Fe_3O_4 nanoparticles due to their porosity visualized by SEM and ultrasonic irradiations give a better removal efficiency of methylene blue.

Keyword: *nanoparticule, iron oxyd, green chemistry*

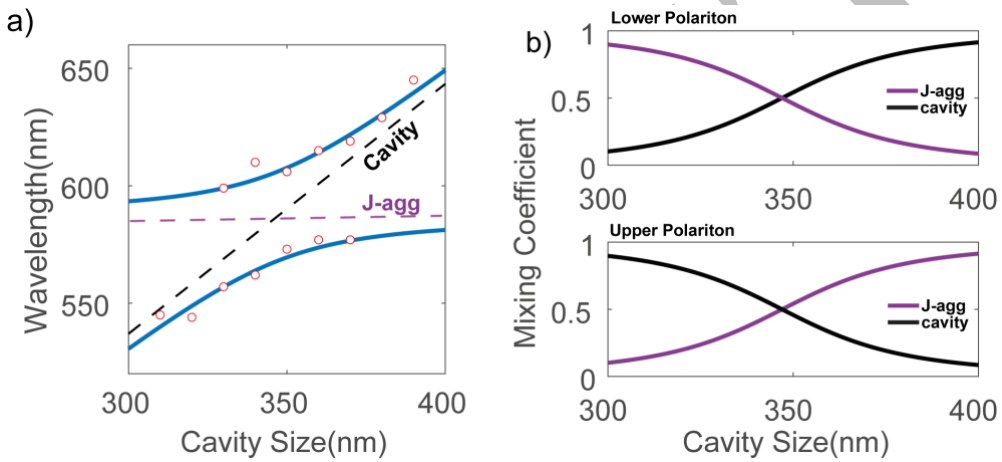
DRAFT

ID: 264

Exciton Polaritons in an Optical Microcavity

Nahit Polat*, **Sinan Balcı**
Department of Photonics, Izmir Institute of Technology, Izmir 35430, Türkiye

In this study, an optical microcavity has been used to generate exciton polaritons at room temperature. The microcavity consists of two thin silver mirrors separated by a thin polymer film containing TDBC dye molecules as the exciton source. The separation between the silver mirrors allows us to control the optical resonance state of the microcavity. The two silver mirrors are perpendicular to the longitudinal axis and have partially reflecting surfaces. J-aggregate molecules embedded in a thin layer of polymer are carefully placed between the silver mirrors. By controlling the distance between the two mirrors with different polymer layer thicknesses, the detuning coupling has been varied and the relationship with cavity size has been investigated (Fig.a). We have extensivelly studied the energy transfer between the upper and lower polaritons due to the strong coupling by using the Tavis-Cummings Hamiltonian (Fig.b).



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Keyword: *Exciton, Polariton, cavity*

DRAFT

Optimization of Electron Beam Lithography and Lift-off Process for Nanofabrication of Sub-50 nm Gold Nanostructures

Osman Şahin[*1], Oğuz Mustafa Albayrak[1], Murat Kaya Yapıcı[2,3,4]
[1] *Faculty of Engineering and Natural Sciences, Sabanci University, 34956 Istanbul, Türkiye*
[2] *Sabancı University, İstanbul, Türkiye*
[3] *Sabanci University SUNUM Nanotechnology Research Center, İstanbul, Türkiye*
[4] *Department of Electrical Engineering, University of Washington, 98195 Seattle, USA*

Since the demonstration of the first integrated circuit in the late 1950s, the microelectronics industry has witnessed a vast transformation with transistor densities doubling roughly every two years as a result of continuous scaling down of device dimensions, referred to as miniaturization. The fundamental concept of miniaturization has not only been employed for the realization of ultra large scale integrated (ULSI) circuits with reduced manufacturing costs, lower power consumption, higher speed and computational power; but also, for developing novel transducer elements and energy storage devices by harnessing the unique physical effects that arise at micro/nanoscales such as higher surface-to-volume ratios. One of the most important technologies in micro/nano device fabrication, if not the single most important, is lithography. The broad range of lithographic techniques ranging from conventional optical lithography methods (e.g. ultraviolet-UV, deep ultraviolet-DUV, extreme ultraviolet-EUV) to unconventional ones (e.g. electron beam lithography, x-ray lithography, ion-beam lithography, stereolithography, scanning probe lithography, nanoimprint lithography, directed selfassembly) can be used to create features with microns to tens of nanometer resolution and below. Among these, electron beam lithography (EBL) stands out as a powerful direct-write tool offering nanometer scale patterning capability and is especially useful in low-volume R&D prototyping. However, patterning with EBL requires a careful balance of process parameters, which must be considered in conjunction with the pattern transfer technology that can be either etching or lift-off specifically for the case of metallic layers. Accordingly, this study provides a systematic study to address the gap in process optimization of the lift-off process based on EBL patterning of sub-50 nm metallic nanostructures using a lower-cost PMMA/PMMA positive tone bilayer resist spin approach. The governing parameters in EBL including exposure dose, bake temperature, develop time, developer solution, substrate effect, and proximity effect (PE) are experimentally studied and their effects on nanopatterning are characterized by field emission scanning electron microscopy (FE-SEM) of fabricated nanostructures.

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Keyword: *E-beam lithography, gold nanowire, nanogap, lift-off, proximity effect*

Ultrasensitive Electrochemical Magnetoimmunosensing of Cardiac Troponin-T Biomarker Based on Gold Nanoparticles Coated Nanoscale Zero-valent Irons

Mohamed Amine Djebbi[*1], Saber Boubakri[1], Mohamed Braiek[2], Nicole Jaffrezic Renault[2], Philippe Namour[3], Abdesslem Ben Haj Amara[1]

[1] Laboratory of Resources, Materials & Ecosystem (RME),University of Carthage, Faculty of Sciences of Bizerte Bizerte, Tunisia

[2] Institute of Analytical Sciences, University of Lyon Villeurbanne, France

[3] INRAE, UR RiverLy, Centre de Lyon-Villeurbanne Villeurbanne, France

Early, inexpensive, reliable, and accurate diagnosis of cardiovascular abnormalities has become of crucial importance to prevent and halt their progression. Herein, we report a label-free electrochemical magnetoimmunosensing for monitoring cardiac diseases through qualitative and quantitative detection of cardiac troponin-T (Tpn-T) in an aqueous solution. A nanocomposite of gold nanoparticles coated with a magnetic nanoscale zero-valent iron core (NZVI©Au) is employed as a substrate to facilitate electron transfer and to bind more primary Tpn-T antibodies. The immunosensing platform consists of an anti-cardiac troponin-T antibody (Tpn-T-ab) modified NZVI©Au magnetic membrane attached to a boron-doped diamond (BDD) electrode. Sensing experiments were performed while imposing an external magnetic field at the backside of the electrode. The sensor response was performed using impedimetric assays, wherein the increase in the electron transfer resistance (Rct) correlated with an increase in the concentration of Tpn-T. Linearity was obtained in the range from 1 fg/mL to 109 fg/mL with a detection limit of 0.354 fg/mL. The proposed platform exhibited high selectivity, high reproducibility, and good stability, whilst retaining more than 90 % of the sensitivity after two weeks of storage at 4° C. The current method is far superior when compared with previously reported methods and has been successfully tested in human serum samples. This encouraging result suggests that the developed sensing strategy provides a high potential for the early assessment of Tpn-T in point-of-care testing applications.

Keyword: *Cardiac disease, Troponin-T (Tpn-T) biomarker, Nanoscale zero-valent iron (NZVI), Gold nanoparticles (AuNPs), Impedimetric assays*

DRAFT

Amine Functionalized Graphene Oxide Decorated Rh (0) Nanoparticles: As an Effective and Stable Catalyst for the Reduction of Nitroarenes

Mehmet Gülcan[*1], **Bagher Eftekhari-Sis**[2]

[1] *Department of Chemistry Faculty of Science, Van Yüzüncü Yıl University, Van 65080, Türkiye*

[2] *Department of Chemistry, University of Maragheh, Maragheh 55181-83111, Iran*

Nitroaromatics are toxic and generally delivered into the environment by the agrochemical and dye industries, so their removal through the reduction to corresponding amines is of particular importance from an environmental point of view. In the present work, amine-functionalized graphene oxide supported Rh (0) nanoparticles (Rh/GO-NH_2) were prepared by the deposition-reduction method, and advanced techniques such as ICP-OES, P-XRD, XPS, TEM, HR-TEM and EDX have been applied to explain the structure and morphology of the catalyst. The results show that the Rh (0) nanoparticles are perfectly dispersed on the surface of the amine-functionalized graphene oxide. Then, the catalytic efficiency of Rh/GO-NH_2 for the reduction of various substituted nitroaromatic compounds (Fig. 1) in aqueous solution at moderate conditions was investigated.

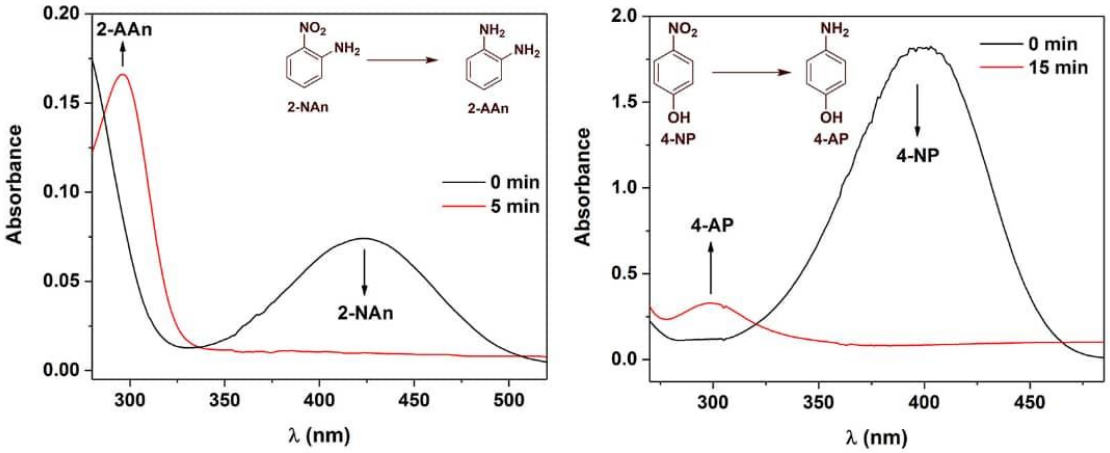

Fig. 1 Rh/GO-NH_2 catalyzed the reduction of 2-nitroaniline and 4-nitrophenol, investigated by the UV-Vis spectrophotometer at the beginning (0 min) and end of the reduction.

Keyword: *Catalyst, Graphene oxide, Nanoparticle, Nitroaromatics, Reduction*

DRAFT

Unleashing the Photovoltaic Potential: Optimizing Zn-Doped Co3O4 Films via Ultrasonic Spray Pyrolysis

Ibrahim Gunes[1], Emrah Sarica[2], Hakan Bilal Ozcan[3], Idris Akyuz[4], Ayse Kucukarslan[5], Vildan Bilgin[*5]

[1] Department of Electricity and Energy, Canakkale Onsekiz Mart University, Biga, Canakkale, Türkiye
[2] Department of Electrical and Electronics Engineering, Baskent University, 06790 Ankara, Türkiye
[3] Department Of Physics, Bursa Technical University, 16310, Bursa, Türkiye
[4] Eskisehir Osmangazi University, Department of Physics, 26480, Eskisehir, Türkiye
[5] Department of Physics, Canakkale Onsekiz Mart University, 17020 Canakkale, Türkiye

In this study, undoped and zinc-doped cobalt oxide (Co_3O_4) films were deposited on microscope glass substrates using the ultrasonic spray pyrolysis technique at a substrate temperature of 375 °C. The effect of different Zn doping concentrations (3%, 6%, and 9%) within the film structure on the morphological, structural, and optical properties of Co_3O_4 films was investigated to optimize their optoelectronic and photovoltaic applications. Morphological, structural, and optical analyses of all films were carried out using atomic force microscopy (AFM), scanning electron microscopy (SEM), X-ray diffraction (XRD), and UV-visible spectroscopy, respectively. The morphological and structural analyses revealed noticeable changes on the surfaces with increasing doping concentration, while no significant change in the crystallite size was observed. For optical analyses, the optical transmittance and absorption spectra of the films were obtained in the wavelength range of 300-1200 nm, and some optical parameters such as optical band gaps and Urbach parameters were determined using these spectra. As a result, it was observed that the deposited films could be successfully obtained for photovoltaic applications using the ultrasonic spray pyrolysis method.

Acknowledgments:
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Keyword: *Zn-doped Co3O4 thin films, Ultrasonic spray pyrolysis, Morphological, XRD, Optical properties*

DRAFT

The Effect of Sulfurization Temperature on As-prepared SnS Films Deposited by Ultrasonic Spray Pyrolysis

Ibrahim Gunes[*1], Barbaros Demirselcuk[2], Emrah Sarica[3], Hakan Bilal Ozcan[4], Idris Akyuz[5], Ayse Kucukarslan[6], Vildan Bilgin[6]

[1] Department of Electricity and Energy, Canakkale Onsekiz Mart University, Biga, Canakkale, Türkiye
[2] Department of Electricity and Energy, Canakkale Onsekiz Mart University, 17020 Canakkale, Türkiye
[3] Department of Electrical and Electronics Engineering, Baskent University, 06790 Ankara, Türkiye
[4] Department Of Physics, Bursa Technical University, 16310, Bursa, Türkiye
[5] Eskisehir Osmangazi University, Department of Physics, 26480, Eskisehir, Türkiye
[6] Department of Physics, Canakkale Onsekiz Mart University, 17020 Canakkale, Türkiye

In this study, SnS films were deposited onto glass substrates using the ultrasonic spray pyrolysis technique at a substrate temperature of 350°C. Subsequently, these films underwent secondary processing in a tube furnace with 50 mg of sulfur powder at three different temperatures (300°C, 350°C, and 400°C). The effect of secondary processing on the structural, morphological, and optical properties of the SnS films obtained at different ambient temperatures was investigated. The structural, morphological, and optical properties of all films were analyzed using X-ray diffraction (XRD), scanning electron microscopy (SEM), atomic force microscopy (AFM), and UV-vis spectrophotometry. Structural analysis revealed that all films were formed in an orthorhombic structure, and the crystallization levels of the films were significantly affected by the sulfurization process. Morphological analysis showed that the particles had a longitudinally elongated, rice-shaped surface structure. The optical band gaps were calculated to range from 1.60 eV to 1.86 eV.

Acknowledgments:
This work was supported by the Canakkale Onsekiz Mart University Scientific Research Projects Committee under Project Number FBA-2022-3992.

Keyword: *SnS thin films, Sulfurization temperature, Ultrasonic spray pyrolysis*

DRAFT

Size effect in ZnO nanoparticles for the enhancement of supercapacitor electrode performance

Eminenur Sarıtaş*, Emre Erdem, Mohamad Aleinawi
Department of Material Science and Nanoengineering, Sabancı University, İstanbul, Türkiye

ZnO, an immensely defective semiconductor material with a wide bandgap (3.2 - 3.4 eV) energy at room temperature, holds great potential to be used as electrode material in energy storage systems such as supercapacitors. In this study, the performances of four ZnO nanoparticle electrodes with 30, 40, 85, and 110 nm average crystallite sizes were investigated in supercapacitors to explore the impact of the crystallite size of the electrode material on the performance, which is referred to as size effect. A symmetric and an asymmetric supercapacitor with carbon black as the second electrode and 6 M KOH as the electrolyte were designed. Electrochemical measurements were performed using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) techniques. Furthermore, photoluminescence (PL) and electron paramagnetic resonance (EPR) techniques were utilized to gain insight into the defect structures of the ZnO. In addition, the crystal structure and average crystallite sizes of the samples were determined using X-ray diffraction (XRD). Finally, specific capacitance values were calculated using the data obtained from CV. It was observed that the supercapacitors prepared with the electrode which has an average crystalline size of 30 nm, gave the highest specific capacitance value among both symmetric and asymmetric supercapacitors, yielding 55 $F.g^{-1}$ and 417 $F. g^{-1}$ at the scan rate of 10 $mV.s^{-1}$, respectively.

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Keyword: *ZnO, Supercapacitor, Spectroscopy, Electrochemical performance, Nanomaterials*

DRAFT

Efficient Optical Thin Film Filters for Far-UVC 222 nm Excimer Lamps

Nurcin Karadeniz[*1], Serap Yigen[1], Polatkan Ozcan[1], Merve Ekmekcioglu[2], Hatice Eker[3], Metin Kaya[4], Mehtap Ozdemir[2], Lutfi Ozyuzer[1]

[1] Department of Physics, Izmir Institute of Technology, Urla, 35430, Izmir, Türkiye
[2] Teknoma Technological Materials Inc., IYTE Campus, Urla, 35430, Izmir, Türkiye
[3] Arcelik A.S. Research and Development Center, Tuzla, 34950 Istanbul, Türkiye
[4] Arcelik A.S. Refrigerator Plant Research and Development Center, 26110, Eskisehir, Türkiye

Ultraviolet (UV) light exposure is a direct antimicrobial approach and its effectiveness against different strains of airborne viruses has long been established [1]. Conventional UVC devices, like low pressure mercury vapor lamps emitting at 254 nm, have been shown to pose risks to human skin and eyes, causing skin reddening (erythema) and inflammation of the cornea (photokeratitis) [2]. Far UVC light (222 nm) is as effective as conventional germicidal UV light in killing microorganisms, without the same health risks associated with direct exposure [1]. Thus, the growing interest in 222 nm Far UVC light is due to its fewer harmful effects on mammalian cells [3]. Emerging devices like krypton chloride (KrCl*) excimer lamps offer safer and more effective surface disinfection in occupied spaces compared to conventional UVC devices [2]. Our group showed successful high efficiency thin film filters, paving the way for advancements in UV technology [4]. Leveraging our experience with thin film filters, we focused on designing optical filters for dielectric barrier discharge (DBD) excimer lamps, specifically targeting a 222 nm band pass filter. These filters were deposited onto quartz substrates using a 2-inch magnetron sputtering system under high vacuum conditions, consisting of multilayer thin film layers. The optical properties of the filters were obtained using a spectrophotometer in the wavelength range of 200 to 2600 nm, and commercial excimer lamp were utilized for further analysis with spectrometers. The results confirmed the successful design of the 222 nm band pass filter, essential for enhancing the efficiency of DBD excimer lamps. Moreover, microbiological tests showed a remarkable bacteria reduction rate of over 90 percent. Overall, the promising results from the microbiological tests contribute to the advancement of optical filter technology, opening up potential applications in fields like ultraviolet sterilization, surface treatments, and other optical applications. This study provides valuable insights into the design and implementation of efficient optical filters for practical applications.

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Keyword: *Far UVC excimer lamps, optical thin film filters, UV sterilization*

DRAFT

Preparation of nitrogen and boron doped graphene oxide and metal oxide composite materials for high-performance lithium-ion battery anodes

Recep Sıvacı*, Zekerya Dursun
Ege University, Faculty of Science, Department of Chemistry, Department of Analytical Chemistry, İzmir, Türkiye

Rechargeable energy systems based on lithium chemistry are promising for future generation energy storage due to their owing to high-reversible capacity, high- power capability, good safety, long life and zero-memory effects. Regardless, longer-battery-life, higher-current and power density, beter safety, and flexibility, crucial for portables and hybrid electric vehicles further fuel the research to beter their electrochemistry. Developing powerful lithium anodes is improved battery safety as well as reduce battery production costs. Electrode materials are vital for performance of batteries. New developments in nano science and nanotechnology present potential expectations to devise novel electrode materials fornext generation superior performans of LIBs.

Due to the high conductivity, large surface area, high flexibility and chemical stability of graphene, significant advances have been made with graphene/graphene oxide-based composite materials to solve the problems of volume expansion and low conductivity, especially in batteries containing metal oxide and metal phosphate.

In the present study, graphene oxide (GO) synthesized by Hummers method and then nitrogen and boron were doped to GO. To prepare metal oxide containing composite anode electrode, cobalt and molybdenum oxide compounds were synthesized and a new type composite anode material was obtained by combining them with boron and nitrogen doped GO using solid state and sol-gel methods. The prepared composite anode electrode material was characterzied by SEM, XPS, FTIR and TEM techniques.

Electrochemical performances of prototype lithium-ion batteries in Cr2032 cell size made of the developed composite material were obtained by using cyclic voltammetry, charge/discharge measurements and Electrochemical Impedance Spectroscopy (EIS) for each material and each half-cell battery.

As a result of the electrochemical tests: It has been revealed that the lithium-ion battery formed from Nitrogen and Boron doped Co/GO (N-B@Co_3O_4/GO) nanocomposite has a current density of 395 mAh/cm^2 at the beginning and a current density of 340 mAh/cm^2 after 50 cycles and largely maintains the reversible capacity.

Keyword: *Lithium Ion Battery, Graphene, Graphene Oxide, Metal Oxide, Anode Material*

DRAFT

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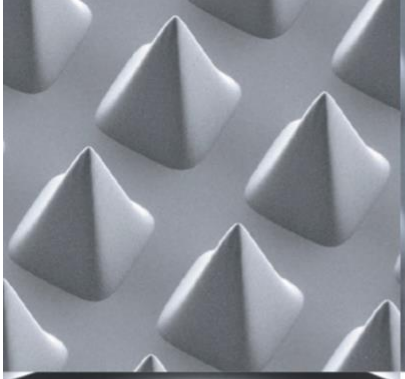
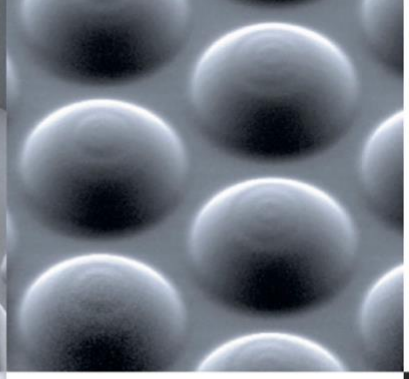

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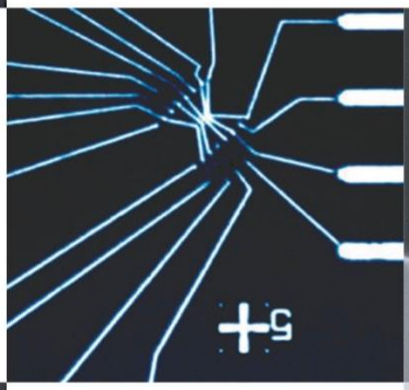
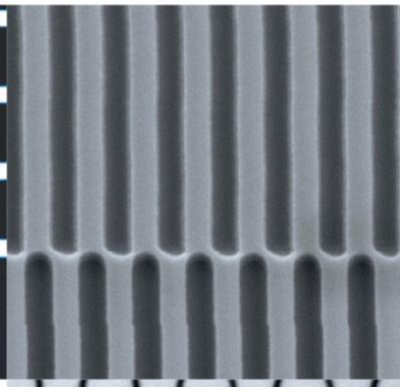
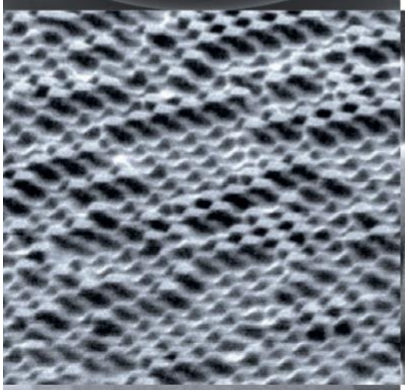
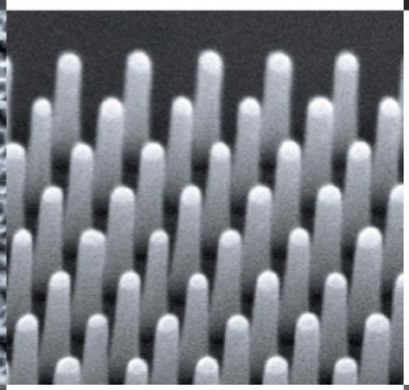

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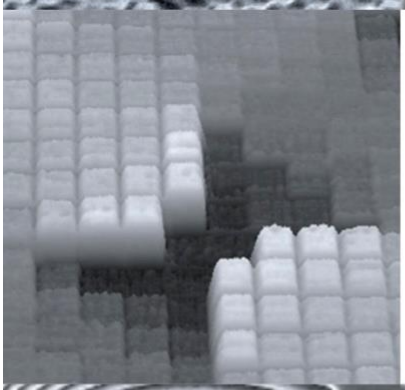

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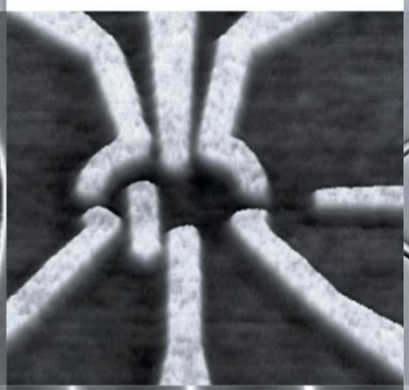
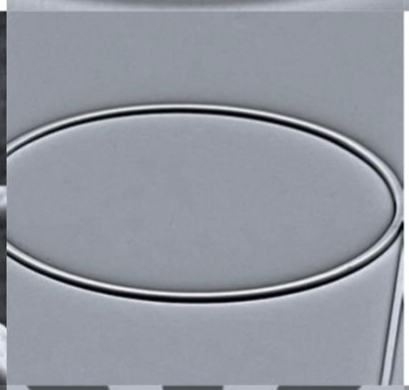

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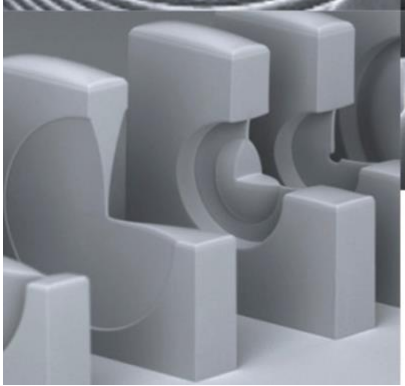
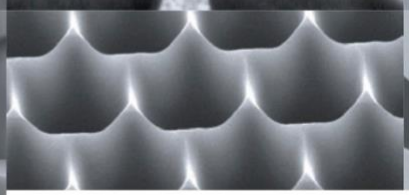

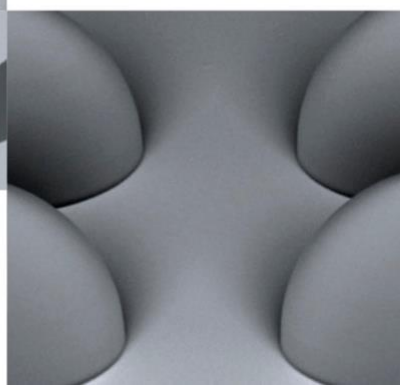

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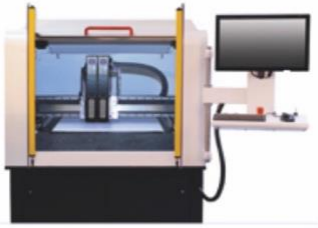



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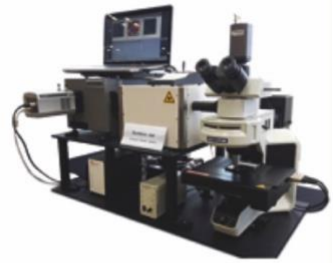





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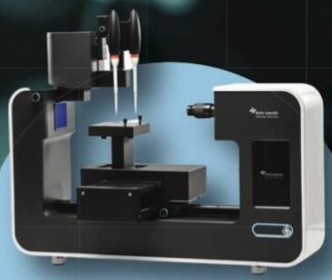

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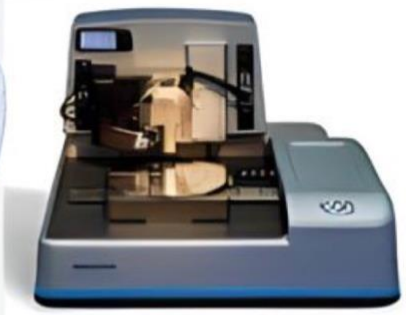





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