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Joint Event

5th International Conference on

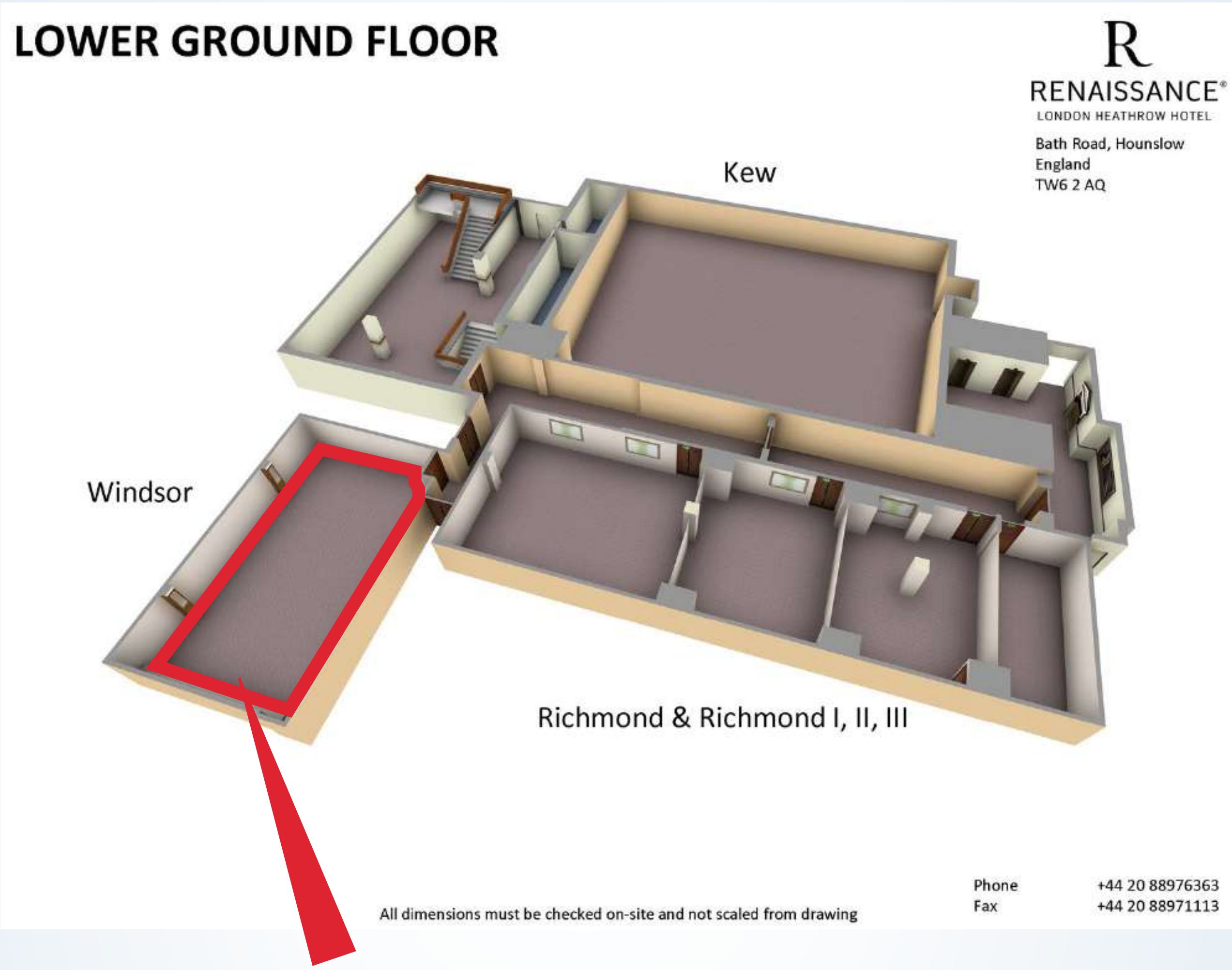
ADVANCED FUNCTIONAL MATERIALS

&

BIOMATERIALS & BIODEVICES

October 14-15, 2024 | London, UK

Floor Map



Conference Hall

Wi-Fi Details:

Username: Marriott Guest

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Conference Program

Scientific Program

Monday
October 14, 2024

5th International Conference on

Advanced Functional Materials & Biomaterials & Biodevices

Day 1 – October 14th 2024	
Meeting Hall : Windsor Suite	
08:00 -08:45	Registrations
08:45 - 09:00	Introduction
Keynote Presentations	
09:00 - 9:40	Protective Nanocoatings from Polyelectrolytes: Flame Retardancy, Heat Shielding, and Super Gas Barrier
	Jaime C. Grunlan, Texas A&M University, USA
09.40 - 10.20	Fully Bioresorbable Polymeric Scaffolds for Treatment of Peripheral and Coronary Diseases: Current Developments and Future Perspectives
	Kadem Al-Lamee, Arterius Limited, United Kingdom
Networks & Refreshments (10.20 - 10.40) @York Lobby	
10:40 - 11:20	Advanced Carbon Based Materials via Sustainable Synthetic Procedure for Sensing and Environmental Applications
	Claudia Espro, University of Messina,Italy
Oral Presentations	
Session chair	**Jaime C. Grunlan,** Texas A&M University, USA
Session chair	**Kadem Al-Lamee,** Arterius Limited, United Kingdom
Sessions:	Functional Hybrid Materials |Applications of Biomaterials | Carbon Based Materials | Biomimetic Materials | Bio-inspired Intelligent Biomaterials |Biomaterials in Drug Delivery Systems | Functional Materials, Synthesis and Characterizations |Advanced materials and Applications | Biomaterials & Nano technology|Biodevices and Biomedical Optics | Functional Materials|Energy Materials |Micro or Nano Materials |Biomaterials | Hydrogels | Sustainable Materials
11.20 - 11.45	From Biomimicry to Architecture: The Future of Responsive Shading
	Maria João de Oliveira, ISCTE – Instituto Universitário de Lisboa, Portugal
11.45 - 12.10	Synthesis of Functionalized Chitosan Polymeric Nanoparticles and their Properties for Controlled Drug Release
	Nekane Martin, I+Med S.Coop., EHU/UPV, Spain
12.10 - 12.35	Investigation on Corrosive Degradation of the Thermally Sprayed TiNbMoMnFe High Entropy Alloy Coatings in Simulated Body Fluid
	Deepak Kumar, Indian Institute of Technology Delhi (IIT Delhi), India
12.35 - 13.00	The Impact of Metal Dots on Time-Resolved Luminescence of Aero-GaN
	Tudor Braniste, Technical University of Moldova, Moldova
Group Photo (13.00 - 13.15)	
Lunch (13.15 - 14.00) @Market Garden Restaurant	
14.00 - 14.25	Machine Learning-Accelerated Analysis Synthesized the Characteristics of $CaCO_3$ Particles with the Methods of Microwave, Ultrasonic, and Magnetic Steering, as well as their Possible Applications
	Junnan Song, Ghent University, Belgium

Scientific Program

Monday
October 14, 2024

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Advanced Functional Materials & Biomaterials & Biodevices

14.25 - 14.50	Advancing Uniform Stochastic Design in Photomatrix Therapeutic Systems
	Oleg Karaduta, University of Arkansas for Medical Sciences, USA
14.50 - 15.15	Green Carbon-Based Nanomaterials with Advanced Properties for Environmental Applications
	Viviana Bressi, University of Messina,Italy
15.15 - 15.40	SEWAT - Sustainable Energy by Waves Trap
	Giulio Teodoro Maellaro, Geco -Global Engineering Constructions S.R.L. ,Italy
15.40 - 16.05	Dual-Action Coatings for Implant Failure Prevention in Temporary Magnesium-Based Orthopaedic Implants
	Isabel Sousa, DEMaC/CICECO, University of Aveiro, Portugal
Networks & Refreshments (16.05 - 16.30) @York Lobby	
Poster Presentations @ 16:30 - 18:00	
Poster Judge	**Kadem Al-Lamee,** Arterius Limited, United Kingdom
PP-01	Experimental and Computational Studies of Crystal Violet Removal from Aqueous Solution using Sulfonated Graphene Oxide
	Olayinka Oluwaseun Oluwasina, The Federal University of Technology Akure, Nigeria
PP-02	Development of a Critical Time-Temperature Indicators (cTTI) using Thermosensitive Copolymers with Tunable LCST
	Seung Won Jung, Dongguk University, South Korea
PP-03	From Sea Urchins Waste to Tissue Regeneration: Innovative Composite Biomaterials
	Giordana Martinelli, University of Milan, Italy
PP-04	Comparative Evaluation of Sea Urchin Waste as a Sustainable Source of Bioactive Collagen-Based Biomaterials
	Margherita Roncoroni, University of Milan, Italy
PP-05	Flexible Thermoelectrics based on 3D Interconnected Magnetic Nanowire Networks
	Luc Piraux, UCLouvain, Belgium
PP-06	Tuning the Structure-Functional Relationship within Peptide-Mimicking Antimicrobial Hydrogels
	Samuel Attard, University of New South Wales, Australia
PP-07	Categorizing/Testing Biomaterials, A Major Challenge for Valeo Lighting Systems / Light Division
	Laurent Barre, Valeo Lighting Systems, France
PP-08	Food-Based Biomaterials: pH-Responsive Alginate/Gellan Gum/Cellulose Hydrogel Beads for Lactoferrin Delivery
	Lin Cao, Ghent University, Belgium
PP-09	Study of Ceramic Coatings as a Novel Radiation Receiver on Furnace Building Material using Thermal Spraying Technique
	Wu-Han Liu, Industrial Technology Research Institute, Taiwan
Day 1 Concludes followed by Certificate Felicitation	

Scientific Program

Tuesday
October 15, 2024

5th International Conference on

Advanced Functional Materials & Biomaterials & Biodevices

Day 2 - October 15, 2024	
Meeting Hall : Windsor Suite	
Keynote Presentations	
9.30 - 10.10	Nickel-Zinc Ferrite and Graphene Nanoplatelet-Enhanced Epoxy Hybrid Nanocomposites
	Sahrim Ahmad, Universiti Kebangsaan Malaysia, Malaysia
10.10 - 10.50	An Environment-Friendly $Na_{0.4}K_{0.1}Bi_{0.5}TiO_3$ Ceramic for Direct Replacement of PZT-Based Ceramics in Multiple Applications
	Ajit R. Kulkarni, Indian Institute of Technology-Bombay (IIT Bombay), India
Networks & Refreshments (10.50 - 11.15) @York Lobby	
Oral Presentations	
Session chair	**Ajit R. Kulkarni,** Indian Institute of Technology-Bombay (IIT Bombay), India
Session chair	**Kadem Al-Lamee,** Arterius Limited, United Kingdom
Sessions:	Advanced Functional Materials | Functional Materials | Hydrogels |Biodegradable Biomaterials |Thin Films | 3D Bio Printing Technology | Biosensors & Biorobotics
11.15 - 11.40	Chemically Identical Hydrogels with Distinct Mechanical Properties
	Xingjian Sun, Shenzhen Institute of Advanced Technology & Chinese Academy of Sciences, China
11.40 - 12.05	Exploring the Potential of $CsPbBr_3$ Perovskite Solar Cells: Experimental and Theoretical Investigations
	Amina Laouid, Nicolaus Copernicus University in Torun,Poland
12.05 - 12.30	4D Printed Piezoelectric Bilayer Wound Dressing Mesh to Accelerate Skin Wound Healing
	Gholamreza Mohammadi Khounsaraki, Institute of Materials Research, Slovakia
12.30 - 12.55	Advancements in Fiber Optic Biosensors for Real-Time Glucose Monitoring
	Pallavi Dhillon, Shen Clinical Services LLP, India
12.55 - 13.20	Membrane Separation Technology in Direct Air Capture
	Naiying Du, National Research Council of Canada (NRC), Canada
Lunch (13.20 - 14.30) @Market Garden Restaurant	
14.30 - 14.55	Preparation, Function, and Safety Evaluation of a Novel Degradable Dermal Filler, The Cross-Linked Poly-Γ-Glutamic Acid Hydrogel Particles
	Mian Chen, Shandong Academy of Pharmaceutical Sciences, China
14.55 - 15.20	Microwave-Synthetized Lanthanide Upconversion Nanoparticles: Light Nanotransducers for Biomedical Applications.
	Gloria Lesly Jimenez Miranda, AGH University of Krakow, Poland

15.20 - 15.45	Biopolymer Based in Situ Injectable Hydrogels Loaded with Curcumin Nanocrystals for Bone Tissue Engineering, (HydroBoneReg)	
	Syed Ahmed Shah, Institute of Fundame, Poland	
15.45 - 16.10	To be announced..	
	Ketevan Tavamaishvili, Georgian American University, Georgia	

Networks & Refreshments (16:10- 16:30) @York Lobby

Day 2 Concludes followed by Vote of thanks and Certificate Felicitaions

Day-1
Keynote Presentations

PROTECTIVE NANOCOATINGS FROM POLYELECTROLYTES: FLAME RETARDANCY, HEAT SHIELDING, AND SUPER GAS BARRIER

Jaime C. Grunlan

Texas A&M University, USA

Abstract

Layer-by-layer (LbL) assembly is a conformal coating "platform" technology capable of imparting a multiplicity of functionalities on nearly any type of surface in a relatively environmentally friendly way. At its core, LbL is a solution deposition technique in which layers of cationic and anionic materials (e.g. nanoparticles, polymers and even biological molecules) are built up via electrostatic attractions in an alternating fashion, while controlling process variables such as pH, coating time, and concentration. Here we are producing nanocomposite multilayers (50 – 1000 nm thick) that can be completely transparent, stop gas permeation, and impart extreme heat shielding to carbon fiber reinforced polymer composites. In an effort to impart flame retardant behavior to fabric using fewer processing steps, a water-soluble polyelectrolyte complex (PEC) was developed. This nanocoating is comprised of polyethylenimine (PEI) and poly(sodium phosphate) and imparts self-extinguishing behavior to cotton fabric in just a single coating step. Adding a melamine solution to the coating procedure as a second step renders nylon-cotton blends self-extinguishing. A PEC comprised of PEI and poly(acrylic acid) exhibits undetectable oxygen transmision rate (OTR < 0.005 $cm^3/m^2/day$) at a thickness of 2 μm. This is a true foil (i.e., aluminum) replacement technology. Either of these two coating techniques (LbL or PEC) can be deposited using roll-to-roll processing (e.g., flexographic printing, dip-coating, or spray-coating). Opportunities and challenges will be discussed. Our work in these areas has been highlighted in C&EN, ScienceNews, Nature, Smithsonian Magazine, Chemistry World and various scientific news outlets worldwide

Biography

Jaime Grunlan is the Leland T. Jordan '29 Chair of Mechanical Engineering at Texas A&M University, where he has worked for 20 years. He holds joint appointments in the Department of Materials Science and Engineering and the Department of Chemistry. He is a world leader in organic thermoelectric materials, super gas barrier layers, and environmentally-benign, flame retardant nanocoatings. He has published more than 200 journal papers, with more than 26,000 citations. He is an Editor of the Journal of Materials Science and Progress in Organic Coatings. In 2018, Prof. Grunlan became a Fellow of the American Society of Mechanical Engineers (ASME) and was awarded a doctorate honoris causa from the University of South Brittany (Lorient, France). In 2019, he became a Senior Member of the National Academy of Inventors (NAI). In 2023, he became a Fellow of the American Chemical Society (ACS).

FULLY BIORESORBABLE POLYMERIC SCAFFOLDS FOR TREATMENT OF PERIPHERAL AND CORONARY DISEASES: CURRENT DEVELOPMENTS AND FUTURE PERSPECTIVES

Kadem Al-Lamee

Arterius Limited, United Kingdom

Abstract

Coronary heart disease (CHD) and peripheral artery disease (PAD) are the most prevalent vascular and cardiovascular disorder worldwide. Both diseases are mainly caused by atherosclerosis (a build-up of fatty deposits inside the arteries to narrow overtime), meaning less blood can get through to the heart and to the lower extremities. In the last three decades, the development and innovation of metallic drug-eluting stents (DES) have been largely increased for the treatments of coronary heart disease and peripheral vascular disease. The long-term complications associated with implantation of these devices include caging the vessels which can prevent restoration of physiology and further surgical revascularisation, have prompted a search for more conservative treatments, and a "leave nothing behind" strategy. Bioresorbable scaffolds can overcome these limitations as they can fully absorb and leave nothing behind after providing temporary support to the arteries. A very limited number of bioresorbable scaffolds for cardiovascular and peripheral applications are currently under development. First-generation large-wall thickness strut coronary bioresorbable scaffold (BRS) has been reported to increase the risk of late-thrombosis which limited its clinical uses. Arterius Ltd has developed a thinstrut scaffold (ArterioSorb™), made of poly (L-lactic acid) (PLLA) and coated with antiproliferative Sirolimus drug to inhibit neointimal proliferation and restenosis (re-narrowing of the arteries). ArterioSorb™ PLLA polymer has been processed using a novel and cost-effective method called "Solid-Phase Orientation (Diedrawing)" technique to significantly increase the tensile strength of PLLA, leading to manufacture scaffold with high mechanical properties like the metallic drug-eluting stents with strut wall thickness of 95µm. The in-vivo and in-vitro performances of the ArterioSorb™ scaffolds will be presented in this event and reveal the data to compare with the best-in-class metallic stent DES clinically available, making ArterioSorb™ a lead candidate of the next generation BRS for the treatments of CHD and PAD.

Biography

Kadem is a Polymer Chemist with MSc and PhD from Liverpool University, United Kingdom. Worked in the Clinical Engineering department at Liverpool University for 14 years before joining the industry. His main interests are biomaterials, surface modifications and coating of materials commonly used in medical devices, drug delivery systems, hydrogels for medical applications, cardiovascular devices, wound care products, urology, and tissue engineering. To date, he has over 40 years of experience in the field of biomaterials for different medical applications and published over 60 scientific papers in international journals and hold over 30 granted patents/patent applications. He was the key co-founder of PolyBioMed Limited. The company was acquired by Lombard Medical Technologies plc and was then acquired by Bayer. He was integral to the development of the business since its foundation, including strategic development, fundraising, commercialization, technical development, and the establishment of its intellectual property portfolio. At present he is the Chief Technical Officer and the co-founder of Arterius Limited.

ADVANCED CARBON BASED MATERIALS VIA SUSTAINABLE SYNTHETIC PROCEDURE FOR SENSING AND ENVIRONMENTAL APPLICATIONS

Claudia Espro

University of Messina, Messina, Italy

Abstract

Background: Natural raw materials such as biomass and plant wastes are the most stimulating feedstock for the synthesis of carbonaceous nanomaterials as a result of their high accessibility, eco compatibility, and resemblance with Green Chemistry principles. Several attractive properties, such as high porosity, good structural stability, small background current, and good electro-catalytic performance made, carbon materials effective in many applications and devices with unlimited possibilities of development.

Objective: Development of innovative synthetic routes for the biomass conversion into added value products.

Methods: This study presented, an environmentally friendly protocol for the recovery of hydrochar by hydrothermal carbonization (HTC) of various biomass waste materials. HTC conditions such as temperature (180-300°C) and reaction time (60-300 min) were investigated to study the differences between the obtained samples and find the optimal conditions that maximize the yield of hydrochar.

The obtained biocarbons were characterized by several techniques (XRD, FTIR, XPS, SEM-EDX, and BET. And were used for the production of screen printed modified carbon based electrodes for the electrochemical sensing of different pollutants.

Results: Furthermore, some advanced sensing applications of the obtained bio-carbon, i. e. the conductometric detection of NO_2 in the air at ppb (part per billion) levels, and the electrochemical determination of dopamine at nanomolar concentration will be discussed, as well as the adsorption of environmental pollutants capability of the carbonaceous materials obtained will be discussed

Conclusion: The exploration of this single-step hydrothermal process represents a promising example of wet organic waste valorization to produce value-added products with high yields, and at the same time, to avoid potential and serious environmental issues arising from the citrus processing waste management and disposal.

Biography

Claudia Espro (PhD in Chemical Technologies and Innovative Processes at the University of Messina, Italy), permanent employee as Associate Professor. Master's Degree in Industrial Chemistry at the University of Messina. Claudia Espro is responsible of laboratory activity as supervisor of several PhD and post-doc students and coordinator of various Public funded projects. Her research activity is focused on the development of novel routes and green processes to nanostructured materials, their characterization, and the study of their chemical-physical properties. In this area she is pursuing fundamental and applied research objectives. The main topic of her scientific activity lies in the conversion of renewable biomass into intermediates and chemicals of higher added value. Her scientific activity is also devoted to the development of innovative materials for applications in the biomedical, sensor and environmental fields. She is author of about 170 papers, (91 articles on SCOPUS/WOS indexed International journals, more of 81 communication and conference proceedings at National and Int. Congresses; 1 patent) with an i-10 h-index 61 (Google-Scholar) and Scopus H-Index 25.

Day-1
Oral Presentations

FROM BIOMIMICRY TO ARCHITECTURE: THE FUTURE OF RESPONSIVE SHADING

Maria João De Oliveira
ISCTE – Instituto Universitário de Lisboa, Portugal

Abstract

Background: Architecture has evolved with industrial and material advancements, climatic constraints, new technological capacities, societal changes, and cultural premises. Biomimetic processes have proven effective in addressing various problems, including diseases and material challenges. While we possess the knowledge to solve current challenges, building interdisciplinary bridges remains essential. One major challenge in transdisciplinary teams is the lexicon. Biomimetics, already sharing terminology with fields like engineering and medicine, could enhance architectural responsiveness and interaction if integrated into architecture schools and practices.

Objective: The aim is to develop a problem-based methodology, the Bioshading System Design Methodology (BSDM), using natural events as models to create performative and design solutions for responsive shading systems.

Methods: BSDM operates through a circular relationship among three domains: Architecture, Nature, and Artifact. Each domain represents a stage in the design process. The "Architecture" domain involves defining the architectural challenge; the "Nature" domain involves abstracting natural elements to create the Biomeme, which supports the shading system design concept; and the "Artifact" domain involves emulating this concept to develop the architectural design solution.

Results: While the final prototype is crucial, the richness of information and experience gained during the BSDM process is key to its success. BSDM users will be capable of observing, analyzing, reconfiguring, and improving their shading solutions in ways that would not have been possible without this methodology.

Conclusion: BSDM integrates Architecture, Biology, and Digital Tools to create efficient, environmentally responsive shading systems. The most significant contribution is the dissolution of disciplinary boundaries, fostering robust connections among these fields. This transdisciplinary approach enables the creation of a common lexicon and the development of the Biomeme—an inspirational, human-made biological concept that provides the fundamental characteristics for the shading system.

Biography

Maria João de Oliveira is an architect, designer, and teacher specializing in biomimetic design methodologies. She teaches Design at the International Sharing School (ISS) in the Middle Years Programme (MYP). Her current research focuses on integrating biomimetic design methodologies into the International Baccalaureate® (IB) MYP. She holds a PhD in Architecture - Biomimetic Design and a postgraduate degree in Digital Architecture. Over the past decade, she has organized and served on scientific committees for international events, and provided tutoring and teaching in workshops and summer schools on biomimetics, digital fabrication, and performance-based design. She has also been part of scientific review teams for various publishers and renowned journals. She earned her Master's and PhD in Architecture from Iscte-Instituto Universitário de Lisboa and specialized in Digital Architecture Product through a joint venture between ISCTE and Faculdade de Arquitectura da Universidade do Porto (FAUP). She is an integrated researcher at ISTAR_Iscte.

SYNTHESIS OF FUNCTIONALIZED CHITOSAN POLYMERIC NANOPARTICLES AND THEIR PROPERTIES FOR CONTROLLED DRUG RELEASE

Nekane Martin

I+Med S.Coop., EHU/UPV, Spain

Abstract

Background: Chitosan is a natural polymer whose biomedical use is being widely studied due to its excellent bioactive properties. In addition, work is also being done to extend its biomedical capabilities through modifications with functional groups.

Objective: Synthesis of ammonio-quaternized chitosan derivatives by functionalization through chemical reactions and purification processes. To obtain different chitosan nanoparticles with differential characteristics, such as greater mucoadhesiveness to biological tissues, whose ultimate purpose will be their utility as carriers for active ingredients with controlled release capacity, in this case, aimed at improvements in eye care treatments.

Methods: First, a chemical synthesis of chitosan derivatives is performed by modifying their primary amine groups. The modification is identified and quantified by H-NMR technique. The next step is to synthesize nanoparticles (NPs) of this modified polymer under strong agitation and addition of a cross-linker. DLS and SEM techniques are used for characterization of particle size distribution, polydispersity index and morphology. Finally, these NPs are loaded with active principles and their controlled release profiles analyzed by HPLC technique.

Results: Chitosan amino quaternary derivatives with substitution percentages between 20% and 30% can be obtained by controlling the amount of reagent added. Nanoparticles of about 170 - 200 nm are obtained, both empty and loaded with active principles and of pure chitosan or its derivatives. A controlled release of up to 8h is achieved with nanoparticles loaded with ophthalmic active ingredients.

Conclusion: The method of synthesis of modified chitosan nanoparticles is optimized, from the first step of chitosan functionalization up to the obtaining of nanoparticles with controlled release capacity of active ingredients. This new dosing system is potentially applicable to eye treatments to improve the difficulties derived from the physiology of this organ.

Biography

Nekane graduated in Pharmacy in 2020 from the Euskal Herriko Unibertsitatea (EHU / UPV). After working in the pharmacy, she entered the field of research and has continued her training at the biomedical cooperative of scientists I+Med, a leading company in the field of nanotechnology and controlled release where she has been working for more than 3 years. She continued her training with the master "Biomedicine: technologies and knowledge management" (year 2021-2023) and currently within the PhD program Research and Evaluation of Medicines. Application of Pharmaceutical Technology to the Development of Advanced Therapies at the EHU/ UPV under the supervision of Jose Luis Pedraz manager of the Pharmaceutical Technology Department.

INVESTIGATION ON CORROSIVE DEGRADATION OF THE THERMALLY SPRAYED TINBMOMNFE HIGH ENTROPY ALLOY COATINGS IN SIMULATED BODY FLUID

Abhijith N.V. and Deepak Kumar

Indian Institute of Technology Delhi (IIT Delhi), India

Abstract

Background: Prosthetic devices are needed to support different biomedical conditions. Corrosive degradation is one of the prime failure reasons for the metallic prosthetic devices. Prolonged exposure is associated with the release of metallic ions from the prosthesis which adversely affects the human body and causes severe health problems. To address the biomechanical and biomedical issues, there is need to explore the ceramic and polymer-based biomaterials or develop new biomaterials. Recently, High Entropy Alloys (HEAs) have gained significant attention due to their excellent biological and mechanical properties.

Objective: To examine the long-term corrosion behaviour of the thermally sprayed TiNbMoMnFe high entropy alloy coatings in simulated body fluid (SBF).

Methods: The development of TiNbMoMnFe-based HEA coating involves two steps; (i) mechanical alloying for feed stock powder generation and (ii) coating development using high velocity oxy-fuel (HVOF) thermal spray process on SS304 steel substrate. The corrosion response of the developed HEA coatings was recorded for 1 to 5 weeks in a simulated body fluid medium followed by the systematic exploration of metallurgical and microstructural changes using Field Emission Scanning Electron Microscope (FESEM), X-ray Diffraction Spectroscope (XRD), and X-ray Photoelectron Spectroscope (XPS). The corrosion response of the HEA coatings was examined using a Potentiostat via linear polarization and electrochemical impedance spectroscopy (EIS) techniques.

Results: It is noted that the HEA coating contains majorly TiNbMo and $MnFe_2O_4$ phases. The corrosion resistance the coating to SBF increases with exposure duration which is attributed to the presence of evolution of TiNbMo and $MnFe_2O_4$. The EIS indicates the developed passive film is continuous and growing with exposure time. The metallurgical exploration suggests that the passive layer is enriched with TiO_2.

Conclusion: The thermally sprayed TiNbMoMnFe-based HEA coating offers resistant to corrosion under long term exposure to SBF environment.

Biography

Deepak Kumar is working as Professor at Centre for Automotive Research and Tribology (CART), Indian Institute of Technology Delhi. He obtained his BTech (Production Engineering) from G.B. Pant University of Agriculture and Technology Pantnagar India, and MTech (Metallurgical and Material Engineering) Indian Institute of Technology Roorkee India and PhD (Mechanical Engineering) from the Indian Institute of Science Bangalore India. His major areas of research interests include Tribology, Wear and corrosion resistant coatings, Environmental friendly metalworking fluids and greases. Materials for energy storage applications is new addition to the research explorations. He has published more than 60 papers in respected international journals. Kumar received Best PhD award and Gold medal from Indian Institute of Science Bangalore in 2010. He is an active reviewer for many international journals.

THE IMPACT OF METAL DOTS ON TIME-RESOLVED LUMINESCENCE OF AERO-GAN

Tudor Braniste[1,2], Vladimir Ciobanu[1,2], Florica Doroftei[2], Radu Tigoianu[2] and Ion Tiginyanu[1-3]

[1]Technical University of Moldova, Republic of Moldova
[2]"Petru Poni" Institute of Macromolecular Chemistry, Romania
[3]Academy of Sciences of Moldova, Republic of Moldova

Abstract

We report on the impact of noble metal nanodots on the carrier lifetime in 3D architecture called Aero-GaN or Aerogalnite. Aero-GaN represents a semiconductor material consisting of an interpenetrated network of GaN hollow mictoretrapods with the thickness of the walls in the range of 20-120 nm. The material is obtained by growing ultrathin layers of GaN on a sacrificial template consisting of interconnected ZnO microtetrapods. During the technological process of GaN deposition, the ZnO template is being decomposed under harsh conditions (corrosive atmosphere and high temperature). Ultrathin layers (about 10-nm thick) of Silver and Platinum were deposited on the as-grown aero-GaN using plasma sputtering. After deposition the samples were annealed at 300°C for 1 h at normal atmospheric conditions. The scanning electron microscopy demonstrates the formation of metallic nanodots on the surface of aero-GaN, which alter the optical properties of the material. Time-resolved photoluminescence excited with a Xe arc lamp shows an increase of the carrier lifetime with about 20% in the samples functionalized with silver nanodots compared to the as-grown aero-GaN specimens. Functionalization of aero-GaN with noble metal nanodots enhances the photocatalytic activity of the material, demonstrating an increase of antibiotic photodegradation by about 30% in the same interval of time.

Biography

Tudor Braniste is working on the development of technologies for production and characterization of the micro- and nano-architectures based on wide-bandgap semiconductor materials like GaN, ZnS, TiO2. He earned his PhD in micro-nano-electronics and optoelectronics in 2017 from the Technical University of Moldova. Braniste has experience at the intersection of nanotechnologies with biomedical engineering, collaborating with several international research centers such as Hannover Medical School in Germany, Institute of Microtechnologies in Bucharest, etc. Since 2019 he is coordinating the Department of Academic Management and International Cooperation, there he is responsible for the organization of scientific events of national and international relevance, as public reports of scientific projects realized under the national calls, public lectures, and conferences for specific audience and for the whole society. In 2022 together with other young colleagues he initiated the creation of the Moldova Young Academy.

MACHINE LEARNING-ACCELERATED ANALYSIS SYNTHESIZED THE CHARACTERISTICS OF CACO3 PARTICLES WITH THE METHODS OF MICROWAVE, ULTRASONIC, AND MAGNETIC STEERING, AS WELL AS THEIR POSSIBLE APPLICATIONS

Junnan Song

Ghent University, Belgium

Abstract

Background: In the realm of material science, artificial intelligence and machine learning are heralding a new age in image analysis, with significant advancements across various microscopy techniques and quality control processes. When it comes to micro-nano particles, size and shape are the most important morphology parameters determining particles' potential applications, especially in the area of biomedicine, as it has a high relationship to particles' biodistribution. $CaCo_3$ - one of the most prominent worldwide inorganic minerals in biological and geological systems - mainly has three anhydrous forms, namely calcite, aragonite, and vaterite, and each phase has its own representative shape. Therefore, building up a model to predict the particle phase based on its surface characteristics via a machine learning approach would be the bridge to connect both sides.

Objective: Find an efficient method for synthesizing particles with specific size, shape, and phase; Build a model to achieve high-throughput image analysis targeting micro-nano particles, freeing the researcher from the tedious and time-consuming counting work.

Methods: Four methods covering magnetic stirrer, microwave and magnetic stirrer, ultrasound agitation, and ultrasound agitation coupled with magnetic stirrer were taken into consideration, given that the reaction time was in the 90 s. The size and shape of synthesize particles were extracted from scanning electron microscopy (SEM) images. Semi-supervised machine learning, like the Segment Anything Model, was utilized to accelerate particles' characteristics like area, ratio, surface ratio, volume, mass and so on, with the hand-analyzed result as a control.

Results: Considering the particles' shape and size uniformity, ultrasound agitation coupled with magnetic stirrer produced the particles with the highest uniformity spherical and the smallest size 0.69 ± 0.2 µm, followed by ultrasound agitation, magnetic stirrer, microwave, and magnetic stirrer. Based on semi-supervised machine learning, a particle boundary detection model was built for SEM images.

Conclusion: Ultrasound agitation coupled with a magnetic stirrer is suitable for the synthesis of smaller vaterites with high uniformity. The prediction model based on the SEM images would boost the micronano nanoparticle morphology analysis.

Biography

Junnan Song has expertise in micro-nanoparticle synthesis and a passion for exploring biomaterial's applications. Her model based on semi-supervised machine learning provides a new way to micro-nano particle analysis based on images. This model would be normalized to the rest microscope technology like TEM, and would be expand to the various particles like Au, Ag, Pt, SiO_2. In the bio-application, the synthesized vaterites existed good biocompatibility which has been verified as good carries candidates to dsRNA delivery. 03/2021- now Ghent University PhD in Bioscience engineering Financial support by China Scholarship Council (CSC), BOF(Ghent University). 09/2017-06/2020 South China University of Technology Master in Bioengineering 2022.10 Gold Prize Mo-Trol Biolab: A model driven Synbio platform (Team leader) The 8th China International College Students "Internet+" Innovation and Entrepreneurship Competition.

ADVANCING UNIFORM STOCHASTIC DESIGN IN PHOTOMATRIX THERAPEUTIC SYSTEMS

Oleg K Karaduta
University of Arkansas for Medical Scienses, USA

Abstract

Background: Photomatrix therapeutic systems (PMTS) harness low-intensity light-emitting diodes (LEDs) for medical applications such as preventive medicine, stimulation, and rehabilitation. These systems utilize the quasi-monochromatic properties of LEDs to deliver targeted photobiological effects. However, existing systems face challenges with non-uniform light distribution, which can lead to inconsistent physiological responses.

Objective: This study aims to develop a novel design methodology for PMTS that employs stochastic algorithms to enhance the uniformity of LED irradiation, thereby improving the efficacy and safety of phototherapy.

Methods: The proposed approach utilizes stochastic sequences and pseudorandom number generators to control LED switching, achieving a more uniform light distribution across the treated area. Mathematical and engineering calculations were used to design the placement and operation of LEDs on the PMTS, ensuring consistent light exposure irrespective of the physical arrangement or geometrical shape of the LED matrix.

Results: The implementation of stochastic control algorithms resulted in significantly improved uniformity in LED irradiation. Experimental setups demonstrated that these enhancements led to more reliable and predictable physiological responses from biological tissues under treatment, particularly in terms of photobiological activation and therapeutic outcomes.

Conclusion: The introduction of a stochastic approach to the design and operation of PMTS offers a promising advancement in phototherapy technology. By ensuring uniform irradiation, the modified systems can potentially increase treatment effectiveness and reduce the risk of adverse reactions, making this approach highly beneficial for clinical applications in various medical fields. Further studies and clinical trials are recommended to validate these findings and optimize the system configurations for specific therapeutic needs.

Biography

Oleg Karaduta, a graduate of Volgograd State Medical University with a degree in General Medicine, completed his residency in General Surgery, later becoming the Chief Resident at Volgograd Regional Hospital in 2006. In 2011, Karaduta joined UAMS, focusing his research on the management of cardiovascular diseases in chronic kidney disease patients and exploring the gut microbiome's role in chronic kidney disease during his postdoctoral fellowship. His research has been supported by prestigious grants from the Burroughs Wellcome Fund and recognized by multiple awards. After his fellowship, he continued as a faculty member in the Department of Biochemistry and Molecular Biology at UAMS. In 2021, he transitioned to become the Director of Research at the College of Health Professions, where he developed a novel approach for designing uniform stochastic photomatrix therapeutic systems, enhancing the medical application of light-emitting diodes in therapy to ensure uniform irradiation and effective treatment outcomes.

GREEN CARBON-BASED NANOMATERIALS WITH ADVANCED PROPERTIES FOR ENVIRONMENTAL APPLICATIONS

Viviana Bressi and Claudia Espro

University of Messina, Messina Italy

Abstract

The use of green raw materials, such as biomass, plant residues and bio-waste, emerges as a compelling feedstock for synthesizing carbonaceous nanomaterials due to their extensive availability, environmental friendliness, and alignment with 17 goals of Sustainable Developments. Carbon nanomaterials exhibit intriguing properties, including high water solubility, structural stability, high surface area, and excellent electro-catalytic behavior, making them effective in multiple fields with vast development potential. Biomass-derived carbon materials can be easily synthesized through appropriate thermochemical approaches, such as hydrothermal carbonization (HTC) or microwave irradiation, addressing environmental and energy challenges. HTC is a thermochemical conversion process operating in a water medium under autogenous pressure at relatively low temperatures (180–300°C), emerged as a promising treatment technique for wet lignocellulosic biomass waste. Throughout this process, biomass undergoes dehydration, resulting in the formation of solid, liquid, and non-condensable gaseous products. The HTC-solid material derived from citrus processing waste, called as hydrochar, showed abundant oxygenated functional groups, making it a versatile substance applicable in pollutant adsorption, soil improvement, energy generation, and as a cost-effective material for electrochemical applications. Additionally, the light bio-oil extracted from the aqueous phase during hydrothermal carbonization contains valuable compounds suitable for biofuels and platform chemicals. Despite the recognized importance of these applications, untapped opportunities exist for incorporating bio-carbon into more sophisticated technologies, such as sensors. This discussion underscores the potential of HTC applied to biomass, emphasizing the production of bio-nanocarbon and bio-oil, alongside crucial considerations for process optimization and scale-up. Furthermore, these materials have been employed in advanced sensing applications involving the voltammetric detection of pollutants and the conductometric detection of NO_2 in the air at ppb levels. The exploration of this streamlined hydrothermal process represents a promising approach to valorize wet organic waste, generating value-added products while addressing environmental concerns linked to the management and disposal of citrus processing waste.

Biography

Viviana Bressi is a postdoctoral researcher at the University Mediterranea of Reggio Calabria (Italy). She completed her PhD at the Department of Engineering of the University of Messina (Italy), specializing in Engineering and Chemistry of Materials and Construction. Additionally, she conducted her doctoral research in collaboration with the Organic Chemistry Department at the University of Còrdoba (Spain), getting her doctoral degree in the program of Fine Chemistry. Her primary scientific focus centred on converting waste and biomass into intermediates, high-value chemicals, and carbon-based materials and nanomaterials, with applications ranging from catalysts to electrochemical sensing for monitoring water pollution and addressing environmental challenges.

SEWAT - SUSTAINABLE ENERGY BY WAVES TRAP

Giulio Teodoro Maellaro, Vito Mosè Maellaro, Cosimo Maellaro, Felice Frascino and Antonio Frascino

GECO -Global Engineering Constructions s.r.l., Italy

Abstract

Background: The search for energy sources is a vital necessity. The energy possessed by waves is a neglected and wasted source.

The key words of the project are therefore:

- Exploitation of a new energy source;
- Fight against energy waste;
- Sustainable use of natural resources and territory;

Objective:

The objectives are interconnected and consequential:

- Produce sustainable energy at low cost with a very simple but highly productive modular device.
- Use a natural resource that would otherwise be wasted without altering the balance of other ecosystems and without occupying productive territory;
- Effectively protect the coast from erosion;
- Capture waste transported by the waves;
- Capture fish species for monitoring and study;

Methods: The system consists of modular concrete tanks, placed in the sea, placed on the side exposed to the waves, of dams and breakwater barriers or far away to protect the coast i. The wall exposed to the waves is equipped with mobile gates which, opening with the push of the wave water, allow entry into the wave water basin but prevent its exit. Water accumulates in the tank which must be immediately poured back into the sea.

Throughout the process, energy production occurs cumulatively in three ways:

- Taking advantage of the transfer flow of the water accumulated in the tank;
- Taking advantage of the movement of the mobile gates:
- Taking advantage of the water hammer that is generated within the mass of water in sudden movement inside the tank.

Results: We conservatively believe that a module 50 meters long and 10 meters wide can produce 5,500 MWh/year

Conclusion:

the SEWAT project:

- Reflects numerous Sustainable Development objectives of the UN 2030 Agenda (7 - 1 - 9 - 12 - 14);
- Falls within the field of clean technologies due to the absence of waste and CO_2;
- It is free from risks for the environment and the community;

Ultimately it is a simple and non-invasive solution to very complex problems.

Biography

Giulio Teodoro MAELLARO was born in Brindisi (Italy) in 1955. He graduated in mechanical engineering from the University of Padua (Italy). He was an officer in the technical services corps of the Italian army in the motorization sector. He taught thermotechnics and heating systems in industrial technical institutes. At the “Carnaro” Nautical Institute in Brindisi he taught marine machinery, on-board technical systems and mechanical technology. Expert in sustainable energy and energy transformations. Freelance designer engineer in the construction, plant engineering and energy saving fields. Convinced advocate of the need to immediately implement the energy transition. He created the SEWAT (Sustainable Energy by Waves Trap) device to obtain sustainable energy from sea waves

DUAL-ACTION COATINGS FOR IMPLANT FAILURE PREVENTION IN TEMPORARY MAGNESIUM-BASED ORTHOPAEDIC IMPLANTS

Isabel Sousa

DEMaC/CICECO, University of Aveiro, Portugal

Abstract

Background: The need for artificial implantable devices is increasing daily, due to fractures too complex for external treatment, caused by ageing and trauma. Biomaterial implants have emerged as an attractive approach due to their ability to be gradually dissolved and absorbed, avoiding additional surgeries and healthcare associated costs. Albeit its positive impact on population's health, infection and device failure are persistent issues, thus improved biomaterials for the regeneration of bone are still needed to treat an increasing number of bone-related injuries. Among them, Magnesium is most likely suitable due to similar density to natural bone. From a biological point of view, Mg's biocompatibility is due to its key role in human metabolic processes, however, its high degradation rate does not match bone healing time.

Objective: Development of hybrid organic-ceramic coatings fitted for magnesium-based temporary implants, to simultaneously control implant degradation (by corrosion) and provide antibacterial action by exploring the dual-action of fluoroquinolone antibiotics.

Methods: Natural-based microspheres were prepared through water-in-oil microemulsions and/or spray-drying, incorporated in polyetherimide coatings and deposited on hydroxyapatite coated Mg1Ca alloys and tested to their corrosion protection.

Results: Preliminary studies carried out for Mg1Ca alloys reveal that the addition of a hydroxyapatite pretreatment, followed by a polymeric coating containing microspheres leads to a greater resistance to corrosion. Preliminary release studies performed suggest that a small amount of levofloxacin was successfully incorporated into the microspheres, which contributes to their possible application in controlled delivery of anti-bacterial drugs to tackle implant-related issues.

Conclusion: Natural-based spheres were successfully prepared and incorporated into polyetherimide coatings. Release studies point out the need for a more efficient crosslinking but nevertheless a better control of Mg1Ca degradation was achieved in the presence of a hydroxyapatite and a microsphere-loaded polymeric coatings.

Biography

Isabel Sousa expertise lies on the development of nano and microstructured materials for the controlled release of active species, corrosion studies, coatings and fluoroquinolones. Her research has focused, mainly, on encapsulation for a wide range of applications: from drug delivery systems to corrosion protection/sensing. A desire to provide solutions to solve problems arisen from surgery and implantation grew and, in the past years, she began to explore of new alternatives for active species-controlled release and development of new coatings for degradation control of biodegradable materials of biomedical application such as Mg alloys. She won the "Best pitch" award at the 1st CICECO Hackathon on product development based on the topics of her research. Recently she was invited, along with Dr. Beatriz Mingo (University of Manchester) to write a feature article for Materials World (IO3M magazine) to be published in their June edition.

Day-1
Poster Presentations

EXPERIMENTAL AND COMPUTATIONAL STUDIES OF CRYSTAL VIOLET REMOVAL FROM AQUEOUS SOLUTION USING SULFONATED GRAPHENE OXIDE

Olayinka Oluwaseun Oluwasina, Adedeji Adebukola Adelodun, Olugbenga Oludayo Oluwasina, Helio Anderson Duarte and Sunday Joseph Olusegun

The Federal University of Technology Akure, Nigeria

Abstract

Positively charged contaminants can be strongly attracted by sulfanilic acid-functionalized graphene oxide. Here, sulfonated graphene oxide (GO-SO_3H) was synthesized and characterized for cationic crystal violet (CV) adsorption. We further studied the effect of pH, initial concentration, and temperature on CV uptake. The highest CV uptake occurred at pH 8. A kinetic study was also carried out by applying the pseudo-first-order and pseudo-second-order models. The pseudo-second-order's adsorption capacity (qe) value was much closer to the experimental qe (qe_{exp}:0.13, qe_{cal}:0.12) than the pseudo-first-order model (qe_{exp}:0.13, qe_{cal}:0.05). The adsorption performance was accomplished rapidly since the adsorption equilibrium was closely obtained within 30 minutes. Furthermore, the adsorption capacity was significantly increased from 42.85 to 79.23%. The maximum adsorption capacities of GO-SO_3H where 97.65, 202.5, and 196.2 $mg{\cdot}g^{-1}$ for CV removal at 298, 308, and 328 K, respectively. The Langmuir and Freundlich adsorption isotherms were applied to the experimental data. The data fit well into Langmuir and Freundlich except at 298 K, where only Langmuir isotherm was most suitable. Thermodynamic studies established that the adsorption was spontaneous and endothermic. The adsorption mechanism was revealed by combining experimental and computational methods. These findings suggest that GO-SO_3H is a highly adsorbent for removing harmful cationic dye from aqueous media.

Biography

Olayinka O. Oluwasina completed her Ph.D. in 2020 from the prominent University of KwaZulu-Natal, South Africa. She is a Lecturer at The Federal University of Technology, Akure, Nigeria. She has proven to be resourceful with an astonishing enthusiastic drive for positive change in applied material science to marine pollution remediation, with a keen interest in adsorption, ocean acidification, and data science. In her brief time of research so far, she has won various awards to her credit. Her research interest focuses on synthesizing and functionalizing graphene oxide to clean up polluted coastal waterways and ensure potable water.

DEVELOPMENT OF A CRITICAL TIME-TEMPERATURE INDICATORS (CTTI) USING THERMOSENSITIVE COPOLYMERS WITH TUNABLE LCST

Seung Eun Lee, Seung Ju Lee and Seung Won Jung

Dongguk University, Republic of Korea

Abstract

Thermosensitive polymers that exhibit phase transition in response to temperature change can be used as materials for cTTI because they can control hydrophobic gel shrinking force depending on the critical temperature. Thermosensitive copolymers with the various comonomer compositions composed of N-isopropylacrylamide (NIPAAm) with acrylic acid (AAc), vinylsulfonic acid (VSA), polyethylene glycol (PEG) and glycerol (GCL) were prepared by free radical copolymerization with methylenebis acrylamide as crosslinker and ammonium peroxodisulfate as initiator. The copolymers were swollen significantly at lower than lower critical solution temperature (LCST) but shrunken at above the LCST. This may be attributed that comonomer weakens the hydrophobic gel shrinking force as the hydrophilic comonomer. The swelling ratio of these copolymers were poly(NIPAAm-co-AAc) > poly(NIPAAm-co-VSA) > poly(NIPAAm-co-PEG) > poly(NIPAAm-co-GCL) in decreasing order. Also, the LCST was observed in same order. These results suggested that the produced copolymers prepared in this study could have high potential for application in cTTI materials of time exceeding a certain temperature.

FROM SEA URCHINS WASTE TO TISSUE REGENERATION: INNOVATIVE COMPOSITE BIOMATERIALS

Giordana Martinelli

University of Milan, Italy

Abstract

Background: Sea urchins, as marine organisms, present a reservoir of valuable compounds also holding promises for biomedical applications. Their unique anatomical and physiological adaptations, particularly specialized connective tissues such as Mutable Collagenous Tissues (MCT), offer interesting avenues for collagen-based biomaterials development. Additionally, sea urchins possess antioxidant secondary metabolites, polyhydroxynaphtoquinones (PHNQs), a class of polyphenolic pigments with a potent free-radical scavenging activity, found within their test and spines, further enhancing their biomedical significance.

Objective: In a circular economy context, the focus of this work was to process the food waste from edible sea urchins, which constitutes up to 90% of their mass, targeting added value compounds, namely collagen and PHNQs. Composite biomaterials, rich in both polyphenols and collagen, were developed and extensively characterized to assess their suitability for skin regeneration.

Methods: From the waste, fibrillar collagen was successfully extracted from the peristomial membrane1,2 while polyhydroxynaphtoquinones were separated from the test and spines[3]. Subsequently, collagen and antioxidants were combined to produce composite biomaterials, characterized for their ultrastructure (by SEM), degradation kinetics (in both physiological and enzymatic conditions) and antioxidant release capacity (by ABTS assay). Its regenerative potential was tested by using an ex vivo rat skin wound healing model.

Results: Results indicate that these composites closely resemble pure collagen-based materials in terms of ultrastructure, exhibiting a homogeneously porous architecture without visible aggregates. Importantly, they exhibit enhanced stability compared to conventional collagen-based and UV-crosslinked biomaterials. Furthermore, the presence of PHNQs within the collagen matrix enhances the biomaterials antioxidant properties, crucial for potential tissue repair applications. Indeed, biomaterial-treated wounded skin showed a better improvement of regeneration based on histological and molecular observations.

Conclusion: In conclusion, our findings highlight the comprehensive utilization of sea urchin waste for extracting valuable molecules and developing innovative, multifunctional biomaterials for skin regeneration.

Biography

Giordana Martinelli is currently a PhD researcher at the Department of Environmental Science of the University of Milan. She graduated in pharmaceutical biotechnology with an experimental thesis regarding the chemical synthesis and chemical characterization of peptides. The main purpose of her research is to develop innovative biomaterials from sea urchins waste aimed to the valorization of these products for regenerative medicine for skin regeneration. The activities involve their chemical, analytical and biological characterization.

COMPARATIVE EVALUATION OF SEA URCHIN WASTE AS A SUSTAINABLE SOURCE OF BIOACTIVE COLLAGEN-BASED BIOMATERIALS

Margherita Roncoroni
University of Milan, Italy

Abstract

Background: Composite biomaterials made from sea urchin's unique collagen and antioxidants (namely polyhydroxynaphthoquinones; PHNQs), have recently been developed in our laboratory to fully valorise sea urchin food waste discarded by restaurants and processing industries. Following a circular economy approach, the protocols were first optimised starting from the waste of *Paracentrotus lividus*, the most common edible species in the Mediterranean Sea.

Objective: As numerous species of sea urchins, other than *P. lividus*, are marketed worldwide for gonad consumption, we aimed to explore the possibility of producing sustainable collagen-based biomaterials by extracting antioxidants (from sea urchin tests and spines) and collagen (from the peristomal membrane) from other edible sea urchin species that make up the global waste, particularly *Sphaerechinus granularis*.

Methods: We conducted a separate comparative study of PHNQs, collagen and collagen-based biomaterials obtained from *Paracentrotus lividus* and *Sphaerechinus granularis*. PHNQs were extracted, identified, and quantified (by Ultra Performance Liquid Chromatography coupled to Photodiode Array Detection and Electrospray Ionization-High Resolution Mass Spectrometry; UPLC-PDA-ESI-HR-MS). Their antioxidant activity was evaluated (ABTS assay). Collagen extraction was performed, and yields were compared. Subsequently, collagen-based biomaterials were prepared and evaluated for their ultrastructural features (by SEM), degradation kinetics (in physiological solution and collagenase) and mechanical resistance to compressive stress.

Results: The PHNQs profile was partially similar in both species, while the PHNQs yield was significantly higher in *P. lividus*, the antioxidant activity was higher in *S. granularis*. The collagen-based scaffolds showed similar ultrastructural features. *S. granularis* scaffolds had denser pores and larger collagen fibrils, resulting in higher stability.

Conclusion: Overall, this study highlights the potential for successful and sustainable production of bioactive collagen-based biomaterials using waste from different edible sea urchin species. Differences in antioxidant activity of PHNQs or scaffold properties may lead to different applications to diversify the use of biomaterials from different species in biomedicine.

Biography

Margherita Roncoroni is a biologist currently working at the Department of Environmental Science and Policy, University of Milan (Italy), on projects such as "Circular" and "Brites", which aim to fully recycle a food by-product, namely sea urchin waste from the food industry (restaurants and seafood companies) and transform it into innovative and diversified products for specific applications. These products include collagen-based biomaterials (skin substitutes) for skin regeneration applications, bioactive molecules such as antioxidant pigments, and novel calcium and antioxidant feed supplements for animal farming, particularly for layer hens.

FLEXIBLE THERMOELECTRICS BASED ON 3D INTERCONNECTED MAGNETIC NANOWIRE NETWORKS

T da Camara Santa Clara Gomes, N Marchal, F Abreu Araujo and L Piraux
UCLouvain, Belgium,

Abstract

3D networks of ferromagnetic (FM) nanowires fabricated by direct electrodeposition into the crossed nanopores of polymer templates are effective thermoelectric materials. The interconnected nanowire networks are formed from pure metals, alloys, and FM/Cu multilayers. Giant magneto-Seebeck effects in multilayer nanowires allow the determination of key parameters in spin caloritronics such as spin-dependent Seebeck coefficients and can be exploited to design flexible thermoelectric switches with optimal magnetic fieldinduced control of the sign and magnitude of the thermoelectric power output. Homogeneous nanowire arrays exhibit extremely high thermoelectric power factors that make them effective materials as flexible active Peltier coolers for thermal management of hot spots.

TUNING THE STRUCTURE-FUNCTIONAL RELATIONSHIP WITHIN PEPTIDE-MIMICKING ANTIMICROBIAL HYDROGELS

Samuel Attard
University of New South Wales, Australia

Abstract

Background: The Centers for Disease Control and Prevention defines antibiotic resistance as “bacteria evolving to dimmish and/or abolish the effectiveness of antibacterial agents”, threatening the most important discovery in the history of medicine. It is estimated that the U.S. death rate due to antimicrobial resistance calculated to be approximately 10,000,000 million by the year 2050, including skin and surgical site infections.

Objective: To synthesise anthranilamide-based hydrogels with antimicrobial activity, measure hydrogelation capacity, mechanical strength, and antibacterial activity.

Methods: Peptide-mimicking hydrogels were synthesised from an isatoic anhydride starting material over 5-7 steps. Hydrogels were made up in water (1% w/v) with 5 eq. NaCl using heat as a trigger. Hydrogel mechanical properties were measured using rheological studies, including frequency and strain sweeps. AFM images of the 3-D fibrous networks were obtained from xerogels. Secondary structures of fibres were measured using circular dichroism. The minimum inhibitory concentration of antibacterial activity was measured by layering a bacterial solution on top of the hydrogel, diffusing the fibres into a solution of water, followed by measuring of activity against both *Escherichia coli* and *Staphylococcus aureus*. Cytotoxicity studies were measured against HEK239T cells.

Results: Bromine atoms in the 5’ position of the anthranilamide ring and 2’ biphenyl aromatic caps did not form hydrogels, while hydrogen atoms in the 5’ position, and 3’ and 4’ biphenyl aromatic caps did. A positive correlation was observed between decreased conformational isomers and increased mechanical strength. Hydrogelating compounds all showed moderate-good activity against S. aureus & E. coli. Hydrogels showed moderate-low toxicity against HEK293T cells.

Conclusion: The mechanical strength and gelation properties of peptide-mimicking anthranilamide hydrogels can be tuned through the aromatic cap of the hydrogel. This evidence suggests that a balance of polarity needs to be maintained. Hydrogels showed moderate-good antimicrobial activity (MIC < 200 μM) against *E. coli* and *S. aureus*. Future work will aim to strike an improved balance between cationic charge and hydrophobicity, as well as incorporate nitric oxide donors for improved bactericidal and antibiofilm activity.

Biography

Samuel Attard has his expertise in organic synthesis and medicinal chemistry, with a passion for improving the health and wellbeing of society through treating disease. His broad knowledge in a multidisciplinary field, with strong foundations in organic chemistry, material science and microbiology highlights new avenues of treatment for furthering the antimicrobial field of study. Following an honours project in the development of novel inhibitors of the bacterial β-sliding clamp through organic synthesis and molecular modelling, he is currently aiming to improve the anthranilamide scaffold through the work of his PhD, in which he is in his third year. The foundation is based on previous work of the Kumar group (V. Aldilla & R. Kuppusamy, 2018-2022) utilising previous generations of chemical analogues for comparisons in antibacterial activity and hydrogelating factors.

CATEGORIZING / TESTING BIOMATERIALS, A MAJOR CHALLENGE FOR VALEO LIGHTING SYSTEMS / LIGHT DIVISION

Laurent BARRE

Valeo Lighting Systems, France

Abstract

Background: Automotive strives to provide renewable material solutions, encompassing structural and aspect parts. Given that aesthetics and safety are at stake, biomaterials are seriously considered to become part of the automotive materials portfolio. In order to “dispel the mist” surrounding the over-arching structure of so-called biomaterials, one needs to address proper definitions and naming prior to investigating key properties for specific applications, especially so since no analytical means to trace back batches’ origins and contents will bring any insight into materials composition and behaviour.

Objective: To propose a breakdown of biomaterials subcategories and to provide insights into matching properties between such categories and lighting primary parts.

Methods: Cross checking of categories already initiated globally in automotive and proposing original breakdown of classification to better match intrinsic properties and targeted requirements for automotive optical systems. Employing some key evaluation results (environmental, structural and perceived quality criteria) to build a list of risks for primary failures pertaining to the proposed classification. Distinguishing between stream types, molecular builds and mixes also represents a key interest so as to pre-empt material failure modes within their potential lifespans. Foreseen overlapping categories between biomaterials and mechanically recycled resin to increase renewable carbon rates is also briefly addressed.

Results: Biomass-balance drop-in solutions are deemed to be the most fit to replace historical resin families, while hybrid or fully biobased materials display strong sensitivity to environmental constraints due to atomic composition, and composites of classical resins with natural fibers display processing and end-of-life limitations to recovery.

Conclusion: Short-term replacement of resins for safety and aspect parts need to rely on drop-in solutions, while mid to long term solutions may be devised from original biomaterial structures or composite blends.

Biography

Laurent BARRE graduated from Southampton University, in Polymer Physics in 2004. He works for VALEO LIGHTING SYSTEMS since 2005 and is recognized for his senior expertise over organic materials, and their shaping processes and product performances.

FOOD-BASED BIOMATERIALS: pH-RESPONSIVE ALGINATE/GELLAN GUM/CELLULOSE HYDROGEL BEADS FOR LACTOFERRIN DELIVERY

Lin Cao

Ghent University, Belgium

Abstract

The present study utilizes a combination of sodium alginate (Alg), gellan gum (GG), and sodium carboxymethyl cellulose (CMC) to fabricate a ternary composite hydrogel system with the aim of encapsulating and releasing lactoferrin (LF). Rheological properties as well as extensive microscopy and spectroscopy characterization are performed on these materials demonstrating that the physical properties of the resultant hydrogels, such as particle size, water content, gray value, and shrinkage rate were related to the concentration of Alg. In addition, most of these hydrogels were found to have reticulated shells and inner laminar structures assembled based on hydrogen bonding and electrostatic forces. Furthermore, the encapsulation efficiency of LF in hydrogels ranged from 78.3 ± 0.33 to 81.43 ± 3.06 %. Notably, a small amount of encapsulated LF was released from the hydrogel beads in an acid environment (up to 2.16 ± 0.34% in 2 h), while a controlled release manner was found to take place in an alkaline environment. This phenomenon indicated the potential of these hydrogels as promising matrices for LF loading and adsorption. The release mechanism varied from Alg concentration suggesting the tunable and versatile properties of this ternary composite hydrogel system. Our findings identify the potential of Alg-GG-CMC hydrogel as a delivery system suitable for various applications in the food industry.

Background: The food industry has made substantial investments in the creation of fortified products containing bioactive compounds such as minerals, vitamins, proteins, and nutraceuticals, as this is in response to the growing consumer awareness and interest in health and well-being. Nonetheless, a significant portion of these active constituents exhibit susceptibility to various processing and storage conditions, leading to diminished stability and solubility, sensitivity to light and pH, and reduced bioavailability. To address these issues, hydrogels designed with specific biopolymers were employed to protect bioactive substances, improve their functional properties, and control their stability, retention, and release within target sites.

Objective: To fabricate Alg-GG-CMC ternary composite hydrogel beads with varying concentrations of Alg and assess their capability to encapsulate LF.

Methods: The preparation of diverse composite hydrogel beads involves ionic cross-linking bonds. The rheological properties of polysaccharide solutions, physical characteristics, microstructural analysis, as well as molecular interactions of the hydrogel beads were evaluated. After LF was encapsulated, encapsulation capacity, structural analysis, and in vitro simulated digestion assay of these LF-loaded hydrogel beads were determined.

Results: The physical properties of these Alg-GG-CMC ternary composite hydrogel beads including particle size, water content, gray value, and shrinkage rate were in a proportional relation to the concentration of Alg. The Alg/GG/CMC blended system was characterized with the non-Newtonian fluids, while the composite system exhibited Newtonian behavior accompanied by reduced viscosity when the concentration of Alg reached 15 $mg \cdot mL^{-1}$. The Alg-GG-CMC hydrogel beads displayed reticulated shell structures, facilitating the storage of bioactive ingredients inside. Predominant interactions within the hydrogel beads involved hydrogen bonding and electrostatic forces. Furthermore, these Alg-GG-CMC composite hydrogel beads demonstrated exceptional efficacy in safeguarding LF under challenging environmental conditions and in controlling its release within the intestinal environment, performing remarkable pH sensitivity.

Conclusion: The distinct hydrogel combination of Alg, GG, and CMC identified in this work holds substantial potential as a delivery platform for a broad range of applications including those in biomedicine, where broader application of food industry products is seen as particularly beneficial.

Biography

Lin Cao received her M.S. degree in Food Science and Engineering from the National Engineering Research Center of Seafood at Dalian Polytechnic University, China. Her academic journey has been characterized by a keen focus on interdisciplinary research at the interface of food science, engineering, and biotechnology. Currently, she is dedicated to advancing her knowledge and expertise by pursuing a Ph.D. degree in the Biotechnology faculty at Ghent University, Belgium. Her research interests encompass a diverse array of topics within the realm of nanomaterials and organic-inorganic hybrid hydrogels. She is particularly intrigued by their potential applications in biology and food science, aiming to harness their unique properties for various purposes.

STUDY OF CERAMIC COATINGS AS A NOVEL RADIATION RECEIVER ON FURNACE BUILDING MATERIAL USING THERMAL SPRAYING TECHNIQUE

Wu-Han Liu[1], Po-Min Chung[2], Wei-Tien Hsiao[3] and Ming-Sheng Leu[4]
Industrial Technology Research Institute, Taiwan

Abstract

Background: It is well known that iron and steel production are major sources of carbon emissions. The building materials for electric furnaces must provide high temperature and arcing resistance. These materials also need to bond well with the cooling carbon steel lines surrounding the furnace. In fact, due to the lack of adequate refilled building materials during mass steel production, these lines frequently require maintenance to withstand high temperatures and severe thermal shocks from molten steel. To improve the properties of carbon steel lines, various radiation receiver and thermal barrier coatings have been deposited using thermal spray processes.

Objective: To examine the relationship between radiation emission and reflectance of zirconia with addition of $MoSi_2$ in basic electric arc furnace steel plant.

Methods: Four different ZrO_2 ceramic compacts with varying $MoSi_2$ content (0%, 5%, 10%, and 20% by weight) were mixed using a 3D mixer and then deposited using plasma spraying technology. UV-VIS-NIR diffuse reflectance spectra were recorded at room temperature (240-2600 nm). Radiation emissivity of coatings was measured at high temperatures (500-700°C) with wavelengths ranging from 0.6 to 30 µm using a radiation sensor (TD-8533, Pasca). Coating analysis was performed using SEM and XRD.

Results: Light black ZrO_2-$MoSi_2$ composite coatings were fabricated via plasma spraying, whereas pure ZrO_2 coatings displayed a slight yellow coloration. SEM and XRD analyses revealed that the composite coatings contained ZrO_2 within $MoSi_2$ solid solution. The optical reflectance value of ZrO_2 coatings decreased significantly with an increasing $MoSi_2$ content. The peak at 460 nm exhibited a significant blue shift towards a shorter wavelength (440 nm). Emissivity of the ZrO_2 coatings increased with higher $MoSi_2$ content, ranging from 0.79 to 0.93.

Conclusion: The addition of $MoSi_2$ to ZrO_2 coatings enhances radiation emission. The light black composite coatings investigated demonstrated sufficient reflectance across almost the entire UV-VIS-NIR range.

Biography

W.H. Liu has held the position of scientific researcher at Industrial Technology Research Institute (ITRI). ITRI is a world-class applied R&D institute located in Taiwan. He also has over 20 years of experience in the thermal spray industry in various project leader positions, covering areas in improving functional properties of coating, for example, anti-wear, and anti-corrosion and high hardness, etc. The topic of his PhD dissertation was focused on AZO photocatalytic coating deposited by plasma thermal spraying (2017). Other previous area for iron-based hard coatings was based on modified feedstock powder to enhance their wear and corrosion resistances. His current research focuses on reduce of environment thermal field for energy conservation and carbon reduction issue.

Day-2
Keynote Presentations

NICKEL-ZINC FERRITE AND GRAPHENE NANOPLATELET-ENHANCED EPOXY HYBRID NANOCOMPOSITES

Sahrim Ahmad

Universiti Kebangsaan , Malaysia

Abstract

Epoxy is a widely used synthetic polymer in composite manufacturing due to its excellent mechanical, thermal, chemical, and corrosion resistance properties. However, its brittleness and low fracture toughness limit its applications. Adding liquid epoxidized natural rubber (LENR) can enhance the toughness and strength of epoxy resins. Studies have shown that optimal mechanical strength is achieved at a 3% weight addition of LENR, although this reduces the crystallization rate of the epoxy resin. This study aimed to produce and characterize a nanocomposite toughened rubber filled with nickel-zinc (NiZn) ferrite and graphene nanoplatelets (GNP) to improve the mechanical, thermal, and electrical properties compared to composite epoxy/LENR. The addition of these nanoparticles significantly enhanced the mechanical properties at low filler loadings. Specifically, the mechanical strength of epoxy/LENR/NiZn ferrite nanocomposites increased with NiZn ferrite, achieving optimal strength at 4% weight of NiZn ferrite and 0.6% weight of GNP. Thermal stability improvements were observed in all nanocomposites produced. Electrical conductivity was higher in epoxy/LENR/GNP-NiZn ferrite compared to epoxy/LENR/NiZn ferrite and epoxy/LENR/GNP alone. The nanocomposites transitioned from insulators to semiconductors when 4% weight of NiZn ferrite and 0.4% weight of GNP were added. The study also found that the addition of NiZn ferrite increased the magnetic interaction within the nanocomposites, as evidenced by increased saturation magnetization (Ms) and remanence magnetization (Mr). The hybridization of NiZn ferrite and GNP successfully improved the mechanical, thermal, electrical, and magnetic properties of the nanocomposites

Biography

Sahrim Ahmad obtained his PhD from University of Loughborough, United Kingdom in 1988. He is an expert in the field of magnetic, nanocomposites and advanced materials. He has completed more than 60 research projects and consultancy work as a leader and co-researcher. His work on novel radar absorbing materials (RAM) subjected to transverse electromagnetic (TEM) has been successfully developed. His team managed to produce products that offered proper characteristics for handling, flexibility and lightweight, meeting requirement for various applications. He has published more than 250 papers in various journals related to polymer, composites, materials and supervised more than 60 PhD students. Dr Sahrim was former Dean of Faculty Science of Technology and Editor In Chief of Journal Sains Malaysiana (ISI/WOS). Currently he is the Fellow Academy of Science Malaysia. Fellow Academy Profeesor Malaysia and Fellow of Malaysia Solid Science Society.

AN ENVIRONMENT-FRIENDLY NA0.4K0.1BI0.5TIO3 CERAMIC FOR DIRECT REPLACEMENT OF PZT-BASED CERAMICS IN MULTIPLE APPLICATIONS

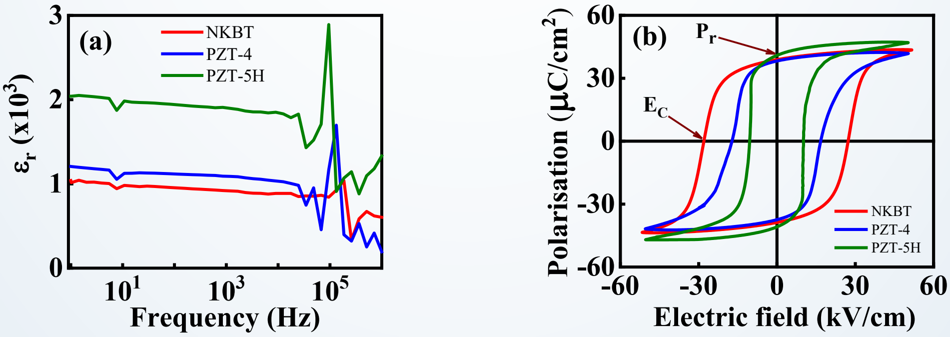
Ajit R Kulkarni, Pravin Varade and N Venkataramani

Indian Institute of Technology-Bombay (IIT Bombay), India

Abstract

The availability of advanced materials has enabled the development of new gadgets for household appliances, automobiles, and strategic/smart devices. In the race for such developments intertwined with commercial gains, toxicity of the component elements and resultant materials became secondary. One such example is the advent of Pb-based piezoelectric materials with its inherent toxicity effect on humans and the environment. In the functionality of inter-converting mechanical and electrical energy, commercially established piezoelectric materials mainly PZT address a wide range of applications - actuators, sensors, transducer. Significant efforts have been directed in recent times towards eliminating lead from piezoelectric ceramics. However, to date, the best lead-free piezo ceramics synthesized in the research laboratories have not yielded compositions with useful piezoelectric properties that may readily replace the well-established commercial compositions of PZT. Thus, the problem of Pb pollution during fabrication, use and disposal lingers on.

In the present work, our efforts are focused on developing Pb-free piezoelectric material with properties matching closely with that of PZT and identifying the figure of merit for non-resonant applications similar to that of a PZT composition, for a direct and easy replacement of lead-based elements in existing devices, without entailing any other design changes and fabrication protocols. We have successfully demonstrated such one-to-one replacement in spark igniter and piezo buzzers and outlines other potential devices.



Comparison of room temperature data, (a) Dielectric constant; (b) PE hysteresis loops of NKBT, PZT-4 and PZT-5H ceramics.

Biography

Ajit Kulkarni is an emeritus Fellow at IIT Bombay. For the last 35 years he was involved in Teaching, research and administration. He has taught several materials science and engineering courses to undergraduate and post graduate students, has supervised 35 Ph. D. students and has completed a large number of externally funded projects. His current interest includes materials for electrical properties of materials, lithium batteries, impedance spectroscopy for materials characterization and environment friendly Ferro and piezo ceramics. He has eight granted patents on electro-ceramics and defective ZnO quantum dots.

Day-2
Oral Presentations

CHEMICALLY IDENTICAL HYDROGELS WITH DISTINCT MECHANICAL PROPERTIES

Xingjian Sun
Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

Abstract

Background: Do materials prepared from identical compositions of constituting ingredients always exhibit similar mechanical properties? The answer is negative for most structural materials, as has been demonstrated by extensive studies on various factors such as the effects of processing and microstructures. However, the same question has seldom been addressed in the case of polymeric gels.

Objective: The current study aims at addressing the fundamental questions: Do gels of identical chemical composition exhibit similar mechanical properties? If not, how are they affected by the initial synthesis condition and/or manufacture processes?

Methods: In this work, through carefully controlled experiments, a set of gel samples are synthesized by curing from precursor solutions of identical solutes but different amounts of water, and swollen/deswollen into identical chemical compositions., the mechanical properties, including elastic stiffness, fracture toughness, and fatigue threshold, of gels with identical chemical compositions are then systematically investigated.

Results: The distinct material properties are rationalized and quantitatively correlated to synthesis conditions and manufacture processes through scaling laws derived from basic physics. Different scaling laws are identified between samples prepared from swelling and deswelling. Extreme mechanical properties, such as the remarkable fracture energy of hydrogels prepared by deswelling from highly swollen samples, are observed and attributed to the structural characteristics of the polymer network, and further correlated to the synthesis processes.

Conclusion: In the current study, through carefully planned systematic experiments, it is observed that PAAm hydrogels of identical chemical compositions can exhibit distinct mechanical properties, which are highly dependent on their initial synthesis conditions and further swelling/deswelling processes. This study provides insights into the synthesis-property correlations of polymeric gels, which may have profound influences on the design of new polymeric materials and their applications in various fields.

Biography

Xingjian Sun has his expertise in the study of the structure-property correlations of polymeric gels. His theoretical scaling models based on classic rubber elasticity and polymer physics create new pathways for improving the mechanical properties of new soft material like hydrogels. He has built this model after years of experience in theoretical and experimental study. The foundation is based on the classic scaling theories of de Gennes and the polymer chain configuration theories in polymer physics. This structure-property correlation model accurately characterizes the relations between the mechanical properties of hydrogels and the polymer networks structures. The model has profound influences on the development of new soft materials and promotes the applications of soft materials in many scientific fields.

EXPLORING THE POTENTIAL OF $CsPbBr_3$ PEROVSKITE SOLAR CELLS: EXPERIMENTAL AND THEORETICAL INVESTIGATIONS

Amina Laouid[1], Amine Alaoui Belghiti[2], Krzysztof Wisniewski[1,2], Przemysław Płóciennik[1,2], Abdelowahed Hajjaji[2] and Anna Zawadzka[1]

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[2]Chouaib Doukkali University of El Jadida, Morocco

Abstract

This study investigated the potential of all inorganic $CsPbBr_3$ perovskite solar cells through a combined experimental and theoretical approach. $CsPbBr_3$ thin films of 700 nm as thickness were successfully fabricated using physical vapor deposition (PVD), and their structural, optical, and optoelectronic properties were extensively characterized. Atomic force microscopy revealed smaller, sharper, and more uniformly distributed nanograins, impacting surface roughness which can influence device performance. Optical studies demonstrated high transparency in the visible/near-infrared regions and a suitable bandgap of ~2.3 eV for efficient light absorption. Photoluminescence analyses unveiled the radiative recombination behavior and charge carrier dynamics within $CsPbBr_3$, providing insights into its optoelectronic properties. Complementing experiments, SCAPS-1D simulations optimized the device structure by determining ideal thicknesses for charge transport layers, absorber layer, and metal work functions in order to enhance the power conversion efficiency. Based on optimized parameters, a $CsPbBr_3$ perovskite solar cell with ITO/SnO_2/$CsPbBr_3$/Spiro-OMeTAD/Au architecture was fabricated via PVD, exhibiting a promising 14.42 % efficiency. The agreement between experimental and simulated results validated the theoretical models, highlighting the synergy of combined experimental-theoretical approaches. This study advances understanding of $CsPbBr_3$ perovskites, paving the way for potential commercialization in renewable energy. Future research can focus on further improving efficiency, and stability, exploring alternative architectures, and addressing manufacturing scalability challenges to unlock the full potential of this photovoltaic technology.

Background: Perovskite solar cells (PSCs) have appeared as an advantageous photovoltaic technology due to their high efficiency, low cost, and ease of fabrication. These characteristics have positioned PSCs as strong competitors in the quest for sustainable and renewable energy sources. The quick advancements in PSC technology have been conducted by the unique properties of perovskite materials, which exhibit excellent light absorption, charge-carrier mobility, and tunable bandgaps. Among the various perovskite materials, all-inorganic cesium lead bromide ($CsPbBr_3$) has achieved significant attention for its excellent thermal and moisture stability compared to organic-inorganic hybrid perovskites. This stability is crucial for the long-term performance and durability of solar cells, particularly under real world operating conditions where exposure to heat and humidity can degrade the material. $CsPbBr_3$ has an appropriate bandgap of around 2.3 eV, making it an attractive candidate for single junction or tandem solar cells. The bandgap of $CsPbBr_3$ is well matched to the solar spectrum, allowing for efficient absorption of sunlight and conversion into electrical energy. This characteristic not only enhances the power conversion efficiency of the solar cells but also makes $CsPbBr_3$ an adaptable material for various photovoltaic applications. In single-junction solar cells, $CsPbBr_3$ can be used as the primary light-absorbing layer, while in tandem solar cells, it can be paired with other materials to capture a broader range of the solar spectrum, thereby boosting overall efficiency. Moreover, the all-inorganic nature of $CsPbBr_3$ eliminates the issues associated with the organic components in hybrid perovskites, such as volatility and chemical instability. This makes $CsPbBr_3$ based PSCs more robust and reliable, potentially reducing the need for encapsulation and other protective measures. The combination of high efficiency, stability, and ease of fabrication positions $CsPbBr_3$ as a leading material in the next generation of photovoltaic technologies, with the potential to significantly impact the renewable energy landscape.

Objective: The objective of this work is to comprehensively investigate of $CsPbBr_3$ perovskite solar cells (PSCs) through experimental and theoretical approaches. It involves characterizing $CsPbBr_3$ thin films prepared by physical vapor deposition (PVD), evaluating solar cells fabricated with inorganic charge transport layers, and conducting theoretical investigations to optimize efficiency and stability. By synthesizing experimental and theoretical findings, the aim is to contribute to the understanding and development of $CsPbBr_3$ based PSCs, facilitating their potential commercialization and widespread adoption in the renewable energy sector.

Methods: In this work, the physical vapor deposition (PVD) technique with a double source of evaporation was employed to fabricate $CsPbBr_3$ thin films of 700 nm as thickness and the complete device structure under a high vacuum of 10^{-5} Torr.

Atomic force microscopy (AFM) was utilized to examine the morphological properties of the samples. The AFM imaging was performed at room temperature in contact mode using a Nanosurf easy Scan 2 AFM equipped with a SICON-A cantilever microscope.The transmission and absorbance spectra of the samples were measured in the spectral range of 200–1100 nm at normal incidence using a double-beam spectrophotometer (SPECORD 250 PLUS). The Tauc plot method was employed to determine the optical bandgap of the samples.

The emission and excitation spectra of the samples were investigated using the FluoroMax-4 apparatus and the FluorEssence software at room temperature. A xenon lamp was utilized as the light source. The decay time of the samples was determined using the FluoroMax-4 instrument by employing a NanoLED photodiode as the excitation source.

Results: The 3D and 2D atomic force microscopy (AFM) images reveal that the $CsPbBr_3$ thin films exhibit a nanostructured morphology characterized by the formation of smaller, sharper, and more uniformly distributed nanograins **Figure 1**. This nanostructured morphology significantly influences the surface roughness of the $CsPbBr_3$ thin films, which plays a crucial role in determining the optoelectronic properties and device performance.

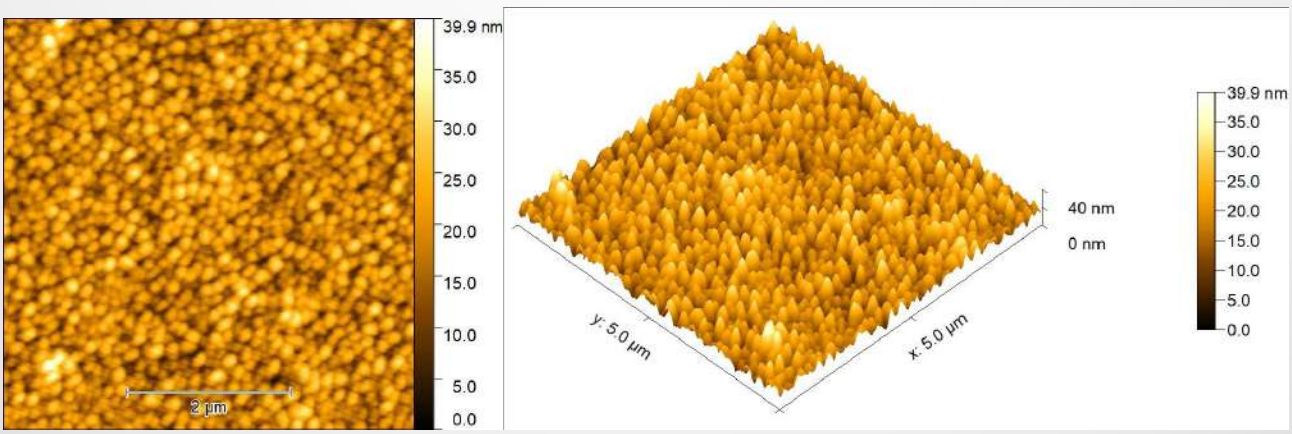

Figure 1: (a) 2D and (b) 3d AFM image (5 µm ×5 µm) of $CsPbBr_3$.

The optical transmittance spectra of $CsPbBr_3$ thin films were measured at room temperature in the wavelength range of 200 to 1100 nm, as depicted in **Figure 2**. The samples exhibited a high transmittance of approximately 70% to 80% in the wavelength range of 500 to 1110 nm, indicating their potential for efficient light absorption and utilization in optoelectronic device.

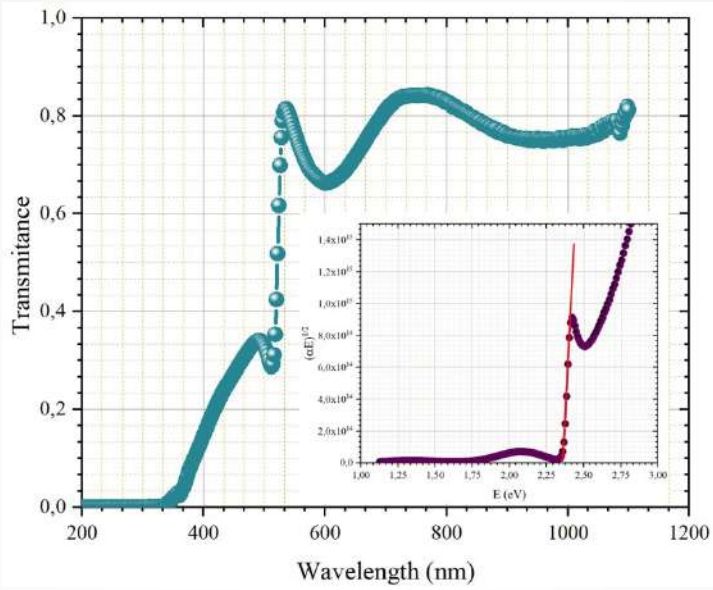

Figure 2: (a) Transmittance spectra $CsPbBr_3$ thin film, and (b) Tauc plot for $CsPbBr_3$ thin film.

The optical bandgap values (Eg) of $CsPbBr_3$ thin films were estimated using the Tauc method, which is applicable for direct allowed transitions, as shown in **Figure 3**. The analysis revealed that the bandgap of the $CsPbBr_3$ thin films was around 2.3 eV, which is consistent with the characteristic bandgap of the $CsPbBr_3$ perovskite material. This bandgap value is well-suited for efficient light absorption and conversion in photovoltaic applications, making $CsPbBr_3$ an attractive candidate for solar cell development.

The combination of high transmittance in the visible and near-infrared regions, along with the appropriate bandgap energy, highlights the promising optical properties of the $CsPbBr_3$ thin films for potential applications in solar energy conversion and optoelectronic devices.

The photoluminescence properties of $CsPbBr_3$ thin films were investigated through spectroscopic measurements conducted at room temperature. **Figure 3** presents a three-dimensional (3D) representation of the excitation and emission spectra of the $CsPbBr_3$ thin film. The emission spectrum exhibits a distinct peak in the green region of the visible spectrum, indicating the characteristic luminescence behavior of the $CsPbBr_3$ material.

The emission spectrum of the CsPbBr3 thin film was obtained for different excitation wavelengths, revealing a broad emission band centered in the green region of the visible spectrum. This emission band is attributed to the radiative recombination of photogenerated charge carriers within the $CsPbBr_3$ perovskite material.

The observed photoluminescence properties of the $CsPbBr_3$ thin films provide valuable insights into their optoelectronic behavior and potential applications in various fields, such as light-emitting devices, optical sensors, and photovoltaic technologies. The emission in the green region of the visible spectrum opens up possibilities for the development of green light-emitting diodes (LEDs) or other optoelectronic devices based on $CsPbBr_3$ perovskite materials.

The lifetime decay of the $CsPbBr_3$ thin film samples was measured at room temperature (300 K) using the FluoroMax-4 spectrofluorometer, which is coupled with the FluoroHub single-photon counting controller. A pulsed diode with an excitation wavelength of 370 nm was employed as the excitation source for these measurements. The choice of the excitation wavelength at 370 nm was specifically selected to match the absorption characteristics of the $CsPbBr_3$ material.

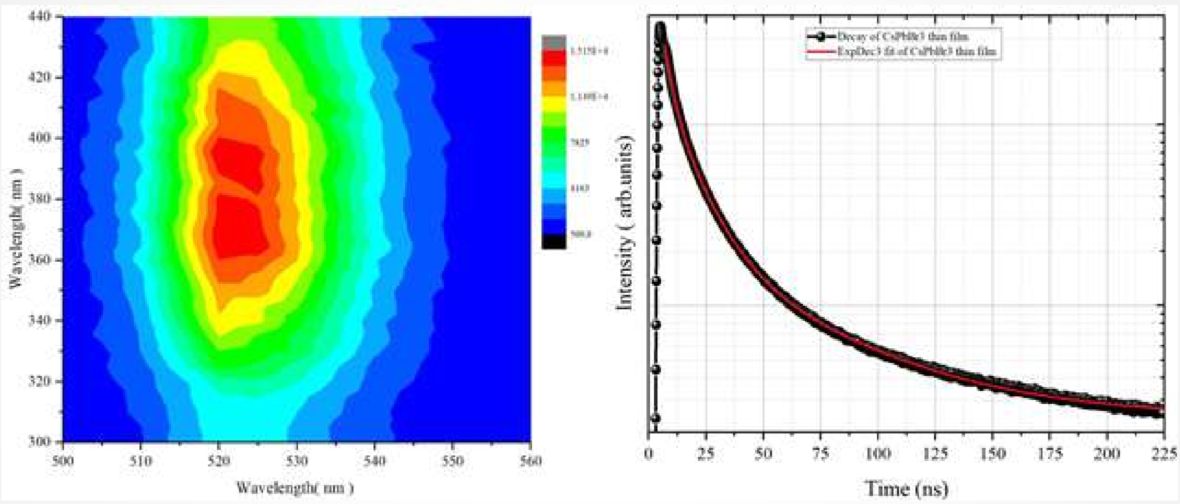

Figure 3:(a) Excitation/Emission of $CsPbBr_3$ thin film, and (b) Decay time of $CsPbBr_3$ thin film.

The photoluminescence decay spectra of all the studied $CsPbBr_3$ thin films exhibited a multiexponential decay behavior, which was best described by a tri-exponential function. To accurately analyze the lifetime decay, the obtained data were fitted using the expdecay3 function. The fitting revealed three distinct decay components with the following time constants: t1 = 11.81 ns, t2 = 3.46 ns and t3 = 50.22 ns. The presence of multiple decay components in the photoluminescence lifetime suggests the existence of different recombination pathways or the involvement of various defect states within the $CsPbBr_3$ thin films. These time-resolved photoluminescence measurements provide valuable insights into the charge carrier dynamics and recombination processes occurring in the $CsPbBr_3$ perovskite material, which are crucial for understanding and optimizing its optoelectronic properties for various applications.

Furthermore, solar cells with the structure ITO/SnO_2/$CsPbBr_3$/Spiro-OMeTAD/Au were fabricated using the PVD method. This device architecture incorporates SnO_2 as the electron transport layer (ETL) and Spiro-OMeTAD as the hole transport layer (HTL), sandwiched between the $CsPbBr_3$ perovskite absorber and the respective electrodes. The use of inorganic charge transport layers, such as SnO_2 and Spiro-OMeTAD, can enhance the stability and performance of $CsPbBr_3$-based PSCs.

Theoretical investigations play a crucial role in understanding and optimizing the performance of perovskite solar cells (PSCs). In this work, numerical simulations were carried out using the SCAPS-1D software, which is a widely used tool for modeling and simulating thin-film solar cell devices. These simulations provide valuable insights into the optimization of $CsPbBr_3$ based PSCs by exploring the impact of various parameters on their overall efficiency and stability.

The SCAPS-1D simulations were employed to investigate the influence of several key parameters on the performance of $CsPbBr_3$-based solar cells. These parameters include the thickness of the electron transport layer (ETL), thickness of the hole transport layer (HTL), thickness of the $CsPbBr_3$ perovskite absorber layer and work function of the metal contacts.

Figure 4 (a) presents the variation of the efficiency as a function of the thickness of the electron transport layer (ETL) and the hole transport layer (HTL) in $CsPbBr_3$-based perovskite solar cells. The theoretical investigations reveal that the efficiency of these devices is significantly influenced by the variations in the thicknesses of both the ETL and HTL. Through a systematic analysis of the simulation results, the optimal thicknesses for the charge transport layers were identified. For the ETL, the simulations indicate that a thickness of 50 nm yields the highest efficiency, while for the HTL, a thickness of 140 nm is found to be optimal. The choice of appropriate thicknesses for the charge transport layers is crucial as it directly impacts the charge carrier extraction and transport processes within the device. Excessively thin layers may lead to inefficient charge extraction, while overly thick layers can introduce additional resistive losses and increase the probability of charge carrier recombination.

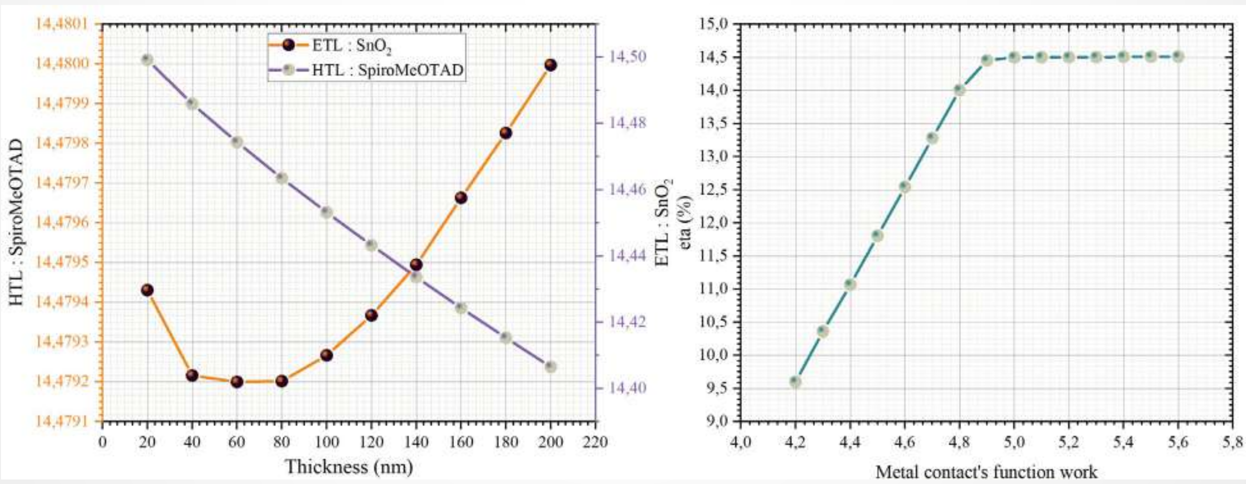

Figure 4: (a) Efficiency of Solar cells as function of the thickness of ETL and HTL, and (b) Efficiency of Solar cells as function of metal contact's function work.

Figure 4 (b) illustrates the variation of the power conversion efficiency as a function of the metal work function in solar cells. The simulation results indicate that for metal work functions higher than 4.8 eV, the efficiency of the perovskite solar cell devices exhibits an increasing trend. This behavior can be attributed to the favorable energy level alignment between the metal contact and the charge transport layers, facilitating efficient charge extraction and minimizing potential barriers at the interfaces. Based on the theoretical analysis, a metal work function of 4.9 eV was selected as the optimal value for further investigations and device fabrication. This choice ensures efficient charge extraction while maintaining a suitable energy level alignment within the device architecture, ultimately contributing to enhanced power conversion efficiency.

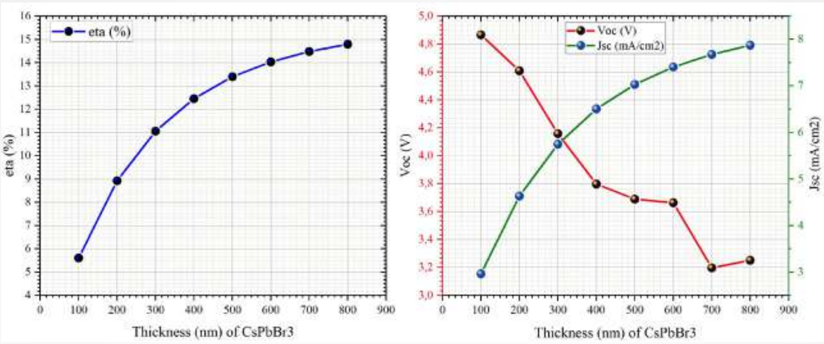

Figure 5: (a) Efficiency of Solar cells as function of the thickness of $CsPbBr_3$, and (b) Voc, Jsc as function of the thickness of $CsPbBr_3$.

Figure 5 (a) depicts the variation of the power conversion efficiency, open-circuit voltage (Voc), and short-circuit current density (Jsc) as a function of the thickness of the $CsPbBr_3$ thin film absorber layer in perovskite solar cells.

As the thickness of the $CsPbBr_3$ absorber layer increases, the simulation results indicate a corresponding change in the device performance parameters. The power conversion efficiency, Voc, and Jsc exhibit distinct trends, highlighting the importance of optimizing the absorber layer thickness to achieve optimal device characteristics. $CsPbBr_3$ absorber layer thickness of 700 nm was identified as the optimal value for the fabrication of high-performance perovskite solar cells. This thickness strikes a balance between efficient light absorption, charge carrier generation, and charge transport within the device architecture.

Following the optimization of the thin film thicknesses through theoretical simulations and experimental investigations, a $CsPbBr_3$ perovskite solar cell was fabricated using PVD method. The device structure consisted of the following layers: ITO (150 nm)/SnO_2 (50 nm)/$CsPbBr_3$ (700 nm)/Spiro-OMeTAD (140 nm)/Gold.

Figure 6 presents the current density-voltage (J-V) characteristic of the fabricated $CsPbBr_3$ perovskite solar cell. The J-V curve is a crucial characterization technique that provides valuable information about the device's performance parameters, including open-circuit voltage (Voc), short-circuit current density (Jsc), fill factor (FF), and power conversion efficiency (PCE).

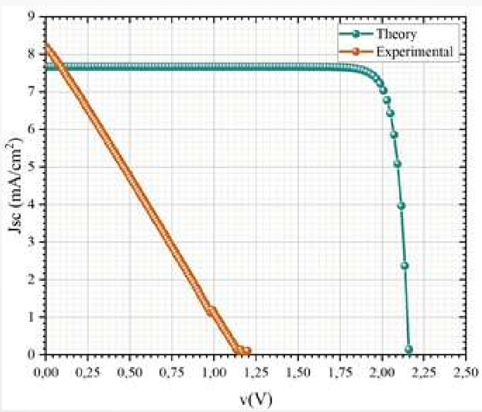

Figure 6: Jsc as function of V for the investigated device (Experimental and theoretical work).

Table 1 summarizes the key results obtained from the experimental and simulated data. According to the table, the fabricated $CsPbBr_3$ perovskite solar cell exhibits an impressive power conversion efficiency of 14.42%, which is a promising value for this type of device architecture and fabrication method. The combination of experimental fabrication and theoretical simulations has enabled the optimization of the device structure, leading to the realization of a high-performance $CsPbBr_3$ perovskite solar cell with a respectable efficiency of 14.42%. The agreement between the experimental and simulated results further validates the accuracy of the theoretical models and simulations employed in this study.

Device architecture	JSC (mA/cm2)	VOC (V)	FF (%)	PCE (%)
ITO/SnO_2/$CsPbBr_3$/Spiro- OMeTAD/Au (Experimental)	8.2	1.15	25.89	14.42
ITO/SnO_2/$CsPbBr_3$/Spiro- OMeTAD/Au (Theory)	7.67	2.16	87.33	14.48

Table 1: Device architecture and the photovoltaic parameter of the devices

Conclusion: In this comprehensive study, the potential of all-inorganic $CsPbBr_3$ perovskite solar cells was explored through a synergistic approach combining experimental investigations and theoretical simulations. The $CsPbBr_3$ thin films of 700 nm as thickness were successfully fabricated using the physical vapor deposition technique, and their structural, optical, and optoelectronic properties were thoroughly characterized.

Atomic force microscopy analysis revealed the formation of smaller, sharper, and more uniformly distributed nanograins in the $CsPbBr_3$ thin films, influencing their surface roughness and potentially impacting device performance. Optical characterization techniques, including transmittance and absorbance measurements, demonstrated the high transparency of the films in the visible and nearinfrared regions, along with a suitable bandgap of approximately 2.3 eV, which is ideal for efficient light absorption and conversion in photovoltaic applications.

Photoluminescence studies provided insights into the radiative recombination processes and charge carrier dynamics within the $CsPbBr_3$ material, revealing a multi-exponential decay behavior with distinct time constants. These findings contribute to a deeper understanding of the optoelectronic properties of $CsPbBr_3$ perovskites.

Complementing the experimental work, theoretical investigations were conducted using the SCAPS-1D software to simulate and optimize the device structure and performance. Through parametric studies, the optimal thicknesses of the charge transport layer (ETL and HTL), $CsPbBr_3$ absorber layer, and metal work function were determined, leading to enhanced power conversion efficiency.

Based on the optimized parameters, a $CsPbBr_3$ perovskite solar cell with the structure ITO/SnO_2/$CsPbBr_3$/Spiro-OMeTAD/Au was fabricated using the PVD method. The device exhibited an impressive power conversion efficiency of 14.42 %, which is a promising result for this type of architecture and fabrication technique.

The agreement between the experimental and simulated results further validated the accuracy of the theoretical models and simulations employed in this study, highlighting the importance of a synergistic approach in the development and optimization of perovskite solar cell technologies.

Biography

Amina Laouid is a dedicated researcher specializing in the synthesis and characterization of nanostructures and thin films of metalorganic complexes and hybrid perovskites for applications in optoelectronics and photovoltaics. With a profound understanding of materials science, Amina's expertise lies in pushing the boundaries of knowledge in her field, seeking innovative solutions for advancing optoelectronic and photovoltaic technologies. Through her interdisciplinary approach, she bridges the gap between theoretical insights and practical applications, driving forward the development of materials crucial for renewable energy and technological advancement. Her commitment to research excellence is matched only by her enthusiasm for contributing to the global scientific community.

4D PRINTED PIEZOELECTRIC BILAYER WOUND DRESSING MESH TO ACCELERATE SKIN WOUND HEALING

Gholamreza Mohammadi Khounsaraki
Institute of Materials Reseach, Slovakia

Abstract

Background: Skin is the largest essential organ of the body and plays a vital function in protecting body from external damages. When the integrity and function of this organ are interrupted, skin wounds occur. While minor injuries can often heal without scarring, acute wounds like burns, or surgical incisions can impede the natural healing process. In severe cases, these wounds can become infected, leading to potentially fatal consequences. Shockingly, the World Health Organization (WHO) has reported approximately 265,000 deaths annually due to burn injuries alone. Thus, the application of appropriate wound dressings becomes imperative for effective treatment.

Objective: Develop a bilayer hydrogel-electrospun wound dressing to accelerate wound healing in critical size skin wound injuries

Methods: A PVA-based mesh was fabricated using DLP 3D printing technique, augmented by the addition of an electrospun layer comprising PCL/$MgSiO_3$ onto the mesh structure. Comprehensive material characterization was conducted, encompassing mechanical properties, rheological behavior, swelling dynamics, and piezoelectric attributes of the wound dressing. Biological assessments were performed to evaluate antibacterial efficacy and cell viability, affirming the suitability of the wound dressing for biological applications. Notably, the final validation will entail rigorous in vivo studies to ascertain its efficacy and safety in practical clinical settings.

Results: The structural dynamics of the various layers were elucidated through SEM analysis, providing insights into their interactions. Additionally, our wound dressing exhibited promising antibacterial efficacy in aqueous environments, highlighting its potential for clinical application. Furthermore, under stimulated conditions, an apparent increase in epithelial proliferation was observed, indicating an increase in healing process. The forthcoming in vivo evaluation aims to comprehensively assess the wound dressing's functionality in alignment with biological tissues.

Conclusion: The bilayer wound dressing demonstrated promising outcomes in expediting the process of skin wound healing. The findings substantiate its considerable potential for effectively treating acute wounds, particularly infected and large-sized surgical wounds, with minimal scarring and within a notably reduced timeframe.

Biography

Mohammadi is an accomplished researcher specializing in biomedical engineering and biomaterials. Currently pursuing his PhD at the Institute of Materials Research in Košice, he has dedicated his studies to exploring the multifaceted applications of hydrogels in biological contexts, including stem cell manipulation, wound healing, and bone regeneration. His research spans diverse domains, ranging from elucidating the molecular dynamics of hydrogels to investigating their interactions with cells and tissues. Additionally, he harbors a keen interest in advanced manufacturing techniques, particularly in 3D printing, encompassing both light-based and extrusion-based methodologies.

ADVANCEMENTS IN FIBER OPTIC BIOSENSORS FOR REAL-TIME GLUCOSE MONITORING

Pallavi Dhillon
Shen Clinical Services LLP, India

Abstract

Background: The continuous monitoring of glucose levels is crucial for effective diabetes management. Traditional glucose monitoring methods are invasive and can be uncomfortable for patients. Recent advancements in fiber optic biosensors offer a promising alternative due to their high sensitivity, specificity, and ability to provide real-time data.

Objective: To explore the recent developments in fiber optic biosensors for real-time glucose monitoring, focusing on their design, functionality, and application in clinical settings.

Methods: A comprehensive literature review was conducted on studies published in the last decade regarding fiber optic biosensors. The review focused on the design and functionalization of optical fibers, the integration of biorecognition elements, signal transduction mechanisms, and the clinical performance of these sensors. Data were analyzed to compare the efficacy, accuracy, and practicality of fiber optic biosensors with traditional glucose monitoring methods.

Results: The analysis revealed significant advancements in the field, including the use of nanomaterials for enhanced sensitivity, novel biorecognition elements for higher specificity, and improvements in miniaturization for patient comfort. Clinical trials have demonstrated that fiber optic biosensors provide accurate real-time glucose readings with minimal discomfort to patients, showing a strong correlation with traditional monitoring methods.

Conclusion: Fiber optic biosensors represent a significant advancement in glucose monitoring technology. Their ability to provide continuous, real-time data with high accuracy and patient comfort makes them a promising tool for diabetes management. Future research should focus on further enhancing their sensitivity and specificity, as well as exploring their potential applications in other areas of medical diagnostics.

Biography

With 17 years of experience in Clinical Trial Management, Prasad Babu is a skilled leader adept at fostering collaboration and achieving collective goals. Pallavi, a proficient Project Manager, adeptly manages clinical trial projects from inception to completion, ensuring on-time delivery within budget and quality benchmarks. She holds a Ph.D. in Pharmaceutics, an M.S. in Clinical Research, and a B. Pharm degree. PMP certified professional with extensive academic and industry expertise. Highly skilled in project planning, team coordination, and risk management. Exceptional in regulatory compliance and resource allocation. Excels in cross-functional collaboration, stakeholder communication, and adaptability. Background in Clinical Operations and Drug Safety, specializing in Oncology Drug Development, Pharmacovigilance, and cutting-edge healthcare technology.

Her strategic mindset is evident in optimizing processes across various therapeutic areas. Holding Masters degrees in Biotechnology and Pharma Business Management, he leads Clinical Operations with a commitment to quality, setting high standards, allocating resources effectively, and implementing corrective actions, showcasing her multifaceted skill set in the field.

MEMBRANE SEPARATION TECHNOLOGY IN DIRECT AIR CAPTURE

Naiying Du

National Research Council / Government of Canada

Abstract

Direct air capture (DAC) is an emerging negative CO_2 emission technology that aims to introduce a feasible method for CO_2 capture from the atmosphere. Unlike carbon capture from point sources, which deals with flue gas at high CO_2 concentrations, carbon capture directly from the atmosphere has proved difficult due to the low CO_2 concentration in ambient air. Current DAC technologies mainly consider sorbent-based systems; however, membrane technology can be considered a promising DAC approach since it provides several advantages, e.g., lower energy and operational costs, less environmental footprint, and more potential for small-scale ubiquitous installations. Several recent advancements in validating the feasibility of highly permeable gas separation membrane fabrication and system design show that membrane-based direct air capture (m-DAC) could be a complementary approach to sorbent-based DAC, e.g., as part of a hybrid system design that incorporates other DAC technologies (e.g., solvent or sorbent-based DAC). Here the reported membrane materials that could potentially be used for m-DAC are summarized. In addition, the future direction of m-DAC development is discussed, which could provide perspective and encourage new researchers' further work in the field of m-DAC.

Biography

Naiying Du is a Research Officer at the National Research Council of Canada (NRC). Before joining NRC, she completed her Ph.D. in Polymer Chemistry and Physics at Graduate University of the Chinese Academy of Sciences. Her research interests focus on an emerging area: design, synthesis, and characterization of advanced polymer materials for energy efficiency and sustainability; micro-porous polymers for CO2 capture and storage; and functional polymers for printable organic electronics and sensors.

PREPARATION, FUNCTION, AND SAFETY EVALUATION OF A NOVEL DEGRADABLE DERMAL FILLER, THE CROSS-LINKED POLY-Γ-GLUTAMIC ACID HYDROGEL PARTICLES

Mian Chen

Shandong Academy of Pharmaceutical Sciences, China

Abstract

Background: Poly-γ-glutamic acid (PGA) is a naturally degradable hydrophilic linear microbial polymer with moisturizing, immunogenic, cross-linking, and hydrogel water absorption properties similar to hyaluronic acid, a biomaterial that is commonly used as a dermal filler.

Objective: To explore the development feasibility of cross-linked PGA as a novel dermal filler.

Methods: The local skin response to PGA fillers and the effect of various cross-linking preparations on the average longevity of dermal injection were studied. Injection site inflammation and the formation of collagen and elastin were also determined.

Results: PGA hydrogel particles prepared using 28% PGA and 10% 1,4-butanediol diglycidyl ether showed optimal filler properties, resistance to moist heat sterilization, and an average filling longevity of 94.7 ± 61.6 days in the dermis of rabbit ears. Local redness and swelling due to filler injection recovered within 14.2 ± 3.6 days. Local tissue necrosis or systemic allergic reactions were not observed, and local collagen formation was promoted.

Conclusion: Preliminary results suggested that dermal injection of cross-linked PGA particles appeared safe and effective, suggesting that cross-linked PGA particles could be developed as a new hydrogel dermal filler.

Biography

Mian Chen, Chief Senior Engineer and Chief Researcher at the Shandong Academy of Pharmaceutical Sciences. She has led and participated in major 10 national and provincial R&D projects, applied for 33 patents (20 granted), and published over 30 papers. Chen's work in collagen peptide preparation and oligosaccharide vaccines has been recognized with multiple awards, achieving significant industry impact.

MICROWAVE-SYNTHETIZED LANTHANIDE UPCONVERSION NANOPARTICLES: LIGHT NANOTRANSDUCERS FOR BIOMEDICAL APPLICATIONS

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Abstract

Nanomaterials (NMs) able to convert a stimulus into a response and return to their original state once the stimulus is removed have garnered significant attention in recent decades. This capability has paved the way for advanced biomedical techniques that promise to be both remote and minimally invasive -optogenetics, theragnostic, and advanced drug delivery. Among these NMs, the light-responsive ones are particularly interesting due to their rapid, almost immediate, reactivity. This makes them ideal for applications where precise spatial and temporal control is crucial, such as neuromodulation. While neurons are not light-sensitive the introduction of light-sensitive proteins known as opsins has made it possible for neurons to respond to light, allowing for precise control over specific cellular events through visible light irradiation. However, a significant challenge remains, because visible light is prone to scattering and has limited tissue penetration, thus fiber optic implants are required to deliver light effectively into the desired biological tissues.

A new strategy to overcome the above limitation is the development of efficient light nanotransducers based on upconversion nanoparticles (UCNPs). These nanoparticles can convert near-infrared (NIR) wavelengths into visible light through the upconversion process. —NIR wavelengths ($\lambda > 780$ nm) provide several advantages including deep tissue penetration, minimal autofluorescence, and reduced scattering. Among various UCNPs, lanthanide UCNPs (Ln-UCNPs) stand out as wireless remote light nanotransducers, due to their low toxicity, high photostability, sharply defined emission spectra, continuous emission, and prolonged decay times. Perhaps their most significant advantage lies in their ability to achieve light conversion using low-power density excitation sources.

Despite the significant progress in controlling and manipulating the composition and morphology of Ln-UCNPs, their application in biomedical fields remains limited due to their size, low efficiency, and the current excitation wavelength which is primarily at 980 nm. Most of the progress of these nanoparticles has relied on conventional heating methods such as thermal decomposition, coprecipitation, and hydro-solvo thermal techniques. While these methods have provided valuable insights, they also face challenges related to scalability and the previously mentioned technical limitations.

Based on these considerations, and recognizing the advantages of microwave irradiation to evoque the reaction heating when polar solvents are employed, this study explored the development of Ln-UCNPs (α- and β- NaYF4) using non-polar solvents without LI in a closed-vessel microwave reactor (MR) pressurized reaction. As well as, determining the influence of different transition metals on the physicochemical properties of α- and β- NaYF4 under optimized conditions. In order to understand the

influence of microwave irradiation on the reaction kinetics to explore other matrices. The reaction conducted in a closed-vessel MR at 290°C for 30 min, using non-polar solvents, and acetylacetonates precursors, resulted in spherical, homogeneous α-$NaYF_4$ nanoparticles with sizes ranging from 20 to 80 nm, depending on the precursor used. The β-$NaYF_4$ phase was favored when a small amount of NaOH was added alongside the Na source. Additionally, the use of co-dopants like Li, Gd, Pt, and Zn influenced not only the structural and morphological properties but also photoluminescent characteristics, including intensity and decay times. These findings demonstrate that a deep understanding of reaction kinetics in a MR not only enables successful tailoring of the NPs but also improves their emission efficiency.

Biography

Gloria Lesly Jimenez is an assistant professor at AGH University of Krakow, specializing in the development of photoluminescent nanomaterials for biomedical applications. She employs techniques such as microwave-assisted reactions and thermal decomposition. Dr. Jimenez obtained her Ph.D. in Nanoscience and Nanotechnology from The Center for Research and Advanced Studies of IPN (Cinvestav) under the mentorship of Prof. Ciro Falcony. Her doctoral research focused on hybrid materials with innovative luminescence properties based on lanthanides, emphasizing their processing, structural, and light-emission characteristics. These materials have significant potential for applications in optical fibers and solar cells.

She completed her first postdoctoral research stay at The University of Texas at San Antonio (UTSA), where she developed magnetic nanoparticles for wireless technologies to modulate neural activity, thanks to the ConTex postdoctoral award. In 2021 and 2022, Dr. Jimenez was selected for the long-term foreign scientist visit program at AGH University of Krakow, where she worked with Prof. Dominik Dorosz's group on the project "Wireless Technology to Modulate Neuronal Activity Mediated by Optogenetics". Dr. Jimenez has collaborated with leading research groups in Mexico, United States, Italy, and Poland, furthering her expertise in magnetic and photoluminescent materials.

BIOPOLYMER BASED IN SITU INJECTABLE HYDROGELS LOADED WITH CURCUMIN NANOCRYSTALS FOR BONE TISSUE ENGINEERING (HYDROBONEREG)

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Abstract

Background: Bone tissue possesses an inherent ability to regenerate itself to some extent, but severe defects can sometimes interrupt this regenerative process. These bone defects have sparked innovative solutions through a range of biomaterials, including scaffolds, bone ceramics, and composite materials, however, these cutting-edge materials still face significant challenges: limited integration with host tissue, inherent brittleness, susceptibility to infection, and insufficient mechanical strength. Despite advancements in biomaterial technology, these limitations remain significant challenges in the field of bone tissue engineering and regeneration.

Objective: To develop biomimetic polymer-based curcumin nanocrystals (Cur-NCs) tailored for controlled and targeted delivery in bone defect models, aimed at enhancing bone tissue proliferation and remodeling. Furthermore, we incorporated these Cur-NCs into bioactive polysaccharides-based in situ injectable hydrogels.

Methods: The fabrication of Cur-NCs involved employing the antisolvent co-sono-precipitation method followed by dynamic light scattering (DLS) to confirm the size and potential of nanocrystals. The enzymatically crosslinked Dextran-Tyramine (Dex-TYR) injectable hydrogels were synthesized using oxidative polymerization, employing bioactive polymers chosen for their structural resemblance to bone tissue extracellular matrix components and mechanical strength. Confirmation of the Dex-TYR functionalization and novel polymeric structure was achieved through nuclear magnetic resonance (1HNMR) and Fourier transform infrared spectroscopy (FTIR), while thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) provided insights into material thermal stability. Scanning electron microscopy (SEM) unveiled the porosity and diffusibility of the fabricated nanocrystal and hydrogel, while X-ray diffraction analysis (XRD) assessed its crystalline and amorphous nature. Developed in-situ hydrogel was subjected to rheological analysis, gelation time and temperature, sol-gel phase transition, viscosity measurement, and optical transmittance analysis at numerous temperatures.

Result: These biomimetic injectable hydrogels exhibit the potential to foster matrix deposition and create a conducive environment for osteocyte differentiation and proliferation. DLS confirming nanocrystal sizes ranging between 150-200 nm, and a zeta potential above -30, indicating the stability of the nanocrystals. TEM and FE-SEM further substantiated the crystalline nature, and visual analysis of the nanocrystals confirmed stability for over 72 hours. The drug release profile revealed sustained release characteristics, with over 90% of the drug released within 32 hours. This innovative approach harnessed the power of curcumin to promote reepithelization and enhance collagen deposition at the defected site, fostering a synergistic healing cascade.

Conclusion: The in situ forming injectable hydrogels were studied in terms of their gelation temperature and times, storage moduli, loss moduli, swelling ratio and drug release profile. Excitingly, in vivo bone healing experiments and histological analysis demonstrated upregulation of osteoblast deposition, suggesting promising potential for bone tissue regeneration afforded by the hydrogel system.

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Biography

Syed Ahmed Shah started his research career dealing with the development, characterization, and in vivo evaluation of stimuli-responsive hydrogels in diversified biomedical and clinical applications. In 2022, he obtained a Ph.D. in Pharmacy and Pharmaceutics from COMSATS University Islamabad, Pakistan. S.A. Shah has been awarded the Research Excellence Award 2022 by Superior University, Pakistan considering his passion for increasing the translation of fresh ideas and concepts in the field of biomedical sciences from bench to bedside through research and innovations. Carrying out the research under the PASIFIC Programme, S.A. Shah is concentrated on enzyme-mediated and pH-responsive hydrogel for accelerated bone regeneration and repair, controlled drug delivery, bone tissue engineering (BTE), and bio-based polymeric systems for de novo bone formation and to assemble functional constructs that synergistically promote the healing of damaged bone tissues.

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