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ABSTRACT BOOK

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EPHRAIM SUHIR, Ph.D
Bell Labs, Physical Sciences and Engineering Research Div., Murray Hill, NJ, USA

Analytical Thermal Stress Modeling in Electronics and Photonics Engineering: Application of the Concept of Interfacial Compliance

Abstract

RESEARH GATE (RG) INFORMATION (as of March.20, 2026): Profile strength: all-star; RG score: 42.41 (higher than 97.5% of RG members); Research Interest score: 2,403 (higher than 97% of RG members and higher than 83% of RG members who first published in 1982). Downloads ("Reads"): 50,056; Citations: 7,346; Citations since 2017: 2,318; Highly Influential Citations (according to Semantic Scholar): 108; Citations value: 84.5%; World ranking 2,018; National ranking 720; H-index (metric of the productivity and citation impact of the publications) H-38; Followers: 4,672; Ranked 720 in United States and 2014 in the world as leading scientist in the area of Mechanical and Aerospace Engineering and 2163 in United States and 7219 in the world as leading scientist in the area of Engineering and Technology (based on D-index (Discipline H-index) metric, which only includes papers and citation values for an examined discipline, and includes only leading scientists with D-index of at least 30 for academic publications made). Research.com, a leading academic platform for researchers, has just released the 2026 Edition of our Ranking of Best Scientists in the field of Mechanical and Aerospace Engineering. You have ranked 850 in United States and 2602 in the world.

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- Mathematical Analogies, and Their Role in Applied Science and Engineering
- Reliability of Artificial Intelligent (AI) and Robotics Systems
- Probabilistic Predictive Modeling in Engineering, Ergonomics, Astrophysics, Biology and Medicine.

Biography

Dr. Suhir is IEEE, ASME, SPIE and IMAPS Life Fellow, APS, IoP(UK) and SPE Fellow, and AIAA Associate Fellow. He received numerous professional awards. Particularly, he is the third Russian American Scientist, after S. Timoshenko and I. Sikorsky, who received the prestigious ASME Worcester Reed Warner Medal for outstanding contribution to the permanent literature of engineering (and establishing a new discipline – structural analysis of electronic and photonic systems). Ephraim authored and co-authored 500+ publications and enjoys numerous references to his published work

Dr. Habil. Bernd Blobel

University of Regensburg, Medical Faculty, Regensburg, Germany

Designing and Managing Integration and Interoperability of Intelligent and Ethical Ecosystems

Abstract

For meeting the financial, quality and safety challenges as well as expectations of the patients, health and social care systems around the globe currently undergo a transformation towards personalized, preventive, predictive, participative precision medicine (5PM), supported by technology. It considers individual health status, conditions, genetic and genomic dispositions in personal social, occupational, environmental and behavioral context, understanding the pathology of diseases and turning health and social care from reactive to proactive. The aforementioned transformation is strongly supported by technologies such as micro- and nanotechnologies, advanced computing, artificial intelligence, autonomous systems and robotics, knowledge representation and management, etc. Beside their opportunities, those advanced technologies also bear risks to be managed, requiring the detailed consideration from a humanistic, moral and ethical perspective. For enabling communication and cooperation between all actors from different disciplines involved, using different methodologies, perspectives, intentions, languages, we shall understand and formally and consistently represent the multidisciplinary, highly complex and dynamic 5PM ecosystem. The outcome is a system-theoretical, architecture-centric, ontology-based, policy-driven approach for designing and managing intelligent and ethical 5PM ecosystems. The necessary model and framework has been developed by the author and meanwhile standardized as ISO 23903 Interoperability and Integration Reference Architecture. The formal representation of any ecosystem and its development process including examples of practical deployment of the approach are presented in detail. This includes correct systems and standards integration and interoperability solutions.

Biography

Dr. Bernd Blobel received a multi-disciplinary education, covering mathematics, physics, systems engineering, electronics, medicine, informatics and medical informatics, including habilitations in medicine and informatics. He was Head of the Institute for Biometrics and Medical Informatics at the University of Magdeburg, and thereafter Head of the Health Telematics Project Group at the Fraunhofer IIS in Erlangen. Thereafter, he acted until his retirement as Head of the German National eHealth Competence Center at the University of Regensburg. He was leadingly involved in many countries health digitalization as well as electronic health record strategy. He was and is still engaged in international standardization at ISO, CEN, HL7, OMG, IEEE etc. Furthermore, he still engaged in international higher education. He is Fellow of several international academies. References to his publications can be found at https://epub.uni-regensburg.de/view/people/Blobel=3ABernd=3A=3A.html.

Zhiqiang Mao
Department of Physics, Pennsylvania State University, University Park, PA, USA

Colossal Room Temperature Nonreciprocal Hall Effect due to geometric asymmetric scattering by textured nanoparticles

Abstract

Nonreciprocal charge transport in quantum materials has attracted enormous interest since it offers an avenue to investigate quantum symmetry related physics and holds many prospective applications such as rectification and photodetection over a wide range of frequencies. The nonreciprocal transport reported to date occurs along the longitudinal direction with the nonreciprocal resistance limited to a few percent of the ohmic resistance. In this talk. I will show a transverse nonreciprocal transport phenomenon with divergent nonreciprocity – colossal nonreciprocal Hall effect (NRHE) [1]. This is revealed in direct current (DC) transport measurements on the microscale Hall devices made of Pt deposited by focused ion beam (FIB) on the Si substrates. When a DC is applied along the x-axis of the devices (Ix), it generates a Hall voltage response along the y-axis (Vy) near room temperature, with Vy quadratically scaling with Ix. Such a transverse NRHE emerges from the geometrically asymmetric scattering of textured Pt nanoparticles within FIB-deposited Pt (FIBD-Pt) structures. Furthermore, the NRHE generated within the FIBD-Pt electrodes can propagate to adjacent conductors like Au and NbP through Hall current injection. Despite Au and NbP being nonmagnetic materials, they display remarkably pronounced nonlinear anomalous Hall effects attributable to the transmitted NRHE. Additionally, we find such a strong NRHE can lead to broadband frequency mixing, with the frequency spectrum of the Hall voltage including second-harmonic generation, sum & difference frequency generations, and other multiple (3-11) wave mixing components. These results not only demonstrate the concept of the nonreciprocal Hall effect but also pave the way for exploring NRHE's applications interahertz communication, imaging, and energy harvesting.

Biography

Zhiqiang Mao is a Professor of Physics at Penn State University specializing in quantum materials, nonlinear transport, and advanced single-crystal growth. Mao has authored more than 450 peerreviewed publications with over 23,000 citations (h-index ~73), contributing major advances in topological materials, high-entropy materials, unconventional superconductors and strongly correlated oxides. His work integrates synthesis, transport measurements, and spectroscopic probe to reveal emergent electronic phenomena relevant to next-generation quantum and electronic technologies

Rabia Asghar

Beijing Key Laboratory for Separation and Analysis in Biomedicine and Pharmaceuticals, School of Medical Technology, Beijing Institute of Technology, Beijing 100081, China

Visual detection of a thrombin microsample on a PDMS-chip

Abstract

To evaluate the comparative fluorescence signal response and analytical performance of the same assay conducted on a PDMS chip (fluorescent microscopy) and on polystyrene plates (spectrophotometric reading), determining the sample volume and detection mode on assay sensitivity and precision. Applying fluorescent bioassays for microvolume testing poses significant challenges, particularly for biomarkers where sample size is limited and fluorescence visualization must be achieved from minimal volumes. While aptamer-based bioassays, ELISAs, and other detection techniques have addressed issues such as sensitivity and reliability, this study developed an "all-in-one" solution that combines reliability, sensitivity, and ease of use for sample size–sensitive disease biomarkers. Here, a fluorescent aptamer-based assay capable of detecting thrombin using sample volumes of less than 5 μL is presented. A PDMS chip serves as the detection platform, enabling fluorescence signal readout for thrombin target. The assay follows a standard protocol with optimized components for enhanced performance. Fluorescence visualization on the chip by using FRET principle was achieved with a lowest detection limit of 0.01 nM and a dynamic range of (0.01 nM to 100 nM) under a confocal fluorescence microscope. The assay repeatedly conducted on the polystyrene microwells of samle volume (200 μL), signal validation was performed through spectrophotometric measurements, confirming the assay's reliability. This approach provides a foundation for microvolume biomarker detection and cell-or tissue-based studies to overcome the challenges of real time anlaysis of confocal microscope. Furthermore, integrating python intraassay specifcity is determined and python libraries for the image analysis to extend its application to innovative diagnostic and analytical platforms.This kind of study will assist to overcome tha challenges involved in case of

confocal microscopy; limited excitation wavelength options, potential cellular damage from high-intensity laser exposure, and long acquisition times required for high-quality imaging restrict the efficiency.

Biography

I completed my Ph.D. at the Beijing Institute of Technology, Beijing, China, where my research focused on FRET-based fluorescent assays and the underlying principles of aptasensor transduction. My work explored the conceptual framework and practical challenges in translating laboratory-based biosensor research into commercially viable technologies. I am engaged in the development of aptasensors for clinical diagnostic applications, including the design and fabrication of PDMS-based microfluidic chips aimed at creating clinically reliable sensors for the detection of protein-based disease biomarkers by integrating nanotechnology and AI-driven analytical systems to enable ultra-sensitive, automated, and intelligent disease diagnostics.

Nusret Kaya

İzmir Katip Çelebi University, Faculty of Naval Architecture and Maritime, Naval Architecture and Marine Engineering, Çiğli, İzmir, Türkiye

Sustainable Recycling of Tungsten Waste for Photocatalytic and Radiation Shielding Applications

Abstract

Tungsten is a critical material widely used in advanced technologies due to its high density, mechanical strength, and superior radiation attenuation properties. However, significant amounts of tungsten-containing waste, particularly tungsten carbide (WC) sludge from machining processes, are generated worldwide. Considering the high cost and environmental impact of primary production, recycling of tungsten has become essential for sustainable material development. In this study, the reuse of tungsten-based waste in different functional applications is explored. Recycled WC was transformed into oxygen-deficient tungsten oxide (WO_3–x), and its photocatalytic performance was investigated, showing high efficiency in the degradation of organic pollutants for wastewater treatment. In addition, the radiation shielding properties of tungsten-based materials were examined using WC/hBN-reinforced epoxy composites and tungsten oxide–polymer systems, which demonstrated enhanced gamma attenuation and neutron absorption. These results highlight that recycled tungsten offers versatile applications, contributing to both environmental sustainability and the development of high-performance functional materials.

Biography

Nusret Kaya is a faculty member at İzmir Katip Çelebi University, specializing in the fields of nanotechnology and material science. With a strong academic background and extensive research experience, Dr. Kaya is dedicated to advancing the understanding of advanced materials and their applications in various industries. His research focuses on the synthesis, characterization, and application of nanomaterials, exploring their potential in areas such as energy storage, environmental remediation, and biomedical engineering. Dr. Kaya employs a multidisciplinary approach, integrating principles from chemistry, physics, and engineering to innovate and develop new materials with enhanced properties.

Hadi Erfani

Islamic Azad University Organization Private university, Iran

The Impact of PLA Materials on the Economic Cycle and its Recycling in 3D Printers

Abstract

Fortunately, this system does not have any technical structural problems and is designed to overcome the problems that existed in old adhesives. In addition to the low quality of old models, it can damage the respiratory system due to the presence of strong chemicals and also harm the environment because it is not dissolved. In addition to a simple structure, it is designed with a very precise plant base, it has the ability to be recharged in the environment, it also does not harm the respiratory system and has a high build quality. This system is designed to overcome the problems and is designed and implemented to improve quality, health and environmental protection. The design of this tool, given the urgency of this process for the environment and the respiratory system, provides a good market for this product to be used in all 3D printers in cities. This is an industrial application in chemical engineering as well as chemistry and related fields. The proposal of this invention is to maximize the use of this adhesive in addition to its many advantages in helping to protect the environment and using renewable materials and waste materials that can be used to produce high-quality materials and help the industry. In recent years, due to the increase in the workload of the people of the society, social life has led to a significant improvement in product efficiency. The designed adhesive is generally simple and yet very practical. This adhesive generally has an internal structure and yet practical, which incorporates unique advantages and clearly demonstrates the capabilities of the system. Preventing environmental pollution, waste from the consumption of gods made of polylactic acid decomposes and disintegrates in the vicinity of the soil. In order to prevent greenhouse gas emissions, the industrial production of polylactic acid requires the cultivation of plants used as bulk feed.

Compatibility with living tissue as raw materials for the production of plant lactic acid in packaging applications is not transferred to packaged goods, especially food, chemicals and unusual materials. Reducing the use of petroleum resources in the production of polylactic acid Not only does oil not use as a raw material, but it also requires less fuel in its production process. By using renewable resources, plants can be produced and recycled as raw materials for the production of polylactic acid. Each of these features alone could be a compelling reason to expand the production and application of polylactic acid compared to today's plastics. The advantages of this industrial application include: improved build quality, better embedding with printers, environmental friendliness, recyclability without waste materials, no harm to the respiratory system, a structure that meets chemical standards, rapid absorption of materials and high adhesion

Keywords: PLA, Recycling, Economic Cycle, 3D Printer, Materials.

Merve Karaman

İzmir Katip Çelebi University, Engineering Science Department, Çigli, İzmir, Türkiye

Polyester Hybrid Composites with Ceramic and Natural Fillers: Mechanical Performance and Thermal Behavior

Abstract

In this study, polyester-based hybrid composites incorporating aluminum nitride (AlN) and a natural lignocellulosic filler were developed and systematically investigated. The total filler content was fixed at 40 wt.%, while the relative proportions of AlN and the natural filler were varied to evaluate their combined influence on composite performance. Mechanical properties were determined through tensile and flexural tests. In addition, thermal characterization analyses were carried out to evaluate the behavior of the composites under elevated temperatures.

Fracture surfaces of tensile specimens were examined using scanning electron microscopy (SEM) to gain insight into filler dispersion, interfacial adhesion, and failure mechanisms within the composite structure. The results indicated that the incorporation of AlN and the natural filler significantly influenced mechanical properties and microstructural characteristics.

Overall, the hybrid filler system provided a tunable balance in composite performance, suggesting potential for applications where material efficiency and sustainability are of interest.

Biography

Merve Karaman completed her undergraduate and graduate studies in Chemistry. She finished her PhD at 34 years old years from İzmir Katip Celebi University.

Muhammad shoaib ashraf

Department of Bioengineering, King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia

Ultra-Simple, Single-Precursor Production of Co_3O_4 Nanoparticles via Thermal Decomposition: Characterization and Scalability-Oriented Techno-Economic Analysis

Abstract

Cobalt oxide (Co_3O_4) nanoparticles are widely used in catalysis, sensing, energy storage, and environmental applications, but many reported synthesis routes remain multistep, solvent-intensive, and less suitable for scale-up. In this study, an ultra-simple one-step thermal decomposition method was developed to synthesize Co_3O_4 nanoparticles directly from cobalt(II) nitrate hexahydrate at 420°C without solvents, surfactants, or additional wet-chemical processing. The synthesized product was characterized by X-ray diffraction, FESEM, and TEM. XRD confirmed the formation of crystalline cubic spinel Co_3O_4, while FESEM and TEM revealed a predominantly nanorod-like morphology with average dimensions of approximately 16 nm in diameter and 36 nm in length, confirming successful formation of phase-pure nanostructured material through this simplified route. A preliminary techno-economic analysis further demonstrated promising batch-scale feasibility for the proposed process, including integration of NO_2 scrubbing during scale-up. Sensitivity analysis showed that project profitability is more strongly influenced by sales performance than by moderate raw material price fluctuations. Overall, this study presents a simple, reproducible, and potentially scalable strategy for Co_3O_4 nanoparticle production with encouraging industrial relevanc.

Biography

Dr. Ronit Ilouz is an Assistent Professor at the Azrieli Faculty of Medicine, Bar-Ilan University. Her research focuses on spatial signaling mechanisms in cancer and neurodegeneration, combining quantitative imaging, proteomics, and structural biology to identify clinically relevant biomarkers. She has contributed to defining Protein Kinase A (PKA) dysregulation in human disease, including lesion-specific biomarkers in prostate cancer.

Ehsan Zolfaghari

School of Chemistry, Chemical Engineering and Biotechnology, Nanyang Technological University, 637457, Singapore.

A Bioinspired Nanomedicine for Thermo-Catalytic Reprograming of Obese Fat

Abstract

Background and aims

Obesity is recognized as a disorder of oxidative stress–driven redox imbalance and metabolic inflexibility, resulting from excessive white adipose tissue (WAT) accumulation and chronic inflammation. Conventional pharmacotherapies often target systemic pathways with limited efficacy and undesirable side effects. Here, we present a bioinspired ruthenium-doped polydopamine nanozyme (Ru@PDA) encapsulated within a hyaluronic acid hydrogel, designed as a multifunctional nanomedicine that synergistically couples antioxidant, nanocatalytic, and photothermal modalities for localized adipose tissue reprogramming.

Methods

Ru@PDA nanozyme was synthesized by co-polymerization of dopamine with Ruthenium (III). Structural, optical, and nanocatalytic properties were evaluated using microscopy, spectroscopy, and enzyme-mimetic assays. Anti-obesity efficacy was assessed in high-fat diet–induced obese mice receiving the hydrogel followed by near-infrared-II laser application (Ru@PDA+L).

Results

Ru@PDA exhibited strong enzyme-mimicking activities, and robust photo-to-thermal performance. In vitro, Ru@PDA efficiently scavenged reactive oxygen/nitrogen species, alleviating oxidative stress in adipocytes. In vivo, Ru@PDA+L induced localized hyperthermia (>42 °C), WAT browning, and lipolysis, resulting in ~16% body

weight reduction and marked decreases in local inguinal and distal epididymal fat masses. Treatment normalized glucometabolic profile, improved hyperinsulinemia and hyperlipidemia, and increased adiponectin levels. Histological and serological analyses confirmed anti-inflammatory activity and systemic metabolic improvement, while biodistribution studies demonstrated favorable biosafety profile.

Conclusion

This study introduces Ru@PDA nanozymes as a versatile, bioinspired nanomedicine bridging nanocatalysis, photothermal engineering, and metabolic therapy. Such multifunctional nanomedicine highlights the potential of nanozyme-enabled precision therapy for obesity and metabolic disorders, advancing the translation of nanoscience innovations into clinically relevant biomedical solutions.

Biography

Ehsan Zolfaghari is a PhD candidate in the School of Chemical and Biomedical Engineering at Nanyang Technological University, Singapore. His research lies at the interface of nanotechnology and biomedical science, focusing on developing nanomaterial-based therapeutics for obesity and metabolic disorders. His current work investigates how engineered nanostructures can regulate redox balance, target adipose tissues, and enhance therapeutic efficacy through advanced nano-bio interactions. During his master's studies, he conducted research on improving cancer therapy using magnetic nanomaterials and developed facile reduction of antibodies via nanoparticles. His research interests include nanomedicine design, targeted drug delivery, and bio-inspired catalytic nanomaterials, with an overarching goal of translating nanotechnology innovations into practical healthcare solutions.

Ferdous Adda

Bioengineering Department, King Fahd University of Petroleum & Minerals, Saudi Arabia

Green Synthesis of Multifunctional Nanohybrids from Biowaste: A Sustainable Approach for Photocatalytic Water Decontamination

Abstract

Water contamination by organic pollutants and microbial pathogens represents a critical global challenge, threatening over 2 billion people worldwide. Methylene blue, a widely used industrial dye, persists as a recalcitrant pollutant in wastewater streams, while Escherichia coli poses severe health risks in resource-limited regions. Conventional treatment methods typically address single contaminant types, requiring multiple sequential processing stages that are economically prohibitive and operationally complex. This research develops an innovative multifunctional nanomaterial platform capable of simultaneously tackling both chemical and biological contaminants using exclusively renewable resources and natural solar energy. Carbon-copper nanohybrids were synthesized via environmentally benign hydrothermal method using orange peel as natural reducing and stabilizing agent. This green synthesis approach valorizes agricultural waste into highperformance functional materials while eliminating hazardous chemical reagents. The hydrothermal conditions induced partial carbonization of organic constituents, producing highly absorbent carbon nanostructures with enhanced light-harvesting capabilities, while concurrently reducing copper ions into antimicrobial nanoparticles uniformly distributed within the carbon matrix. Comprehensive structural characterization via scanning electron microscopy, energy-dispersive X-ray spectroscopy, and Fourier-transform infrared spectroscopy confirmed successful nanocomposite formation with optimal elemental integration and surface functionalization. Performance evaluation demonstrated

that carbon nanoparticles achieved superior photocatalytic degradation of methylene blue under natural solar irradiation across multiple concentration ranges through efficient charge carrier generation. Copper nanoparticles exhibited potent bactericidal activity against E. coli via membrane disruption and copper ion toxicity mechanisms. The integrated nanohybrid delivered exceptional dual functionality, effectively degrading organic dyes while simultaneously inactivating bacterial pathogens in a single treatment step. Critically, solar exposure significantly enhanced antimicrobial performance, revealing synergistic photo-driven disinfection mechanisms. This single-material platform eliminates multi-step treatment processes, operates without external energy requirements, and enables decentralized deployment in communities lacking conventional water infrastructure. The research demonstrates a scalable, cost-effective solution aligned with circular economy principles and global sustainability goals, offering practical applications for addressing water scarcity challenges in resource-limited regions.

Biography

Ferdous Adda is a graduate student in the Bioengineering Department at King Fahd University of Petroleum & Minerals (KFUPM), Saudi Arabia, pursuing a Master's degree in Life Sciences. She earned her Bachelor's and Master's degrees in Biochemistry and Applied Biochemistry from Amar Thelidji University in Algeria, graduating as class valedictorian. Her research focuses on developing sustainable nanotechnology solutions for water contamination through green synthesis methods. She specializes in synthesizing multifunctional carbon-copper nanocomposites fromagricultural waste materials to address organic pollutants and microbial pathogens in water systems. Her work emphasizes waste valorization and solar-driven processes, contributing to circular economy principles and sustainable environmental remediation strategies for communities with limited access to conventional water treatment infrastructure.

Aya Rezaiguia

Bioengineering Department, King Fahd University of Petroleum & Minerals (KFUPM), Dhahran, Saudi Arabia

Bifunctional MgO–Carbon Nanocomposites Derived from Biomass for Solar-Driven Water Remediation

Abstract

Developing multifunctional nanomaterials that can simultaneously degrade organic pollutants and inactivate pathogenic microorganisms is essential for advancing sustainable water purification technologies. In this work, biomass-derived MgO–carbon nanocomposites were synthesized using orange peel waste through hydrothermal carbonization followed by controlled calcination. This green synthesis route transforms lignocellulosic biomass into a functional carbon matrix while enabling uniform nucleation and dispersion of MgO nanoparticles.

A comprehensive characterization strategy was employed to elucidate the structural, chemical, and optical features of the nanocomposite. Fourier-transform infrared spectroscopy (FTIR) verified characteristic Mg–O vibrations along with oxygenated carbon functional groups derived from the biomass precursor. Scanning electron microscopy (SEM) revealed a heterogeneous, porous morphology with well-distributed MgO particles embedded within the carbon framework

Under natural sunlight, the MgO–carbon nanocomposite exhibited significantly accelerated photodegradation of methylene blue, outperforming pure MgO due to improved electron–hole separation and intensified reactive oxygen species (ROS) generation. The synergistic interaction between MgO and the carbonaceous matrix enhances electron mobility, reduces recombination, and promotes sustained photocatalytic efficiency.

Beyond chemical degradation, the material demonstrated strong antibacterial activity against Escherichia coli at low concentrations. Membrane damage, oxidative stress, and cell deformation observed after treatment confirmed that bacterial inactivation arises from combined ROS attack and direct nano–bio interactions. This dual functionality highlights the potential of the material for integrated water purification systems capable of addressing both chemical pollutants and microbial
hazards.

Overall, this study presents a scalable and environmentally responsible approach for producing high-performance MgO–carbon photocatalysts from agricultural waste. The integration of structural and optical characterization with functional testing reveals a robust solar-activated material suitable for next-generation water remediation technologies. These findings reinforce the promise of biomass-derived MgO–carbon nanocomposites as low-cost, sustainable platforms that support circular economy principles while delivering advanced photocatalytic and antimicrobial
performance.s.

Biography

Aya Rezaiguia is a biochemist specializing in green nanotechnology and sustainable materials engineering. She holds a Bachelor's and Master's degree in Biochemistry from Algeria and is currently completing a Master's in Life Science (Bioengineering) at King Fahd University of Petroleum & Minerals, Saudi Arabia. Her research focuses on biomass-derived nanomaterials, photocatalysis, and antimicrobial nanostructures, with an emphasis on solar-activated composites for environmental remediation.

Mariem Ben Attia

Department of Bioengineering, College of Chemical and Materials, King Fahad University of Petroleum and Minerals, Saudi Arabia

Novel Ternary 2D Nanocomposite System: GO-ZnO-CaO Hybrid for Enhanced Broad-Spectrum Antibacterial Applications

Abstract

Global healthcare faces an unprecedented challenge from antimicrobial resistance, claiming 700,000 lives annually with forecasts suggesting 20 million deaths by 2050, necessitating revolutionary antibacterial approaches that evade traditional resistance pathways. This study presents a pioneering graphene oxide-zinc oxide-calcium oxide (GO-ZnO-CaO) ternary nanomaterial platform—representing the inaugural investigation of this specific multi-component two-dimensional system designed to achieve cooperative broad-spectrum bacterial inhibition through concurrent multi-pathway mechanisms that substantially minimize resistance evolution risks.

Our fabrication strategy utilizes modified Hummers oxidation for graphene oxide generation, subsequently integrating zinc and calcium oxide nanoparticles through controlled alkaline co-precipitation and heat treatment protocols. This methodical construction ensures homogeneous metal oxide deposition across graphene nanosheets, establishing close interfacial interactions that promote charge migration and amplify collaborative antibacterial functions. The fabricated GO-ZnO-CaO platform merges graphene oxide's remarkable surface-to-volume ratio and atomically-sharp architecture with zinc oxide's light-activated catalytic properties and calcium oxide's pH-driven bactericidal effects, producing outstanding antimicrobial capabilities via complementary destruction mechanisms.

Thorough material analysis employing XRD crystallographic assessment, FTIR functional group identification, SEM surface imaging, and TEM nanoscale visualization validates successful ternary composite construction with favorable physicochemical characteristics. Initial antibacterial testing reveals remarkable effectiveness spanning both Gram-negative and Gram-positive bacterial classifications. The ternary platform displays substantially amplified bactericidal performance relative to pristine graphene oxide when challenged with Escherichia coli ATCC 25922 and Bacillus subtilis ATCC 23857 organisms, demonstrating pronounced cooperative enhancement among constituent materials.

The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) assessments via serial dilution techniques establish effective bacterial suppression and total elimination at notably reduced material loadings compared to singular components. The bactericidal action encompasses cooperative destruction routes including direct mechanical damage and cellular encapsulation by graphene oxide's sharp edges, light-triggered reactive oxygen species production plus zinc cation discharge creating oxidative cellular damage, and highly basic local conditions generated by calcium oxide triggering protein structural collapse alongside calcium ion disruption of metabolic balance.

This integrated approach functions concurrently without supplementary chemical compounds, tackling the core weakness of conventional single-target antimicrobials. The simultaneous deployment of mechanical, chemical, and light-activated killing strategies generates cumulative bacterial stress from diverse angles, profoundly diminishing resistance development likelihood. This investigation validates ternary two-dimensional nanostructured composites as promising advanced-generation antibacterial materials, advancing worldwide antimicrobial resistance reduction initiatives while delivering pragmatic solutions for biomedical implant surfaces, tissue repair applications, aqueous decontamination technologies, food preservation systems, and clinical facility sanitization.

Biography

Mariem Ben Attia holds a degree in Industrial Bioengineering and is currently pursuing her Master of Science in Life Sciences at King Fahad University of Petroleum and Minerals (KFUPM), Saudi Arabia. Her research focuses on developing nanomaterial composites for antimicrobial applications, specifically addressing the global antimicrobial resistance crisis through innovative multi-mechanism antibacterial strategies. Under the supervision of Prof. Amjad Khalil and Prof. Tawfik Abdo Saleh Awadh, she is pioneering the synthesis and characterization of graphene oxide-based ternary nanocomposites. Her work integrates principles of materials science, nanotechnology, and microbiology to create next-generation antibacterial agents with applications in medical devices, water *treatment, and infection control. She is committed to advancing sustainable, eco-friendly antimicrobial and effective solutions to combat drug-resistant pathogens and improve global public health outcomes.*

Mohammadali Meskaraf-asadabadi
Department of Tissue Engineering, School of Medicine, Kermanshah University of Medical Sciences, Kermanshah, Iran

Incorporating bioactive glass nanoparticles in silk fibroin/ bacterial nanocellulose composite scaffolds improves their biological and osteogenic properties for bone tissue engineering applications

Abstract

Polymeric composite scaffolds combining natural biopolymers represent a significant class of biomaterials with desirable physicochemical and biological characteristics. This investigation presents the development and characterization of three-dimensional composite scaffolds incorporating bacterial cellulose (BC), silk fibroin (SF), and bioactive glass nanoparticles (BGNPs) for promoting bone regeneration capacity in human adipose-derived stem cells (hASCs). Morphological analysis via scanning electron microscopy revealed that synthesized BGNPs exhibited spherical geometry with dimensions between 15-30 nm. Incorporation of BC and BGNPs into SF matrices resulted in reduction of scaffold porosity to approximately 210±10 µm and 205±10 µm respectively, alongside enhancement of mechanical properties including compressive strength and elastic modulus. Fourier transform infrared spectroscopy confirmed the successful integration of all constituent materials within the composite structure. Flow cytometric analysis validated the phenotypic markers characteristic of hASCs. The addition of BC and BGNPs demonstrated beneficial effects on scaffold stability through decreased degradation and moisture absorption rates. Molecular analysis including gene expression profiling of osteogenic markers (Runx2, alkaline phosphatase, and osteocalcin) substantiated the osteoinductive effects of BGNPs within BC/SF matrices on hASC populations. Quantitative assessment of cellular behavior through metabolic activity assays (MTT), ultrastructural examination, mineralization staining, and enzyme

activity measurements collectively demonstrated enhanced cell attachment, metabolic activity, and osteogenic differentiation within both BC/SF and BC/SF/BGNPs formulations. These findings suggest the developed composite scaffolds hold considerable potential as bioengineered constructs for bone tissue repair applications.

Keywords: Bone tissue engineering; Osteogenic differentiation; Biocomposite scaffolds.

Biography

Mohammadali Meskaraf-Asadabadi is an MD graduate from Tehran University of Medical Sciences, Iran. His research interests lie in regenerative medicine and tissue engineering, with a focus on the development of biocompatible and biodegradable hydrogels. He is currently undertaking a neurosurgery residency at 7 Tir Hospital, where he aims to integrate regenerative medicine strategies into neurosurgical research and clinical practice.

Zhiliang Cheng

University of Pennsylvania, USA

sPLA2 inhibitor-loaded nanoparticles for the treatment of osteoarthritis

Abstract

Treating osteoarthritis (OA) remains a major clinical challenge. Despite recent advances in drug discovery and development, no disease-modifying drug for knee OA has emerged with any notable clinical success, in part, due to the lack of valid and responsive therapeutic targets and poor drug delivery within knee joints. In this work, we show that the amount of secretory phospholipase A2 (sPLA2) enzyme increases in the articular cartilage in human and mouse OA cartilage tissues. We hypothesize that the inhibition of sPLA2 activity may be an effective treatment strategy for OA. To develop an sPLA2-responsive and nanoparticle (NP)–based interventional platform for OA management, we incorporated an sPLA2 inhibitor (sPLA2i) into the phospholipid membrane of micelles. The engineered sPLA2i-loaded micellar NPs (sPLA2i-NPs) were able to penetrate deep into the cartilage matrix, prolong retention in the joint space, and mitigate OA progression in different OA animal models. These findings suggest that sPLA2i-NPs can be promising therapeutic agents for OA treatment.

Biography

Dr. Cheng has strong skills and experiences in chemistry, biomaterials, molecular imaging and drug delivery. His current research in University of Pennsylvania has been focused on the development of novel in vivo imaging agents and drug delivery systems. The long-term goal of his research is to develop new nanotechnology for better understanding of biology, early diagnosis of disease, monitoring therapy response, and for guiding drug discovery/development. Once implemented, these technologies will provide more options to the clinician in providing personalized patient care, at an earlier time point, than currently available methods.

Suihong Liu

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Nature-Inspired Bioactive Protein Bioinks for Functional Tissue Biofabrication

Abstract

Biofabrication, particularly 3D bioprinting, has emerged as a powerful platform for generating hierarchically organized, native-like tissue constructs with precisely controlled cellular architectures. Despite significant progress, the scarcity of sufficiently bioactive bioinks remains a major bottleneck, limiting the fabrication of volumetric and vascularized tissues that faithfully recapitulate biological function.

To address this challenge, our work focuses on developing an accessible, low-cost, and inherently bioactive bioink for functional tissue biofabrication. Inspired by natural systems, we engineered a series of protein-rich, bioactive bioinks derived from egg white (EW) proteins—ranging from native EW solution, to EW powder–enhanced formulations with elevated protein content, to photoresponsive EW-methacrylamide. These formulations span hybrid composite bioinks to single-component EW hydrogels, and from protein-rich bulk hydrogels to interparticle-crosslinkable porous microgel systems.These protein-based bioinks are compatible with multiple bioprinting modalities, including extrusion-based, laser-assisted, and aspiration-assisted bioprinting. Across these platforms, the bioinks demonstrate robust biofunctionality, supporting cell adhesion, spreading, and proliferation, while also promoting vascularization, modulating inflammatory and immune responses, and enhancing osteogenic differentiation and mineralization for bone regeneration. Together, these findings demonstrate that EW-derived, protein-powered bioactive bioinks represent a promising class of accessible and multifunctional materials for next-generation tissue engineering, regenerative medicine, and cellular agriculture.

Biography

Suihong Liu, Ph.D., is a postdoctoral researcher at Penn State University (USA). He earned a joint Ph.D. in Mechanical Engineering from Shanghai University (China) and TU Dresden (Germany) and has authored over 30 peer-reviewed publications. His research focuses on intelligent biofabrication of functional tissue analogs, high-throughput bioprinting, and the development of albumen-derived, nutrient-rich bioactive biomaterials for regenerative medicine and sustainable cellular agriculture.

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CFD Modeling of CO_2 Capture in a Packed Column Using Amine-Based Nanofluids: Effects of $Al2O_3$, SiO_2 and TiO_2 Nanoparticles

Abstract

CO_2 emissions are a critical environmental concern driving global climate change, particularly the rise in Earth's average temperatures. Therefore, reducing CO_2 release into the atmosphere is essential. One promising solution for capturing and removing CO_2 from industrial gas streams is the use of absorption columns with amine-based solutions. In this study, an amine absorption column in a petrochemical plant was investigated. The column consists of two sections with different diameters: The column's upper section features a smaller diameter, while the lower section is broader. The column receives lean amine at its uppermost section, with semi-lean amine being fed where the diameter changes. Nanofluid solutions containing Al_2O_3, SiO_2, and TiO_2 nanoparticles were utilized. The flow rates of both amine streams were kept constant, while the inlet gas flow rates were set at 215, 161, and 140 tons per hour. Nanofluids with weight concentrations of 0.03, 0.05, and 0.1 wt% and particle sizes of 20, 50, and 80 nanometers were considered. The study focused on analyzing CO_2 concentration profiles along the column, mass transfer coefficient, absorption efficiency and pressure drop in the presence of amine and nanofluid solutions. Results show elevated gas velocities correlate with diminished CO_2 removal performance in all cases. Also, the numerical simulation results indicate that increasing wt% leads to higher CO_2 absorption efficiency and mass transfer coefficient. Furthermore, comparison between nanoparticles of different sizes shows that smaller particles exhibit better performance.

Biography

Ahmad Azari has completed his PhD at the age of 30 years from Amirkabir University of Technology (Tehran Polythechnic), I.R. Iran. Currently, He is the associate professor in department of Chemical Engineering, Persian Gulf University, I.R. Iran. He presented papers in more than 40 national and international conferences.

Thank You