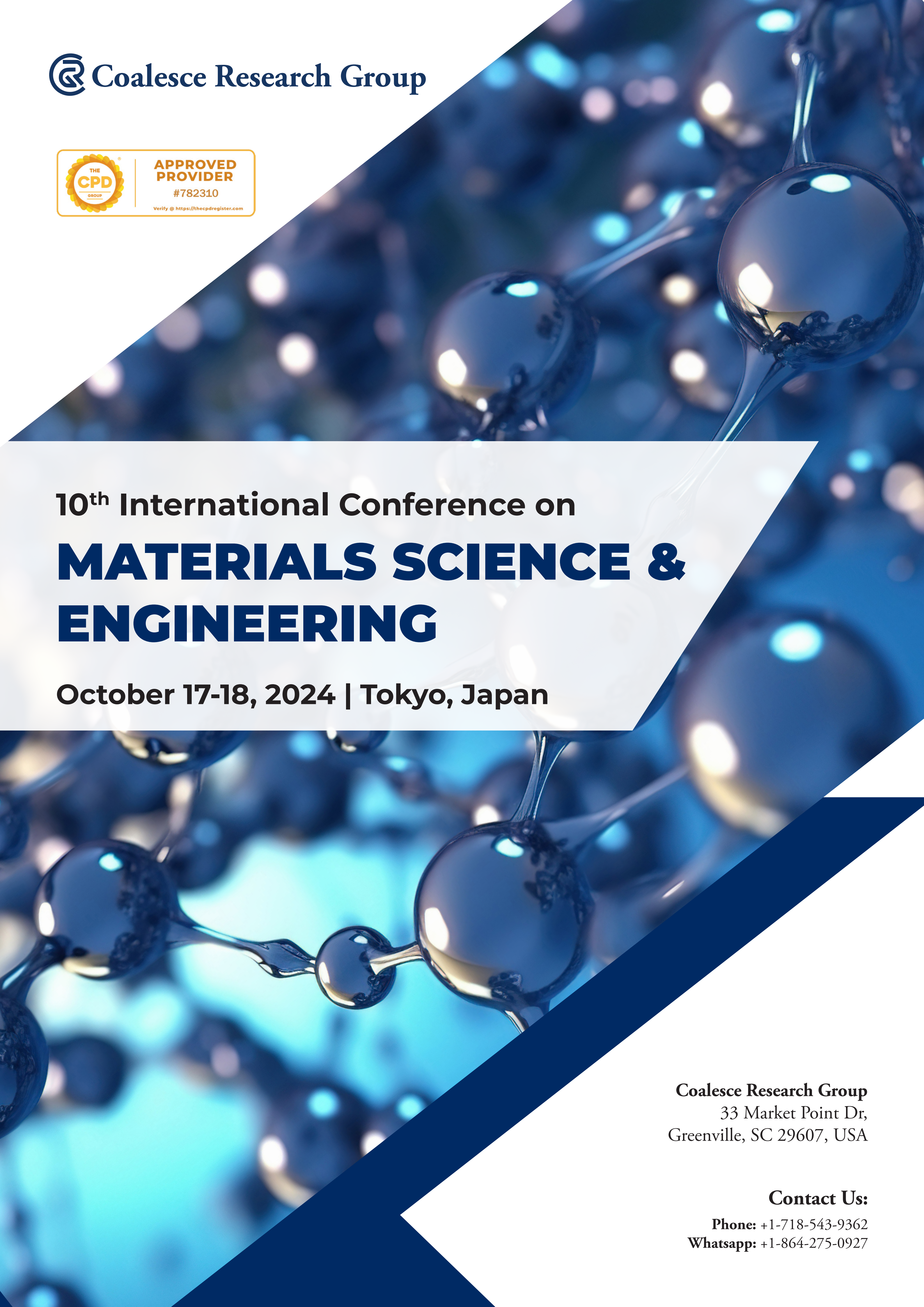
Coalesce Research Group

APPROVED PROVIDER
#782310
Verify @ https://thecpdregister.com



10th International Conference on

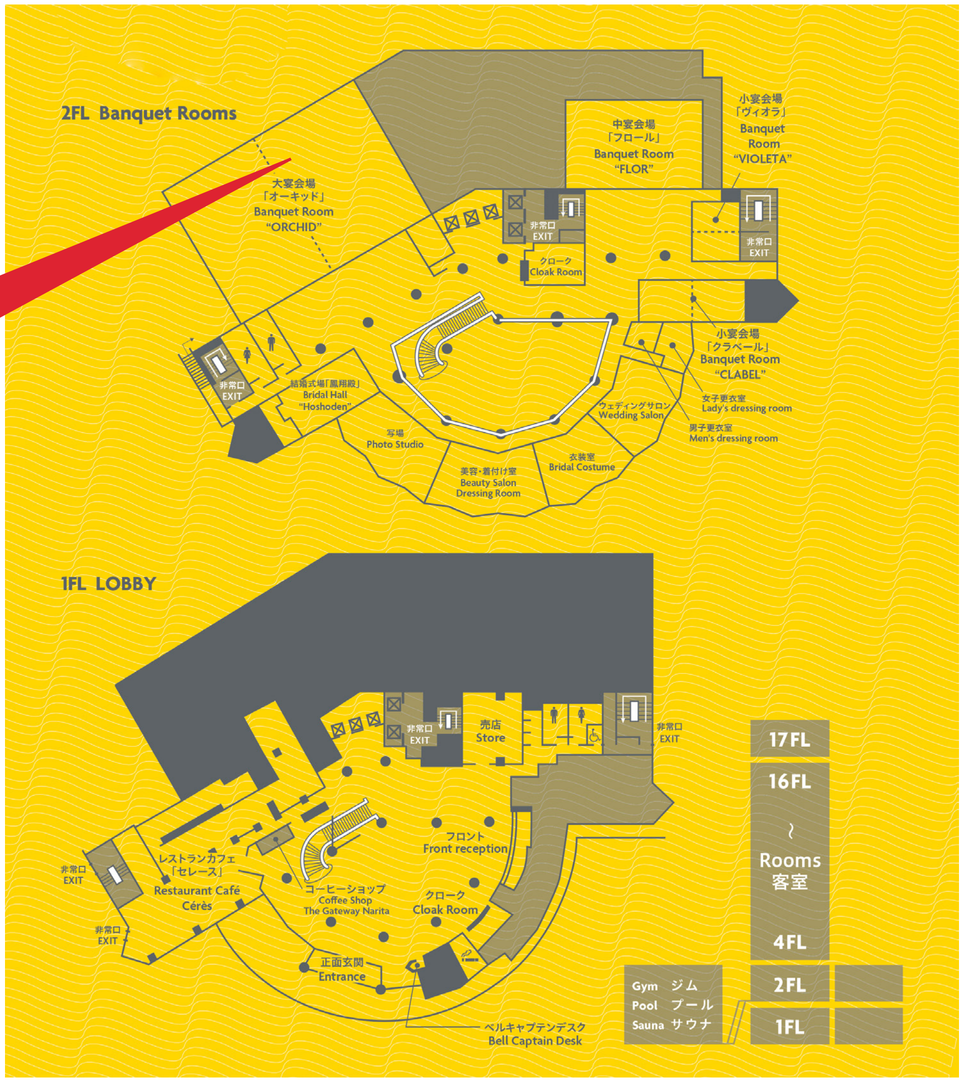
MATERIALS SCIENCE & ENGINEERING

October 17-18, 2024 | Tokyo, Japan

Coalesce Research Group
33 Market Point Dr,
Greenville, SC 29607, USA

Contact Us:
Phone: +1-718-543-9362
Whatsapp: +1-864-275-0927

Floor Map



Conference Hall

Wi-Fi Details:

SSID : IHG One Rewards Free WIFI

Password: not required but log in page will be coming up, and put **1311** into the access code and submit

Scientific Program

Scientific Program

Thursday
October 17, 2024

10th International Conference on

Materials Science & Engineering

Day 1- October 17, 2024	
Meeting Hall: Orchid 1/3	
08:00-08:40	Registrations
08:40-09:00	Introduction
Keynote Presentations	
09:00-09:40	Title: Computer-Assisted Planning, Manufacturing and Surgical Implantation of an Individualized 3D Printed Titanium Cage for Cervical Fusion
	Uwe Spetzger, Karlsruhe Institute of Technology, Germany
09:40-10:20	Title:Imaging Strain Tensor of Wavy Silicon Nanomembrane using Third-Harmonic Generation Microscopy
	Hyunmin Kim, Daegu Gyeongbuk Institute of Science & Technology (DGIST), South Korea
Networking & Refreshments @ Orchid Foyer (10:20-10:40)	
Oral Presentations	
Session Chair	**Uwe Spetzger, Karlsruhe Institute of Technology, Germany**
Session Chair	**Kenji Sorimachi, Dokkyo Medical University, Japan**
Sessions:	Functional Materials | 3D printed implants and organs |3D printing & Additive manufacturing | Materials science and Engineering | Environmental and Green Materials | Analytical Chemistry | Composite, Coating and Ceramic Materials | Radiologic Technology | Nanostructures and Nanofilms | Chemical Engineering | Bioceramic materials, Ceramic composites, Bone grafts, and Biodegradable ceramics | Electromagnetic-Wave Absorption | Soft Matter & Nanoscale Materials| Mechanics of Materials and Structures | Biomaterials, Biomechanics & Biosensors | NanoMaterials and Nanotechnology | Materials Chemistry | Electronic, Optical and Magnetic Materials | Artificial intelligence & Robotics
10:40- 11.05	Title: Thermal Characteristics of Closed Porous Aluminum Foams Infiltrated with Phase Change Material (PCM)
	Rico Schmerler, Fraunhofer Institute for Machine Tools and Forming Technology IWU, Germany
11.05 - 11.30	Title: The Influence of Cold Spray Parameters and Feedstock Powder Sizes on Corrosion Behavior of Cold Sprayed Inconel®625 Deposits
	Farrokh Taherkhani, Helmut-Schmidt-University/ University of the Federal Armed Forces Hamburg, Germany
11.30- 11.55	Title: Development and Evaluation of Cost-Effective Silver Nanoparticle-Infused Pharmaceutical Hydrogels for Antimicrobial Applications
	Alaaldin M. Alkilany, Qatar University, Qatar
11.55- 12.20	Title: Effect of Zinc Oxide (ZnO) Dopant on the Physical and Electrical Properties Potassium Sodium Niobate Thin Films
	Mohd Warikh Abd Rashid, Universiti Teknikal Malaysia Melaka, Malaysia
12.20 - 12.45	Title: Preparation and Application of New Materials Based on Natural Deep Eutectic Solvents for Extraction Environmental Pollutants
	Justyna Werner, Poznan University of Technology, Poland

12.45 - 13.10	Title: Toward a Collaborative Platform to Foster Material Circularity of Electrical and Electronic Equipment
	Rinaldo Garziera, University of Parma, Italy
Group Photo (13:10-13:20)	
Lunch @ Restaurant Cafe Ceres (13:20-14:30)	
Keynote Presentation	
14.30 - 15.10	Title: Novel Direct Air Capture (DAC) for CO_2 Production
	Kenji Sorimachi, Dokkyo Medical University, Japan
Oral Presentations	
15.10 - 15.35	Title: FPGA-Based Acceleration of Reinforcement Learning
	Khawla Saif Almazrouei, Autonomous Robotics Research Center (ARRC), Technology Innovation Institute (TII), UAE
15.35 - 16.00	Title: The Development of Radiation Shielding Materials Involves Incorporating Lanthanum Oxide Dopants Into Glass
	Siriprapa Kaewjaeng, Chiang Mai University, Thailand
Networking & Refreshments @ Orchid Foyer (16:00-16:30)	
Poster Presentations (16.30 onwards)	
Poster Judge	**Uwe Spetzger, Karlsruhe Institute of Technology, Germany**
Poster 001	Title: Preparation of Nanostructured Copper Oxide by Means of Wet Corrosion Process (WCP) and their Application to Photocatalysis
	Yuta Igawa, Shibaura Institute of Technology, Japan
Poster 002	Title: Degradation of Sulfapyridine by Ozone-Based Oxidation
	Chung-Hsin Wu, National Kaohsiung University of Science and Technology, Taiwan
Poster 003	Title: Quantifying Bioceramic Bone Graft Degradation Processes in a Biochip
	Man-Ping Chang, National United University, Taiwan
Poster 004	Title: Enhanced Electromagnetic-Wave Absorption Properties of Photosensitivity Epoxy/ Nano Cobalt Buckyball Meta Structure Composites
	Yu-Cheng Kuo, National Chin-Yi University of Technology, Taiwan
Poster 005	Title: Molecular Mechanism of Viscoelastic Creep Deformation of Polyelectrolyte Elastomers
	Mohammad Reza Adibeig, Sustech university, China
Poster 006	Title: Calibration of Visco-Hyperelastic Materials Using Cyclic Loading
	Abuzar Es'haghi Oskui, Sustech university, China
Poster 007	Title: Preparation of Porous Degradable Bone Substitutes Using Calcium Sulfate/ Hydroxyapatite
	Zheng-Kai Fu, National United University, Taiwan

Poster 008	Title: Characterization of Amino-Terminated Self-Assembled Monolayer on Cu/Porous Low-K Dielectrics
	Yi Lung Cheng, National Chi-Nan University , Taiwan
Poster 009	Title: Enhanced NIR Photodetection and Memory Retention in Organic Semiconductor Devices Using DPP-DTT And IEICO-4F
	Min Ju Jung, Pukyong National University, South Korea
Poster 010	Title: Formation of Carbon Nanomaterials-Based Hybrids and their Application for Electromagnetic Wave Shielding Effectiveness
	Sung-Hoon Kim, Silla University, South Korea
Poster 011	Title: Preparation of Effective Heavy Metal Sorbents from Sodium Polysulfide and Epichlorohydrin Production Wastes
	Yerlan Abdykalykov Nurzhanuly, D.V. Sokolsky Institute of Fuel, Catalysis and Electrochemistry, Kazakhstan
Poster 012	Title: Adsorption Characteristics of A Sulfur-Containing Oligomer Based on Chlorex
	Arailym Nalibayeva, D.V. Sokolsky Institute of Fuel, Catalysis and Electrochemistry, Kazakhstan
Day 1 Concludes followed by Certificate Distribution	

Scientific Program

Friday
October 18, 2024

10th International Conference on

Materials Science & Engineering

Day 2- October 18 ,2024	
Meeting Hall: Orchid 1/3	
Keynote Presentation	
10:00-10:40	Title: Investigation of Heat Treatment on Dry Sliding Wear Behaviour of Thixoformed Gnps-A356 Matrix Composites
	Mohd Shukor Salleh, Universiti Teknikal Malaysia Melaka, Malaysia
Oral Presentations	
Session Chair	**Uwe Spetzger, Karlsruhe Institute of Technology, Germany**
Session Chair	**Kenji Sorimachi, Dokkyo Medical University, Japan**
Sessions:	Environmental and Green Materials| Nano medicine | Energy Materials and Sustainability | Encapsulation | Polymeric nanofiber| Nanofiber composite | Materials Science and Engineering | Computational Materials Science | Materials Chemistry | Polymers & Biopolymers | Surface Science and Engineering | Semiconductors | Nanostructures and Nanofilms | Biomedical Engineering
10:40-11:05	Title: Ambient Air-Processed CsPbI3-Based Perovskite Solar Cell Via Semi-Sputtering Deposition and Numerical Studies of Cs3Sb2I9-Based Perovskite Solar Cell
	Hasina Huq, The University of Texas Rio Grande Valley, USA
Networking & Refreshments @ Orchid Foyer(11.05 - 11.25)	
11:25-11:50	Title: Tailoring Composite Materials for Enhanced EM Pollution Mitigation: The Role of Carbon Black and Cobalt
	Yi Jen Huang, National Chin-Yi University of Technology, Taiwan
11.50 - 12.15	Title: Synthesis of the Targeted Metal-Organic Framework as a Novel Strategy for Improving Antitumor Therapeutic Efficacy
	Xiao Fu, Shandong First Medical University, China
12.15- 12.40	Title: Dynamic Testing of Self-Healing Asphalt Concrete with Encapsulated Modifier
	Inozemtsev Sergei, Moscow State University of Civil Engineering (National Research University), Russia
12.40 - 13.05	Title: Predicting Flow-Related Dynamic Recrystallization Parameters and Grain Size Evolution in Hot Forging of SCR420HB using a Direct Method
	Mohd Kaswandee Razali, Metal Forming Research Corporation, South Korea
13.05 - 13.30	Title: Carbon Quantum Dots from Waste Materials for Metal Ion Sensing
	Nigamuni Binu Parlindie Senanayake, Swinburne University of Technology, Australia
Lunch @ Restaurant Cafe Ceres (13:30 -14:30)	
14.30 - 14.55	Title: Electrospun Polycaprolactone (PCL) Nanofibers Containing Endophytic Fungi Metabolite-Based Antibacterial Additives from Australian Native Plants for Wound Dressing Applications
	Meysam Firoozbahr, Swinburne University of Technology, Australia

14.55 - 15.20	Title: Challenges and Solutions Regarding the Fatigue Behaviour of Thermal Direct Joints Made of Titanium and CF-PAEK for Aerospace Applications
	Benjamin Förster, Fraunhofer-Institute for Material and Beam Technology IWS, Germany
15.20 - 15.45	Title: Polymer Nanocomposite Materials for Application X: The Role of Nanoscale Dimension
	Ioannis Zuburtikudis, Abu Dhabi University, UAE
15.45 - 16.10	Title: TFN Nanofiltration Membranes Containing GO Nanoparticles with Enhanced Water Selectivity and Anti-Fouling Properties
	Ioannis Zuburtikudis, Abu Dhabi University, UAE
Networking & Refreshments @ Orchid Foyer(16.10 - 16.30)	
16.30- 16.55	Title: Machine Learning Approaches to Accelerate the Computation of Finite Temperature Properties of Solid Materials
	Pinku Nath, Hokkaido University, Japan
Day 2 Concludes followed by Certificate Distribution	

Virtual Program

Virtual Program

Thursday
October 17, 2024

10th International Conference on

Materials Science & Engineering

Day 1 - Ocotber 17, 2023 BST	
10.00 - 10.10	Introduction
Oral Presentations	
10.10 - 10.35	Title: Investigation the Effect of Combined Quenching and Deep Cryogenic Treatment on Wear Behavior of Martensitic Ductile Irons
	Salome Gvazava, Georgian Technical University, Georgia
10.35 - 11.00	Title: Extraction and Characterization of Cellulose Nano Crystals from Durian Peel Waste Through Oxidation Method
	Henny Pratiwi, Universitas Gadjah Mada, Indonesia
11.00 - 11.25	Title: Rapid and Highly Efficient Removal of Aqueous Perfluorooctanoic Acid Using Deep Eutectic Solvents for Sustainable Water Remediation
	Sana Eid, Khalifa University, United Arab Emirates
11.25- 11.50	Title: Real-Time Monitoring of Cardiovascular Complications Using Pyroelectric Nanogenerators
	Mariana Rocha, University of Porto, Portugal
11.50- 12.15	Title: Highly Sensitive LSPR Gas Sensors Using Scalable PVD-Fabricated Plasmonic Nanocomposites
	Nuno Figueiredo University of Coimbra, Portugal
12.15 - 12.40	Title: Optimizing CZTS Solar Cells: Enhancing Efficiency with rGO and TiO_2 for Sustainable Energy Solutions
	Fatihi Dounia, University of Casablanca, Morocco
12.40 -13.05	Title: Investigation of the Electrical and Magnetic Behavior of Bi1.34Fe0.66Nb1.34O6.35 Synthesized via Sol-Gel Technique
	Susana Devesa, University of Coimbra, Portugal
Lunch Break (13.05 -13.30)	
13.30 -13.55	Title: Influence of Mg Doping on the Structural and Mechanical Properties of MOCVDGrown GaN Thin Films
	Zohra Benzarti, University of Coimbra, Portugal
13.55- 14.20	Title: Electrospun Polymeric Membranes for Tissue Engineering and Cell Growth
	Maria Helena Ambrosio Zanin, IPT - Instituto de Pesquisas Tecnologicas, Brazil
14.20 - 14.45	Title: SpineSync: Enabling Self-Tracking of Progression of Parkinson's-Induced Kyphosis by Leveraging an IMU-Embedded Wearable Device
	Rohan Ramachandran, University School of Nashville, USA
Poster Presentations	
14.45 -15.00	Title: High-Performance Piezo-Responsive Membrane for Efficient Dye Degradation and Sustainable Water Treatment
	Indrajit Mondal, Jadavpur University, India
15.00 - 15.15	Title: Piezo-Driven Antibacterial Chitosan/ ZrO_2 Membrane for Rapid and Reusable Coliform Bacterial Disinfection
	Piyali Halder, Jadavpur University, India

10th International Conference on

Materials Science & Engineering

Video Presentation	
15.15 -15.30	Title: Viscoelastic Future in Chiral Ferroelectric and Antiferroelectric Liquid Crystals
	Dorota Dardas, Polish Academy of Sciences, Poland

Day-1
Keynote Presentations

COMPUTER-ASSISTED PLANNING, MANUFACTURING AND SURGICAL IMPLANTATION OF AN INDIVIDUALIZED 3D PRINTED TITANIUM CAGE FOR CERVICAL FUSION

Uwe Spetzger

Karlsruhe Institute of Technology, Germany

Abstract

Background: Most cervical fusion cages mimic the anatomy of the intervertebral disc space more or less. The production of individualized cages is the next step for further improvement of spinal implants due to an improved load bearing surface.

Objective: Our idea is to respect the individual patient's anatomical situation and manufacture an individual cage with a perfect fitting accuracy. Detailed planning, manufacturing, and microsurgical implantation of an individualized cervical cage is demonstrated.

Methods: The computer-assisted planning, manufacturing, and implantation of the individualized cervical cage were performed in co-operation with 3D-Systems Corporation, Rock Hill, SC 29730, USA and EIT Emerging Implant Technologies GmbH, Tuttlingen, Germany. A 3D model of the patient´s cervical spine obtained from CT data was rendered. The newly developed 3D planning algorithms and special reconstruction software implemented in a high-end image-processing computer allow the virtual simulation of the surgical procedure. The cage implantation was simulated to check the accuracy of fit. This individually designed and patient-specific cage is manufactured of trabecular titanium by selective laser melting (3D printing procedure).

Results: The pilot project of the first implantation of an individualized cervical cage ever resulted in a high accuracy of fit of the implant. During surgery the individualized cervical implant 'found' its correct position after suspending distraction due to its unique endplate design and provides excellent primary fitting accuracy and stability.

Conclusion: Preconditions for the manufacturing of individualized cervical fusion cages using specific patient data are presented. The implantation is uncomplicated. The improved load-bearing surface will lower the rate of implant dislocation and subsidence. The production of individualized cages at a reasonable price has to be figured out by users and the industry.

Biography

Professor Uwe Spetzger is 61 years old and received his medical degree 1989 at the Medical Faculty, University of Heidelberg, Germany. In 1990 he passed the US American medical exam (ECFMG certificate) and got his German board certification of neurosurgeon 1996. In June 1999, he passed the European Examination in Neurosurgery (EANS). Since 2002, he is Chairman of the Department of Neurosurgery, Klinikum Karlsruhe and is member of the Faculty of Computer Science, Anthropomatics and Robotics at the KIT. Spetzger was the CEO of the Klinikum Karlsruhe 2019–2020.

Prof. Spetzger is member of several national and international neurosurgical and medical technological societies and has been consulting for renowned medical technology companies for years. He was the president of the international Society of Medical Innovation and Technology iSMIT2013 and since 2016 he is Vice-President of the International Society of Digital Medicine. In 2023, he received the Order of Merit of Baden-Württemberg. His main surgical and research interests are cerebrovascular-surgery, skull-base-surgery, computer-assisted and robotic surgery, neuro-navigation and spinal microsurgery.

IMAGING STRAIN TENSOR OF WAVY SILICON NANOMEMBRANE USING THIRD-HARMONIC GENERATION MICROSCOPY

Hyunmin Kim[3,4], Gwanjin Lee[1], Jae dong Lee[1] and Jong-Hyun Ahn[2]

[1]Department of Physics and Chemstry, DGIST, Republic of Korea
[2]School of Electrical and Electronic Engineering, Yonsei University, Republic of Korea
[3]Division of Biomedical Technology, DGIST, Republic of Korea
[4]Department of Interdisciplinary Engineering, DGIST, Republic of Korea

Abstract

The semiconductor industry remains vital in the realm of electronics, cell phones, and even electric vehicles, with silicon still playing a crucial role in enabling various functionalities. As devices continue to shrink, 2-dimensional (2D) semiconductors and graphene have been actively explored as potential candidates for next-generation devices. However, silicon maintains its competitiveness in smaller device applications, particularly with the advent of ultrathin silicon nanomembrane (SiNM).

This study presents third-harmonic generation (THG) imaging of wavy-shaped SiNM. Crumpling of SiNM was achieved by releasing the pre-strain in a PDMS polymer substrate with the SiNM attached. The third-order photoelastic tensor of SiNM was modeled based on the polarization-dependent THG signals using a custom-built THG microscope.

Biography

Dr. Kim completed his Ph.D. in Chemistry from the University of California-Irvine in 2009, focusing on nonlinear optical studies of nanostructural systems. He then pursued postdoctoral research at the National Institute of Standards and Technology (NIST) in Gaithersburg until 2011, where he explored multiplicative-type super-resolution microscopy using optical four-wave mixing. Following a brief 10-month postdoctoral stint at the Korea Research Institute of Chemical Technology (KRICT) investigating time-resolved stimulated Raman systems, Dr. Kim serves as a principal investigator at the Daegu Gyeongbuk Institute of Science Technology (DGIST), one of Korea's newly established national laboratories, in 2012.

NOVEL DIRECT AIR CAPTURE (DAC) FOR CO_2 PRODUCTION

Kenji Sorimachi, and Hossam A.Gabber

Dokkyo Medical University and Environmental Engineering, Co., Ltd., Japan

Abstract

Background: The international Panel on Climate Change concluded that climate change has been caused by human activities that have produced CO_2 since The Industrial Revolution. On 27 July 2023, Secretary-general AntÓnio Guterres warned at the press conference of the United Nations as follows: The era of global warming has been ended; the era of global boiling has arrived. However, the concept of the carbon-neutral society by 2050 is obviously too late.

Objective: To reduce the accumulated CO_2 in the ambient atmosphere, which induces climate changes, an innovative method for CO_2 fixation and storage has been designed based on our previously reported methods.

Method: Our developed method for CO_2 fixation and storage can capture efficiently the atmospheric CO_2, using low concentrations of NaOH and $CaCl_2$. A large chamber comprising spray nozzles to capture CO_2 efficiently by mists or droplets of NaOH solution has been designed, where NaOH is easily supplied by the electrolysis of NaCl or seawater with renewable energy sources including solar radiation, wind power, and nuclear power. Contrary, the exhaust gas or atmosphere is formed as micro bubbles to increase the surface area of gas bubbles in contact with NaOH solution.

Results: The prototype plant setup as well as laboratory experiments converted CO_2 to $CaCO_3$, which exists as limestone and coral without environmental concerns. The atmospheric CO_2 in the 2 liter plastic pet bottle was completely fixed with the mists consisting of about 5 ml of 0.1 N NaOH solution and also fixed by babbling of the atmosphere through 500 ml of 0.1 N NaOH solution filled in the vinyl chloride pipe with a 5 cm diameter. The electrolysis unit produced H_2 and Cl_2 using NaCl, and $Mg(OH)_2$ using seawater. Furthermore, the addition of HCl, which was produced in the electrolysis unit, to Na_2CO_3 or $CaCO_3$ converted to CO_2 and NaCl or $CaCl_2$, respectively.

Conclusion: The proposed methods of direct air capturing and CO_2 production demonstrated practical and economical solution to overcome climate challenges and support the sustainable development goals (SDGs).

Biography

Kenji Sorimachi completed his M.E. at Faculty of Engineering, and Ph.D. at Faculty of Medicine, Gunma University, Japan and postdoctoral studies at the National Institutes of Health, USA. Dr. Kenji Sorimachi was affiliated to Department of Microbiology, Dokkyo Medical University, 1978, and then to Educational Support Center, Dokkyo Medical University, where he was currently working as Professor. He has authored and co-authored several national and international publications and also working as a reviewer for reputed professional journals. He had an active association with different societies and academies around the world. He made his mark in the scientific community with the contributions and widely recognition from honorable subject experts around the world. He is the senior author of more than 150 published papers, and has been invited as the plenary or keynote speaker at many international conferences. During recent few years, Dr. Kenji Sorimachi has newly developed the innovative method for CO_2 fixation and storage, Scientific Reports, (2022) 22: 1694.

Day-1
Oral Presentations

THERMAL CHARACTERISTICS OF CLOSED POROUS ALUMINUM FOAMS INFILTRATED WITH PHASE CHANGE MATERIAL (PCM)

Rico Schmerler, Thomas Hipke and Welf-Guntram Drossel
Fraunhofer Institute for Machine Tools and Forming Technology IWU, Germany

Abstract

The thermal characteristics of closed porous aluminum foam infiltrated with phase change material (PCM) were investigated.

Latent heat storage provides higher energy density in comparison with sensible heat due to the enthalpy difference during phase change. However, these PCM usually have a low thermal conductivity. For enabling efficient heat transfer, heat storage materials can be integrated into thermal conductive matrixes. One approach of infiltrating PCM into closed cell metal foam was described in literature. However, experimental results for these composites regarding thermal conductivity including the comparison to the initial foam structure were not published.

In this work, the production and infiltration of closed porous aluminum foam samples with the PCM is described. The investigations were motivated by combining the structural und thermal properties of the foam with the heat capacity of PCM for battery housing components. The investigated AlSi10 foam densities were 0.5 g/cm^3 and 0.7 g/cm^3. A paraffin PCM with a melting range around 44 °C was used generating infiltration rates of 58 to 73%.

Measurements of the specimen thermal conductivity were performed based on the transient plane source method. Experimental tests for the specimens before and after infiltration were carried out for comparisons and drawing conclusions of the PCM influence on the thermal conductivity. The same method was used for the thermal diffusivity.

The thermal conductivity of the composite materials was determined between 18.1 W/(m K) and 25.4 W/(m K). The thermal conductivity of infiltrated samples was 37 % for the foam density of 0.5 g/cm^3 and 16 % higher for 0.7 g/cm^3 than that of non-infiltrated samples. Besides, the thermal diffusivity was found 13.8 to 31.5 mm^2/s. The thermal diffusivity of infiltrated samples decreased by 54 % for the sample density of 0.5 g/cm^3 and by 37 % for 0.7 g/cm^3.

Biography

Rico Schmerler is a mechanical engineer specialized in lightweight design and polymer technology with a diploma from the Technical University of Dresden. Since 2014 his is working at the Fraunhofer Institute for Machine Tools and Forming Technology IWU. Until 2021 he was researching material, design und process solutions with focus on lightweight design and functional integration for electric cars at the Fraunhofer project center in Wolfsburg. Since 2022 he is a group leader for battery systems in Chemnitz and Dresden, Germany.
Mr. Schmerler was and is the project leader in several research and development projects for electric cars like: Secure battery systems (“SafEBat”), Batteries with reduced CO2 emissions (“COOLBat”), Functionally integrated battery housings (“FunTrog”) and Passive thermal management for battery housings (“TheBatE”). Further project were for instance crash protection systems for electric cars and electric heavy duty vehicle and joining technologies for hybrid materials.

THE INFLUENCE OF COLD SPRAY PARAMETERS AND FEEDSTOCK POWDER SIZES ON CORROSION BEHAVIOR OF COLD SPRAYED INCONEL®625 DEPOSITS

Farrokh Taherkhani, Doreen Blanken, Alex List, Frank Gärtner, Max Gündel, Thomas Klassen

Helmut-Schmidt-University/University of the Federal Armed Forces Hamburg, Germany

Abstract

Due to high Cr-content, Inconel®625 is widely used as protective coating to withstand corrosion at high temperatures and harsh and aggressive environments. So far, Inconel®625 deposits are typically produced by means of thermal process routes such as surface deposition welding or thermal spraying, which both result in the formation of oxides as well as possibly metastable phases in the deposit. In order to prevent the oxidation, solid state deposition by cold spraying (CS) can offer advantages for building-up deposits in thickness of up to several millimeters. However, CS of nickel-based superalloys like Inconel®625 is still challenging due to their high strength. Thus, the current study explores the influences of CS parameters and powder sizes on porosity and corrosion performance of sprayed deposits. Inconel®625 powder was cold sprayed on structural carbon steel substrates using N2 as propellant gas. The corrosion behavior was then examined by salt spray test in accordance with DIN EN ISO 9227 and open circuit potential analysis. The quality of as-sprayed deposits was characterized in terms of micro¬structure, porosity, cohesive strength, and the corrosion behavior. The results demonstrate that the corrosion resistance can be improved by increasing the process gas temperatures and pressures in terms of the ratio between particle impact velocity and critical velocity for bonding, as well the use of smaller powders proves as beneficial for reaching better deposit qualities. The findings show conditions that guarantee the above defined ratio η being >1.1 and a minimum thickness of 200 μm are essential to ensure the needed noble behavior. Microstructural analyses reveal that the local corrosion attack takes place via the larger pores and non-bonded interfaces as penetration path, which leads to break the passive film and further penetrating the corrosive medium towards interior layers.

Biography

Farrokh Taherkhani, M.Sc. is a doctoral candidate at the Institute of Materials Technology at Helmut Schmidt University (HSU), Hamburg, Germany and parallel he works as a research staff at the Chair of Steel Structures of HSU. He has studied materials science engineering at the Amirkabir University of Technology, Iran. Afterwards he worked in various positions in industry and science on metallurgical topics. At the chair of Steel Structures, he is researching the galvanizing of hydraulic steel structures and supports other projects; additive manufacturing of steel structures by means of CS and mechanical behavior of steel welded joints under dynamic loading.

DEVELOPMENT AND EVALUATION OF COST-EFFECTIVE SILVER NANOPARTICLE-INFUSED PHARMACEUTICAL HYDROGELS FOR ANTIMICROBIAL APPLICATIONS

Alaaldin M. Alkilany[1], Arshiya Husaini[1], Ahmed Waseem[2], Ousama Rachid[1] and Nahla O Eltai[3]

[1]College of Pharmacy, QU Health, Qatar University, Qatar
[2]Oryx Falcon Veterinarian, Qatar
[3]Biomedical research Canter, Qatar University, Qatar

Abstract

Silver-infused hydrogels represent a significant advancement in exploiting the antimicrobial properties of silver nanoparticles (AgNPs), which are minute particles ranging from 1 to 100 nm in size. Despite the availability of AgNP-based products in the market, their high cost and the scarcity of locally produced generic alternatives pose considerable challenges. This study aims to address these challenges by developing a straightforward and scalable manufacturing process for producing high-quality, cost-effective pharmaceutical hydrogels containing AgNPs, with a concurrent evaluation of their antimicrobial efficacy.

In this study, AgNPs were synthesized in large quantities using a wet chemical method, with sodium borohydride employed as a reducing agent and polyvinyl pyrrolidone as a capping and stabilizing agent. The synthesized nanoparticles were rigorously characterized to determine their size, surface charge, and colloidal stability. These AgNPs were then incorporated into pharmaceutical hydrogels, which were subsequently tested for their in vitro antimicrobial activity against Methicillin-resistant Staphylococcus aureus (MRSA) and Escherichia coli, using SilverStat® Gel as a control. In collaboration with Oryx Falcon Veterinary Clinic, the hydrogels were also applied in vivo to treat a falcon afflicted with ulcerative pododermatitis (bumblefoot).

The synthesized AgNPs demonstrated uniform size distribution, a negative surface charge, and high resistance to aggregation, with consistent reproducibility across different batches. The antimicrobial efficacy of the AgNP-containing hydrogels was found to be comparable to that of the commercial SilverStat® Gel when tested against MRSA. Furthermore, the application of these hydrogels to the falcon resulted in a marked acceleration of the healing process for advanced pododermatitis.

In conclusion, this research successfully established a cost-effective and scalable process for producing high-quality AgNP-containing hydrogels. These hydrogels exhibited excellent colloidal properties and demonstrated antimicrobial efficacy on par with existing commercial products. Additionally, the practical application of these hydrogels in treating advanced pododermatitis in falcons underscores their potential utility in clinical settings. This work contributes to addressing the economic and accessibility barriers associated with AgNP-based antimicrobial treatments.

Biography

Dr. Alkilany is a distinguished Professor of Pharmaceutics and Nanotechnology at Qatar University, where he also serves as the Research Coordinator for the College of Pharmacy. He earned his PhD from the University of Illinois in the USA and completed postdoctoral training at the University of Georgia. With a robust background in pharmaceutical manufacturing, Dr. Alkilany has worked with renowned organizations, including Lilly in the USA and Hikma Pharmaceuticals in Jordan. His extensive industry experience has led to the development of over twenty products for regulated markets.

Dr. Alkilany is highly regarded for his scholarly contributions to the field, boasting more than 60 publications that have garnered over 17,000 citations. His achievements have been recognized with the prestigious German AvH Fellowship, and he is listed among Stanford's Top 2% Scientists globally. His research primarily focuses on the development of nanomaterials for drug delivery and various biomedical applications, positioning him as a leader in the intersection of pharmaceutics and nanotechnology.

EFFECT OF ZINC OXIDE (ZnO) DOPANT ON THE PHYSICAL AND ELECTRICAL PROPERTIES POTASSIUM SODIUM NIOBATE THIN FILMS

Mohd Warikh Abd Rashid, Hidayah Mohd Ali Piah, Umar Al-Amani Azlan and Maziati Akmal Mohd Hatta

Universiti Teknikal Malaysia Melaka , Malaysia

Abstract

Background: Lead zirconia titanate (PZT) is widely used due to its ferroelectric and piezoelectric properties. However, toxic lead in PZT is extensively linked to the greenhouse effect. For this constraint, extensive research is being done to find new piezoelectric materials such as potassium sodium niobate (K0.5Na0.5NbO3 or KNN). Due to processing difficulties, KNN has been disregarded for a long time. Volatilization of alkaline elements causes compositional inhomogeneity and lowers piezoelectric activity of ceramics

Objective: This research examines how ZnO-doping affects the structural and electrical changes and characteristics of potassium sodium niobate (KNN) ceramics

Methods: Potassium Sodium Niobate (KNN) thin films were grown on ITO substrate by using sol-gel spin coating method. The as-deposited thin films were heated 250°C pyrolysis for 5 min and then was annealed at the temperature 650°C with the ZnO dopant from 0.1 to 0.9 mol. Following this, KNN thin films were characterized using X-Ray Diffraction (XRD) and Field Emission Scanning Electron Microscope (FESEM). The electrical properties of KNN thin films were analysed using Atomic Force Microscopy (AFM) and Piezoresponse Force Microscopy (PFM)

Results: Based on the findings, it can be inferred that a doping concentration of 0.9 mol ZnO is considered the most appropriate for the production of a homogeneous and cohesive KNN thin film.

Conclusion: This film demonstrates favourable electrical properties, making it well-suited for implementation in piezoelectric applications.

Biography

Mohd Warikh Abd Rashid has expertise in electroceramic materials for Potassium Sodium Niobate (KNN). Recently, he focused the processing or produced KNN using thin film to replace Lead Zirconia Titanide (PZT). His recently found potassium sodium niobate (KNN) is one of the most promising candidates for a new lead-free piezoelectric material for the purpose of providing a resource and shedding light on the future. He actively involved in teaching, research activities and administration as a deputy director of Centre of Research of university. He was also actively involved in the publication of high-impact journal. He is also actively involved with industry and other university for collaboration for research.

PREPARATION AND APPLICATION OF NEW MATERIALS BASED ON NATURAL DEEP EUTECTIC SOLVENTS FOR EXTRACTION ENVIRONMENTAL POLLUTANTS

Justyna Werner

Poznan University of Technology, Poland

Abstract

Taking into account the principles of Green Analytical Chemistry and sustainable development, an important aspect is the search for materials based on natural compounds that will be efficient sorbents, selective towards selected groups of environmental pollutants, but will also be safe, reusable and biodegradable.

Deep eutectic solvents (DESs) are mixtures of hydrogen bond donors (HBDs) and hydrogen bond acceptors (HBAs), where the formation of hydrogen bonds is crucial in the formation of these compounds. It is also important that achieving the so-called eutectic point means obtaining a mixture characterized by a much lower melting point compared to the melting points of HBD and HBA, which allows obtaining DESs, both in the liquid and solid states. This provides the possibility of using DESs as sorbents in microextraction techniques, such as solid phase microextraction (SPME) and related techniques.

The aim of the research was to design and synthesize deep eutectic solvents based on natural substrates (NADESs) and the possibility of using them as sorption materials for the extraction of environmental pollutants.

For the synthesis of solidified NADES, the following were used, among others: long-chain alcohols, fatty acids, amino acids, cellulose, chitosan, betaine chlorides and non-toxic ammonium chlorides in various combinations HBD/HBA and different molar ratios. The properties of the new natural materials and their surface were characterized using FT-IR, TGA, BET, EDX, and SEM. The obtained solid NADES were then used as sorbents in thin film microextraction (TFME) and dispersive micro-solid phase extraction (d-μSPE) techniques in various construction solutions, on supports also based on natural compounds, such as gelatin, wood or cork. The prepared sorption systems (sorbent/support) were used to extract selected groups of pesticides as well as antibiotics and their metabolites from environmental water samples, and then were determined using the HPLC-UV technique with full validation of the developed analytical method.

Biography

Justyna Werner is currently an assistant professor at the Faculty of Chemical Technology at the Poznan University of Technology (Poland). She has knowledge of analytical chemistry and sample preparation techniques. He has experience in both solvent-based (DLLME, USAEME) and solvent-free microextraction techniques (SPME, TFME, d-μSPE). She also deals with the synthesis of new sorbents and extractants. She mainly focuses on introducing "green" solutions into analytical procedures and focuses on determination trace amounts of environmental pollutants, including: pesticides, bisphenols, parabens, formaldehyde, drugs and their metabolites using liquid chromatography with various detectors.

TOWARD A COLLABORATIVE PLATFORM TO FOSTER MATERIAL CIRCULARITY OF ELECTRICAL AND ELECTRONIC EQUIPMENT

Rinaldo Garziera, Luca Collini, Claudio Favi and Marco Marconi

University of Parma, Italy

Abstract

Electrical and electronic equipment (EEE) are a large family of common products that support the daily activities of our life (e.g. washing of clothes, food storage, cooking). In this sector the scarce use of life cycle engineering methods and tools represents an important barrier against the practical implementation of circular economy models. The study aims to propose a platform, called PiCo2RAEE, to support the design and management of the EEEs during the whole life cycle, fostering collaboration among the most important life cycle stakeholders, from designers to consumers to subjects involved in end-of-life management. The platform integrates three main modules: (i) a tool dedicated to the design for disassembly; (ii) a digital tool to track relevant information among all the value chain stakeholders; (iii) An informatic platform to favor the sharing and recirculation of information, competences, products, components and materials. The PiCo2RAEE platform aids the adoption of circular models based on enhancing EEEs durability, recyclability, repairability, upgradability, remanufacturability.

Biography

Rinaldo Garziera has his expertise in evaluation and passion in improving the health and wellbeing. He is an outstanding scientist in the field of Applied Mechanics. His main subjects are: mechanical vibrations of particular components, multi-stratum dynamics and Lagrangian simulations. Recently he carried on a certain number of studies on the human aorta, with particular focus on the residual stress. He is associate editor of the journal "Applied Mechanics Reviews".

FPGA-BASED ACCELERATION OF REINFORCEMENT LEARNING

Khawla Saif Almazrouei and Tala Bonny

Autonomous Robotics Research Center (ARRC), Technology Innovation Institute (TII), UAE

Abstract

Reinforcement Learning (RL) has emerged as a critical methodology for decision-making in dynamic and uncertain environments, with widespread applications in robotics, autonomous driving, and gaming. Despite its promise, the intensive computational requirements of RL algorithms, particularly in real-time systems, pose significant challenges. Field-Programmable Gate Arrays (FPGAs) have been identified as a potential solution due to their parallel processing capabilities, low latency, and reconfigurability, making them ideal for accelerating RL algorithms. This paper explores the FPGA-based acceleration of the Deep Q-Network (DQN) algorithm, one of the most computationally demanding RL methods. We introduce a novel state transition function, 'convSEG,' which optimizes state representation and action mapping, enhancing the efficiency of the learning process.

The methodology involves defining states and actions in binary form and using 'convSEG' to map transitions in a reinforcement learning environment. We implement this approach on an FPGA platform to accelerate the learning process, significantly reducing training time and enabling real-time decision-making. The empirical results demonstrate that FPGA-based acceleration achieves up to 4.65 times speedup in training and execution compared to traditional CPU-based systems, with similar improvements noted in autonomous robotics and gaming scenarios.

Our findings suggest that FPGA-accelerated RL can effectively address the computational bottlenecks in high-stakes, real-time applications such as autonomous vehicle navigation and robotic control. This work paves the way for future innovations in the deployment of RL across various sectors, demonstrating that FPGAs are a promising hardware solution for scaling RL applications in complex environments.

Biography

Eng. Khawla Almazrouei is an accomplished engineer in the System Prototyping and Integration Team (SPRINT) at the Autonomous Robotics Research Center (ARRC) at the Technology Innovation Institute (TII), Abu Dhabi. Her expertise lies in the areas of autonomous robots, with a special focus on perception, sensor fusion, and machine learning. Khawla has authored several research papers on topics such as dynamic obstacle avoidance, path planning through reinforcement learning, UAVs, computer vision, and sensor architecture. Her passion for artificial intelligence and robotics drives her continuous learning and contribution to advancing autonomous systems. She actively collaborates with innovative teams to push the boundaries of robotics technologies.

THE DEVELOPMENT OF RADIATION SHIELDING MATERIALS INVOLVES INCORPORATING LANTHANUM OXIDE DOPANTS INTO GLASS

Siriprapa Kaewjaeng[1], G Khudyod[1], O Ornketphon[1], P Meejitpaisan[2], C Mutuwong[2] and J Kaewkhao[2]

[1]*Chiang Mai University,Thailand*
[2]*Nakhon Pathom Rajabhat University, Thailand*

Abstract

The glass formula (70-x)P_2O_5: 15NaF: 5ZnF_2: 15AlF_3: xLa_2O_3 where x is 0, 5, 10, 15 mol%, was produced using the melt-quenching technique for photon shielding applications. The glasses were investigated for their physical, transmission, gamma-ray, and x-ray shielding properties. The results revealed an increase in density with higher concentrations of L La^{3+} ions. The transmission spectra of the glasses show higher transparency compared to x-ray windows. In comparative studies of gamma-ray properties between experimental and theoretical data, the mass attenuation coefficients (MAC), effective atomic number (Z_{eff}), and effective electron density (Neff) increased with the rising concentration of La^{3+} ions. Conversely, the half-value layer (HVL) decreased. The energy absorption buildup factor (EABF) and exposure buildup factor (EBF) of dopant La^{3+} ions in the glass samples were calculated and discussed in terms of energy and concentration. In x-ray applications, the HVL decreased with an increase in La^{3+} ions content. The HVL value at a 15 mol% concentration of La^{3+} ions are higher than standard materials at 120 kVp. The glass systems doped with La^{3+} ions could be potential candidates for x-ray and gamma-ray glass shielding in future applications.

Day-1
Poster Presentations

PREPARATION OF NANOSTRUCTURED COPPER OXIDE BY MEANS OF WET CORROSION PROCESS (WCP) AND THEIR APPLICATION TO PHOTOCATALYSIS

Yuta Igawa, T Nishiguchi, H Oshiumi, H Suzuki and SY Lee

Shibaura Institute of Technology, Japan

Abstract

Background: Nanomaterial devices have been extensively studied for use in electronic devices and photocatalysts because their performance can be highly functionalized. Coper (Cu) oxide is a one of the meaningful candidate materials for photocatalysis. In order to increase the photocatalytic effect, a high surface area and sensitivity of the surface charge are recommended. Therefore, nanostructured coper oxide with the possibility of tuning of the surface charge are promising candidate for high performance photocatalysis. Currently, the nanostructure fabrication generally involves complicated process, low reproducibility and/or high cost for chemical modification. Hence, a simple method to synthesize and to tune the desired morphology and property is strongly desirable.

Objective: Study of the best condition to fabricate the nanostructured Cu oxide and their physical properties. In addition, photocatalytic functions of the obtained Cu oxide were evaluated.

Methods: The surface of the Cu substrate (99.9 % 1 cm × 1 cm×1 mm) was polished, followed by ultrasonic cleaning with acetone and ethanol. The Cu substrate was then immersed in KOH solutions of varying concentrations (0.01 mol/L~5 mol/L) and the reaction was carried out for 24h by shaker. After the reaction, the plate was washed with pure water. The obtained products were characterized by SEM, TEM, and AFM. And to evaluate the photocatalytic activity, methylene blue was dropped onto three different pallets (WCP-treated Cu plate, pure Cu plate, and none), and the decomposition degree was measured with a UV-visible spectrophotometer.

Results: Nanostructures were formed on the surface of the Cu substrate at all concentrations of KOH solution, but thin and long needle-like nanostructures were formed in the sample treated with 0.1 mol/L-KOH solution. From TEM images, the diameter of the sample treated with 0.1 mol/L-KOH solution was 23 nm. AFM results showed that the sample treated with 0.1 mol/L-KOH solution had the largest surface area. Based on AFM result, 0.1 mol/L-KOH solution treated Cu displayed high degradation of the methylene blue, indicating the high photocatalytic activity owing to high surface area.

Conclusion: Nanostructured Cu oxides were successfully fabricated by means of WCP, and the best condition to fabricate the needle like nanostructures was 0.1 mol/L-KOH solution treated Cu. In addition, 0.1 mol/L-KOH solution treated Cu oxide exhibited high performance in photocatalytic function.

Biography

Yuta Igawa graduated from the Department of Materials Science and Engineering at Shibaura Institute of Technology and now I am a student in the Master's Program in same department. I have a huge interesting about photocatalysis, so I have been studying the nanostructures fabrication to enhance the photocatalytic activity using Cu.

DEGRADATION OF SULFAPYRIDINE BY OZONE-BASED OXIDATION

Chung-Hsin Wu, YC Wang, LM Chiang and SY Wei
National Kaohsiung University of Science and Technology, Taiwan

Abstract

Sulfonamidess are one of the largest classes of globally used antibiotics should be effectively treated to eliminate them. In this study, sulfapyridine (SPY) was degraded using O_3, UV/O_3, UV/O_3/H_2O_2 and UV/O_3/$Na_2S_2O_8$ systems at pH 7. Under UV irradiation, ozone decomposed to form hydroxyl radicals (HO•), so the residual ozone concentrations in the UV/O_3, UV/O_3/H_2O_2 and UV/O_3/$Na_2S_2O_8$ systems were lower than that in the O_3 system. The photodegradation and mineralization of SFZ in all tested systems exhibited pseudo-first-order kinetics. The pseudo-first-order photodegradation rate constants in O_3, UV/O_3, UV/O_3/H_2O_2 and UV/O_3/$Na_2S_2O_8$ systems were 0.0456, 0.0959, 0.1086 and 0.1219 min- 1, respectively and the pseudo-first-order mineralization rate constants in those systems were 0.0061, 0.0078, 0.0102 and 0.0352 min-1, respectively. The SPY photodegradation rate exceeded the mineralization rate in all tested systems. Combining ozone with UV promoted the mineralization of SPY by the direct and indirect formation of HO•, and adding $Na_2S_2O_8$ promoted the formation of sulfate radicals. Adding NaCl reduced the mineralization rate of SPY in the UV/O_3/$Na_2S_2O_8$ system. The figure-of-merit electrical energy per order was used to estimate the electrical energy efficiencies of the systems. At pH 7, the UV/O_3/$Na_2S_2O_8$ system exhibited the highest energy efficiency and rate of SPY mineralization.

Background: Antibiotics have been detected in environmental matrices globally, owing to their excessive use by humans and in animals and their removal from water and wastewater is largely ineffective. Sulfonamide is one of the largest classes of globally used antibiotics. The European Union stipulates that the maximum tolerable level of sulfapyridine (SPY) in animal medicine is 100 ng/g (Li et al., 2016). Since SPY must be carefully removed from all effluent, it is the target compound in this study. Advanced oxidation processes (AOPs) are based on the intermediacy of hydroxyl and other radicals in the oxidation of recalcitrant, toxic and non-biodegradable compounds into various by-products and, eventually, into inert end-products. The objectives of this study are to compare the efficiencies of mineralization of SPY in O_3, UV/O_3, UV/O_3/H_2O_2 and UV/O_3/$Na_2S_2O_8$ systems. The electrical energy per order of SPY removal (EEO) by mineralization in these systems is also determined.

Objective: To examine the efficiencies of mineralization of SPY in O_3, UV/O_3, UV/O_3/H_2O_2 and UV/O_3/$Na_2S_2O_8$ systems.

Methods: The parent compound SPY, with molecular formula $C_{11}H_{11}N_3O_2S$, was purchased from Acros. The oxidants $Na_2S_2O_8$ and H_2O_2 were obtained from Sigma-Aldrich and Merck, respectively. The pH of solution was adjusted by adding 0.1M HNO3 and 0.1M NaOH, and thereby maintained at pH 7 during reaction. All solutions were prepared using deionized water (Milli-Q) and reagent-grade chemicals. All chemicals were used as received. The initial concentrations of SPY and oxidant in all experiments were 20 mg/L and 5 mM, respectively. The ozone generator was an Ozone Solutions TG-20 (USA) and the outlet ozone flow-rate was 3.353 L/min. The residual ozone concentration in the solution was measured using the indigo colorimetric method (Method 4500) (APHA, 1992). Degradation experiments were conducted in a 3L hollow cylindrical glass reactor. An 8W UV lamp (254 nm, 1.12 W/m^2, Philips, Tokyo, Japan) was placed inside a quartz tube as the light source. The temperature was maintained at 298K in all experiments. The decrease in total organic carbon (TOC), measured using an O.I. 1010 TOC analyzer

(USA), revealed SPY mineralization.

Results: Plots the residual ozone concentration in the ozone-based systems during SPY mineralization. After the first 30 min of aeration of D.I. water with ozone, the concentration of the dissolved ozone was 4.6 mg/L. After SPY was added and allowed to react for 120 min, the dissolved ozone concentrations in the O_3, UV/O_3, $UV/O_3/H_2O_2$ and $UV/O_3/Na_2S_2O_8$ systems at pH 7 were 5.4, 0.67, 0.71 and 0.24 mg/L, respectively. Under UV irradiation, ozone decomposed to form HO•, so the residual ozone concentrations in the UV/O_3, $UV/O_3/H_2O_2$ and $UV/O_3/Na_2S_2O_8$ systems were lower than that in O_3 system. Plot the efficiencies of photodegradation and mineralization of SFZ, respectively. After 60 min of reaction, the degrees of SPY photodegradation in O_3, UV/O_3, $UV/O_3/H_2O_2$ and $UV/O_3/Na_2S_2O_8$ systems were 81%, 91%, 93% and 94%, respectively and the degrees of SPY mineralization in those systems were 40%, 52%, 59% and 93%, respectively. Ozone oxidizes organics via two possible degradation routes: (i) under basic conditions, ozone rapidly decomposes to yield hydroxyl and other radicals in solution (Eq. (1)) and (ii) under acidic conditions, ozone remains stable and reacts directly with organic substrates. Combining ozone with UV promotes the mineralization of SPY by the direct and indirect formation of HO• following ozone decomposition and hydrogen peroxide formation, respectively (Eqs. (2) and (3)). The combined process is more effective than a single process because UV radiation promotes ozone decomposition, yielding more HO•, thereby increasing the mineralization rate. Equations (3) and (4) describe the reactions in the UV/H_2O_2 and $UV/Na_2S_2O_8$ systems, respectively.

$O3 + OH^- \rightarrow O_3^-. + OH$ (1)

$O3 + H2O + UV \rightarrow O_2 + H_2O_2$ (2)

$H_2O_2 + UV \rightarrow 2\ OH$ (3)

$S_2O_8^{2-} + UV \rightarrow 2\ SO_4^-$ (4)

The removal of SPY approximately followed pseudo-first-order kinetics, given by $\ln(Ct/C0) = -kt$, where t represents reaction time; k is the pseudo-first-order rate constant; and C0 and Ct are the concentrations of SPY at times t = 0 and t = t, respectively. summarizes the pseudo-first-order rate constants and correlation coefficients of the removal of SPY in various AOPs at pH 7. The pseudo-first-order photodegradation rate constants in O_3, UV/O_3, $UV/O_3/H_2O_2$ and $UV/O_3/Na_2S_2O_8$ systems were 0.0456, 0.0959, 0.1086 and 0.1219 min^{-1}, respectively; the pseudo-first-order mineralization rate constants in those systems were 0.0061, 0.0078, 0.0102 and 0.0352 min^{-1}, respectively. The SPY photodegradation rate exceeded the mineralization rate in all tested systems. Plots the effects of salinity on SPY mineralization efficiency in the $UV/O_3/Na_2S_2O_8$ system. After a 60 min reaction, the SPY mineralization percentages in the $UV/O_3/Na_2S_2O_8$,

$UV/O_3/Na_2S_2O_8$/1% NaCl and $UV/O_3/Na_2S_2O_8$/3.5% NaCl systems were 93%, 80% and 68%, respectively. Adding NaCl reduced the mineralization rate of SPY in the $UV/O_3/Na_2S_2O_8$ system. Inorganic salts influence ozonation as they are radical scavengers and affect the mass transfer rate. The equations for the reaction of chloride ions with HO• (Eqs. (5) and (6)) (Liao et al., 2001) and SO_4^-• (Eqs. (7)) are as follows. The oxidizing ability of Cl• is weaker than that of HO• and that of SO_4^-•, so the generation of Cl• reduced the rate of SPY mineralization.

$HO\bullet + Cl- \rightarrow HOCl^-\bullet$ (5)

$HOCl-\bullet + H+ \rightarrow Cl\bullet + H_2O$ (6)

$SO_4^-\bullet + Cl- \rightarrow SO_4^{2-} + Cl\bullet$ (7)

The figure-of-merit electrical energy per order (EEO) can be used to estimate the electrical energy efficiency. For low pollutant concentrations, the EEO ($kW•h•m^{-3}•order^{-1}$) value can be obtained using Eq. (8).

EEO = (38.4 x P)/(V x k)   (8)

where P is the power (kW) of AOPs; V is the volume (L) of the solution in the reactor; and k is the pseudo-first-order rate constant (min^{-1}) for mineralization (Daneshvar et al., 2005). A higher EEO value corresponds to a lower energy efficiency of the system. The most effective system for mineralizing SPY herein was $UV/O_3/Na_2S_2O_8$.

Biography

Chung-Hsin Wu received a Doctorate in Environmental Engineering from National Taiwan University in 1999 and joined the faculty of Chemical and Materials Engineering at National Kaohsiung University of Science and Technology (NKUST) in 2010 as a Professor. He is currently a Distinguished Professor there. He was the Head of Department during 2015-2019 and Dean of the College of Engineering during 2019-2022; he is now the Vice- President. He is a registered Professional Engineer (P.E., Taiwan) in environmental engineering. His research interests include processes for treating contaminated waters and hazardous chemicals, and eight Taiwanese patents have been issued for his work. He is currently working on the synthesis of novel photocatalysts. Professor Wu has authored over 135 SCIE journal papers and 85 conference presentations and seminars; additionally, he was one of the top 2% of the most-cited scientists in chemical engineering (career-long and in a single year) as certified by Stanford University.

QUANTIFYING BIOCERAMIC BONE GRAFT DEGRADATION PROCESSES IN A BIOCHIP

Man-Ping Chang and CH Huang

National United University, Taiwan

Abstract

Background: This study developed a microfluidic biochip to quantify the degradation process of bioceramic bone grafts in extreme solutions and simulated body fluid environments. Biocompatible ceramics are prepared using various proportions of hydroxyapatite and calcium sulfate, which are then ground into powder and injected into microfluidic biochips. With microfluidics technology, the bioceramic powder is vibrated and degraded by the solution in the chamber, and microstructural analysis and recording can be performed through a microscope in real-time. The results show that microfluidic biochips can conduct bioceramics degradation testing with a considerably smaller number of samples, thereby providing significant cost-effectiveness and improving more accurate quantitative results.

Objective: Objectively quantify the degradation process of bioceramic bone grafts using microfluidic biochips. The goal is to reduce the cost of related experiments.

Methods: This device is designed with a chamber as a shock zone for bioceramic powder and degradation solution. Above the chamber, there is a PDMS film and a microchannel. This film can be introduced into the microchannel through the gas to increase the internal pressure and cause the film to bulge. The film protrusions cause the liquid in the chamber to agitate and achieve oscillation and mixing, which provides a controlled degradation testing method.

Results: The solution in the chamber was subjected to a 3-day degradation test through a pneumatic vibration of 2 Hz. After each day of vibration, it was left to stand for 5 minutes for image capture. The solution becomes more turbid as the days pass, and the powder area also decreases, making it easier to record the degradation process.

Conclusion: This work has successfully provided a tool to analyze the degradation of biomedical ceramics more conveniently through microfluidic technology. Later, it will be combined with electrochemistry to further improve the accuracy and convenience of quantitative results.

Biography

Man-Ping Chang is Professor in Department of Materials Science and Engineering, National United University (NUU), Taiwan. Prior to joining NUU, she was a Postdoctoral Researcher at the Department of Mechanical Engineering, National Kaohsiung University of Science and Technology, Taiwan (2018-2020). Dr. Chang has expertise in bioceramic materials, ceramic composites, bone grafts, and biodegradable ceramics. In the past, Dr. Chang has focused on developing bone grafts with calcium Sulfate anhydrate-based composites and has published her research about biodegradable calcium sulfate-based bone grafts in some international journals. Recently, she emphasized developing a novel biodegradable evaluation method with a microfluidic biochip. It is hoped that it can provide a more convenient and quantifiable tool for analyzing the degradation of biomedical ceramics, which will help improve bone transplantation technology and patient well-being.

ENHANCED ELECTROMAGNETIC-WAVE ABSORPTION PROPERTIES OF PHOTOSENSITIVITY EPOXY/NANO COBALT BUCKYBALL META STRUCTURE COMPOSITES

Yu-Cheng Kuo and Yi-Jen Huang

National Chin-Yi University of Technology, Taiwan

Abstract

As more electronic devices are used, electromagnetic radiation levels have also gone up. This can cause signal distortion and interference, which makes it harder for new technologies like self-driving cars and wearable electronics to work reliably. The goal of this study is to look into how metastructures with nano cobalt electromagnetic wave-absorbing materials can work together to improve reflection loss in the 2–18 GHz frequency range. Electromagnetic wave absorption hinges on both the material properties and the geometric configuration of the absorbent. We aim to optimize electromagnetic absorption efficiency by carefully considering both magnetic loss properties and structural characteristics. Our methodology entails the synthesis of novel metastructures, wherein nano cobalt is integrated with 3D-printed Buckyball units and UV-curable epoxy. The results demonstrate that the developed metastructural absorbers exhibit absorptivity levels exceeding 90% across a broad spectrum of frequencies. These materials evince exceptional attributes in electromagnetic wave absorption, mechanical strength, and adjustability, thus rendering them highly suitable for diverse engineering applications. The integration of nano cobalt into three-dimensional Buckyball metastructures, in conjunction with UV-curable epoxy, yields materials that manifest remarkable absorptivity for vertically incident waves. Notably, these metastructures offer exceptional electromagnetic wave absorption properties, complemented by impressive mechanical characteristics such as high specific strength and energy absorption. Consequently, they present promising avenues for utilization in lightweight structural materials and electromagnetic wave absorption applications. In summary, this research underscores the potential of metastructural composites to address the challenges posed by electromagnetic interference within electronic systems. It thereby facilitates the exploration of innovative solutions across various engineering domains.

Biography

Yu-Cheng Kuo research primarily focuses on the development of electromagnetic wave absorption materials and light-sensitive epoxy resins. I am involved in the synthesis of advanced metastructures that exhibit exceptional absorption properties across a broad frequency spectrum (2–18 GHz). These innovations promise significant advancements in the field of electromagnetic wave absorption. Additionally, I have secured a patent related to electromagnetic wave absorption technologies, underscoring my expertise and contribution to this specialized area.

MOLECULAR MECHANISM OF VISCOELASTIC CREEP DEFORMATION OF POLYELECTROLYTE ELASTOMERS

Mohammad Reza Adibeig, Qiqi Xue and Canhui Yang

Southern University of Science and Technology, China

Abstract

Background: The past decade has witnessed a significant surge in the field of stretchable ionotronics, wherein stretchable ionic conductors play an essential role. Among the many types of stretchable ionic conductors, polyelectrolyte elastomers have been featured as the most promising candidates for engineering practice owing to their leakage-free nature. Thus, the interest in the advent and development of stretchable ionoelastomers has increased, and it is necessary to understand the fundamentals of their mechanical behavior.

Objective: To examine the effects of using different molar ratios and crosslink densities on the creep behavior of polyelectrolyte elastomers (PEE).

Methods: The viscoelastic creep and delayed fracture behaviors of PEEs by using the poly(1- [2acryloyloxyethyl]-3-butylimidazolium bis(trifluoromethane) sulfonimide-co-methyl acrylate) (P(AT- co-MA)) elastomer crosslinked by 1,6-hexanediol diacrylate (HDDA) as a model material are studied. We synthesize two sets of PEEs: one with different molar ratios of AT:MA (3:1, 1:1, 1:3) at a fixed crosslink density (CD) of 0.1% and the other with different crosslink densities (0.1%, 0.2%, 0.5%) at a fixed molar ratio of AT:MA=1:3. The crosslink density is represented by molar percentage with respect to the monomer. The tensile and creep tests to investigate the mechanical properties of PEEs are conducted and presented in **Figure 1** and **Figure 2**, respectively.

Results: The samples of 0.1% and 0.2% CDs at a molar ratio of AT:MA=1:3 exhibit substantial strain softening at small deformation, implying that certain weak bonds with short association time, such as the electrostatic interactions have been ruptured at the testing strain rate. A decrease in the molar ratio results in a significant increase in stretchability and ultimate strength, which is beneficial to impede the slippage of chains and resist creep.

Conclusion: Chemical crosslinks create a stable three-dimensional network structure, enhancing the resistance to creep by restricting the mobility of polymer chains. The delayed fracture phenomenon has been elucidated, complemented by the effects of applied stress and strain hardening and the variations of creep strain rate with time and applied stress. The strain-rate response further underscores the strain- hardening effect and its correlation with network structure.

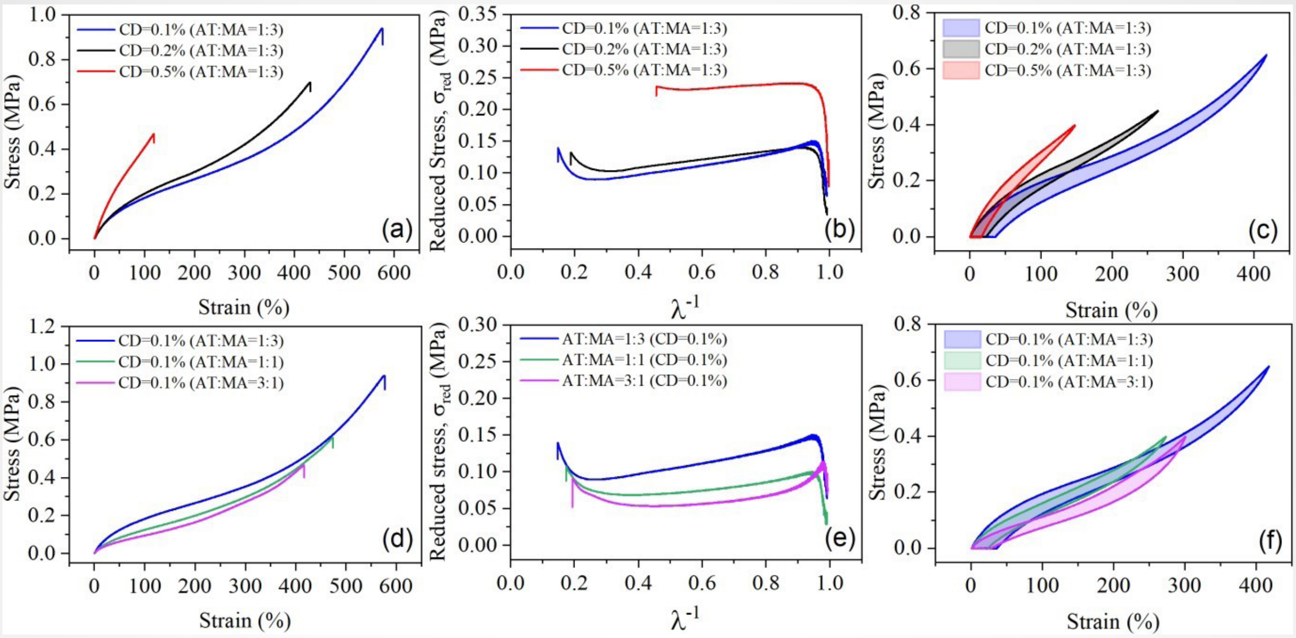


Figure 1: a) Stress-strain curves of samples with CD=0.1, 0.2, 0.5%, and AT:MA=1:3, b) Reduced stress-stretch curves of samples with CD=0.1, 0.2, 0.5%, c) Hysteresis loops for samples with CD=0.1, 0.2, 0.5%, and AT:MA=1:3, and AT:MA=1:3, d) Stressstrain curves of samples with molar ratios of AT:MA=3:1, 1:1, 1:3, and CD=0.1%, e) Reduced stress-stretch curves of samples with AT:MA=3:1, 1:1, 1:3, and CD=0.1%, f) Hysteresis loops for samples with molar ratios of AT:MA=3:1, 1:1, 1:3, and CD=0.1%.

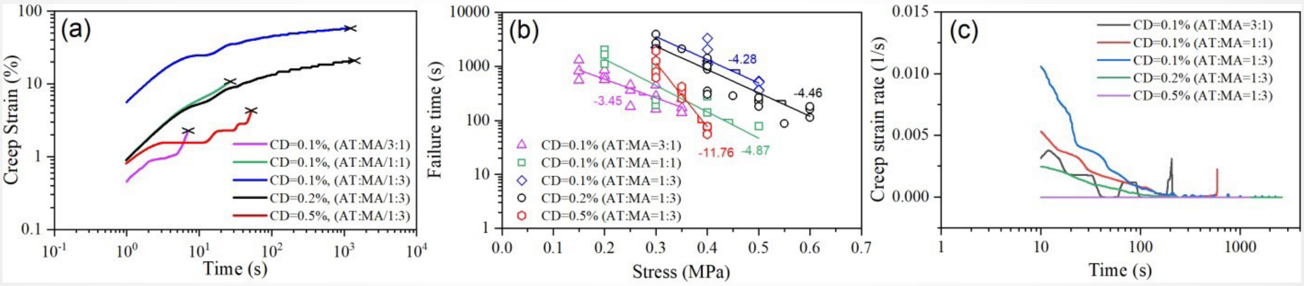


Figure 2: a) Comparison of creep strain of specimens with 0.1, 0.2, and 0.5% CD under initial stress value of 0.4 MPa, b) Variation of creep failure time and c) creep strain rate in terms of time for samples under stress of 0.3 MPa.

Biography

Mohammad Reza Adibeig is a mechanical engineer specializing in solid mechanics and additive manufacturing. With a Ph.D. from the University of Tabriz, his research focuses on the mechanical behavior of various materials, particularly polymers and metals. Dr. Adibeig's pioneering work includes investigating creep behavior in friction stir welded joints, leading to significant advancements in joint design and durability. As a postdoctoral researcher at SUSTech University, he continues to explore innovative solutions in ionic conductive elastomers, contributing to cutting-edge developments in materials science. His interdisciplinary approach, extensive publication record, and collaborative spirit underscore his commitment to advancing engineering knowledge and fostering sustainable technological progress.

CALIBRATION OF VISCO-HYPERELASTIC MATERIALS USING CYCLIC LOADING

Abuzar Es'haghi Oskui, Jinrui Cao, Sorour Sadeghzade and Hongyan Yuan

Southern University of Science and Technology, China

Abstract

Background: Optically clear adhesive (OCA) is an example of almost incompressible, soft, and clear elastomers which has been widely employed in foldable displays such as organic light-emitting diode (OLED) and active-matrix organic light-emitting diode (AMOLED) screens. Nowadays, OCAs are employed in layers of flexible AMOLED modules to form a composite stack structure in backplane, AMOLED films, and polarizers.

Objective: The popularity of OCAs can be assigned to their outstanding advantages including highly transparent, free of bubbles or distortions which can significantly improve the image resolution. Regarding the increasing demand for foldable OLED displays, their extensive application requires the characterization of all their features including OCA materials. As discussed in the following sections, this paper aims to investigate the ability of Three Network Viscoplastic (TNV) constitutive model in the prediction of cyclic loading in OCA.

Methods: It is possible to extract the material's viscoelastic, viscoplastic, and hyperelastic properties by designing some low cycle tests as optimal experiments. By examining such a test, it is also possible to investigate hysteresis, energy dissipation, and damage effect during cyclic loading. **Figure 1** illustrates the time-dependent changes in strain input and stress output. Furthermore, the significant reduction in stress at the stop places clearly demonstrates that relaxation has a significant impact on material behavior. Relaxation will be more significant as the loading or strain rate increases. Particularly during the relaxation period of the last cycle, the stress decreased by approximately 34%. It can be seen in **Figure 1** (colored area below the diagram) that the slope of the loading curve has also decreased during successive loading and unloading cycles, indicating material softening or damage.

Calibration is always an important part of the process of identifying the behavior of materials. Calibration is based on nonlinear regression and curve fitting techniques, which are done with an optimization process. A TNV model was used as constitutive Equation. All branches use the Yeoh component, and two branches use power-law flow. Furthermore, damage Mullin effects are also considered in the last branch. As can be observed in **Figure 2**, the parallel network model has a high ability to calibrate the target material, and the R2 is 0.99.

Results: Cyclic loading is very important when it comes to flexible display panels. This case study was conducted to investigate and confirm whether the presented models were capable of predicting cyclic behavior over a larger number of cycles. The test was conducted for 100 cycles at a maximum deformation of 0.5 mm, which is equivalent to 3.8 strains, 1.9 mean strains, and with strain rate of 0.1s-

1. The experimental and numerical stress-strain outputs are represented in **Figure 3**.

Conclusion: Calibration of constitutive models was performed using experimental data. A cyclic loading test was utilized in order to achieve the greatest variety of loading modes while using a limited number of tests (maximum optimum). It has been observed that cyclic loading leads to more accurate results with fewer tests, despite requiring more complex calibration models.

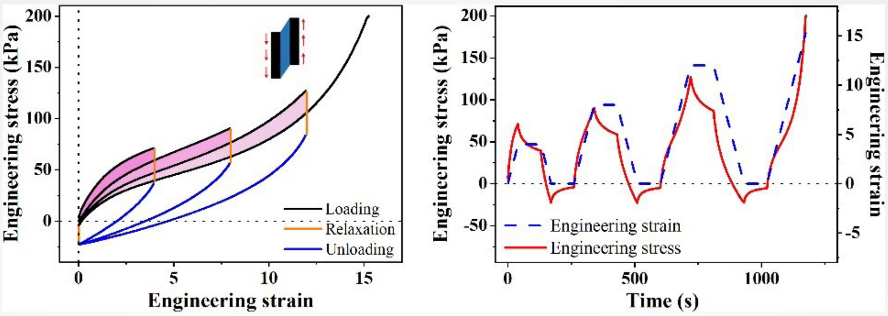


Figure 1: Experimental test results for loading-unloading low-cycle shear test.

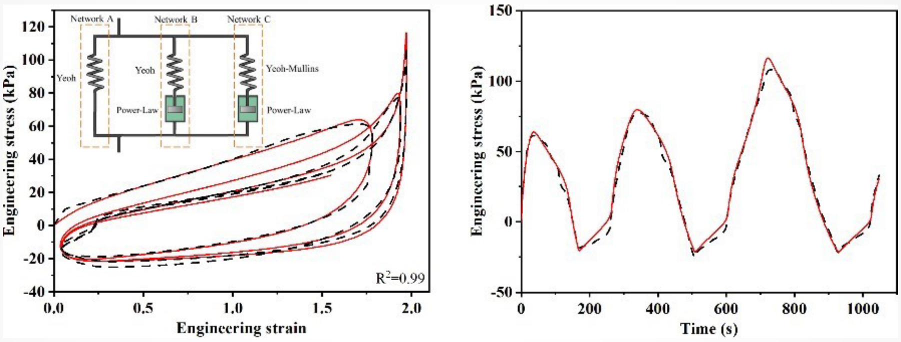


Figure 2: Fitting results of calibrated model based on loading-unloading low-cycle shear test.

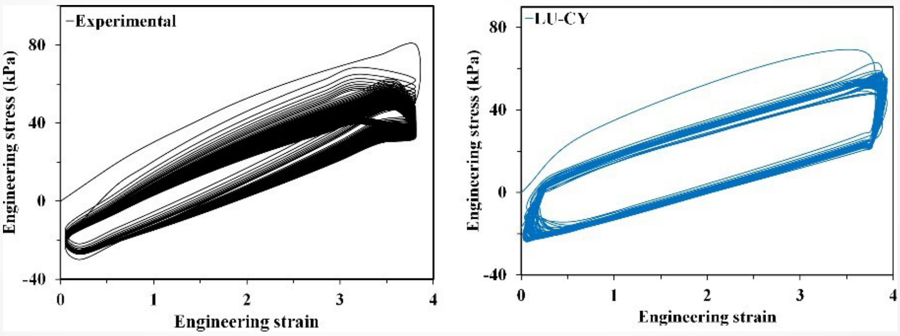


Figure 3: (Left) Experimental data for 100-cycle loading-unloading test (εmax=3.8, strain rate=0.1s^{-1}, f=0.0125Hz, 100 cycles), and (Right) Abaqus simulation by TNV constitutive model.

Biography

Abuzar Es'haghi Oskui is currently a postdoctoral researcher at the Southern University of Science & Technology (SUSTech). He taught mechanical engineering for ten years at the Technical and Vocational University (TVU) before joining SUSTech. The experimental and numerical examination of the mechanical properties of soft materials is the subject of their present project. Most of his research experience is in the fields of fracture mechanics, mixed-mode loading conditions, and material characterization under various forming procedures. Solid mechanics and material characterization of soft materials are his current research interest.

PREPARATION OF POROUS DEGRADABLE BONE SUBSTITUTES USING CALCIUM SULFATE/HYDROXYAPATITE

Zheng-Kai Fu, Chun-Hao Huang and Man-Ping Chang

National United University, Taiwan

Abstract

This study aims to develop a biomimetic bioceramic bone graft resembling cancellous bone, and investigates its degradation behaviors in extreme and simulated environments. The bioceramic bone grafts are synthesized with varying compositions of calcium sulfate and hydroxyapatite. Bulk specimens are used to assess physical properties, while powdered forms is utilized for degradation analysis. Microstructural analysis is performed using scanning electron microscope and true density measurements. In vitro degradation process is simulated in a thermostatic bath to mimic the physiological conditions. The results demonstrate that the physical and biological properties of the samples similar to cancellous bone characteristics, and their degradation behavior fulfills the requirements for clinical bone graft applications.

Background: Bone substitute materials can be classified into autografts, allografts, xenografts, and synthetic bone substitutes. Challenges associated with autografts, allografts, and xenografts include limited availability, transplant rejection, and risks of disease transmission. Calcium sulfate (CS) stands out as a cost-effective and biocompatible biomaterials. Moreover, CS demonstrates excellent bioabsorbable characteristics in biomedical ceramics. However, CS often lacks osteoinductive properties and exhibits poor mechanical strength. Incorporating of hydroxyapatite may potentially improve the performance of CS.

Objective: The aim of this study is to synthesizing bioceramic bone grafts with varying compositions of calcium sulfate and hydroxyapatite, to mimic the properties of cancellous bone and achieve biodegradability. The objective is to develop novel bone graft substitute materials suitable for human applications.

Methods: Varying compositions of calcium sulfate and hydroxyapatite powders are mixed into a solution with gelatin and coconut oil. Gelatin aid solidification, while coconut oil forms a porous structure. After solidification, the specimens are sintered at different temperatures. Their physical properties are evaluated, and degradation tests are conducted.

Results: Based on the SEM results, the average pore size ranges from 112.74 μm to 146.47 μm, and the porosity ranges from 76.75% to 86.09%. The pore size and porosity of the specimens are similar to cancellous bone. Additionally, as the sintering temperature increases, the average pore size and porosity gradually decrease. XRD analysis shows no new phases are formed in the powder before and after degradation. During the degradation process, the solution becomes more turbid over time, and the powder slightly decreases, possibly due to ion release into the solution.

Conclusion: This study has effectively developed a bioceramic bone substitute material with physical properties comparable to cancellous bone, demonstrating efficient degradation characteristics and mechanical strength.

Biography

Zheng-Kai Fu is a graduate student in the Department Materials Science and Engineering at National United University (NUU), Taiwan. His research primarily lies in bioceramic materials, bone grafts, and biodegradable ceramics. His research objective is to develop bioceramic bone grafts that emulate the properties of cancellous bone. He aims to advance bone grafting techniques, ultimately benefiting patients in need of such medical interventions.

CHARACTERIZATION OF AMINO-TERMINATED SELF-ASSEMBLED MONOLAYER ON CU/POROUS LOW-K DIELECTRICS

Yi-Lung Cheng

National Chi-Nan University, Taiwan

Abstract

In this study, amino-terminated self-assembled monolayers (SAMs) were grown onto the porous low-dielectric-constant (low-k) film (p-SiCOH) by using 3-Aminopropyltrimethoxysilane (APTMS) and (3-Trimethoxysilylpropyl) diethylenetriamine (DETAS). Both SAMs derived from APTMS or DETAS can enhance the breakdown field and time-dependent-dielectric-breakdown (TDDB) reliability. Additionally, the formation amino-terminated SAM can serve as barrier and adhesive for Cu/porous low-k integrity. DETAS-SAM had the better adhesion and TDDB reliability due to more amino-terminated bonds with Cu. On the other hand, APTMS-SAM had the superior barrier capacity against Cu migration.

Keywords: self-assembled monolayers; porous low-k film; 3-Aminopropyltrimethoxysilane; (3-Trimethoxysilylpropyl) diethylenetriamine; breakdown; Cu barrier; adhesion.

Biography

Yi-Lung Cheng received the PH.D. degree in material science and engineering in 2004 from National Chiao Tung University. Hsinchu, Taiwan. From 1998 to 2008, he worked in Taiwan Semiconductor Manufacturing Company (TSMC), working in the area of thin film, integration, and reliability of semiconductor devices. He joined the Department of Electrical Engineering, National Chi Nan University, Puli, Taiwan in 2008. Currently, he is professor. His research interests are in gate oxide reliability of metal–oxide–semiconductor devices, Cu/low-k ILD reliability. He has co-authored over 100 publications in referred journals and conferences.

ENHANCED NIR PHOTODETECTION AND MEMORY RETENTION IN ORGANIC SEMICONDUCTOR DEVICES USING DPP-DTT AND IEICO-4F

Min ju Jung and Eun Kwang Lee
Pukyong National University, South Korea

Abstract

Photomemory devices with near-infrared (NIR) detection capabilities are gaining attention as next-generation optoelectronic devices, as they offer not only light detection but also the ability to store and process light stimuli. These devices have potential applications in various fields, such as medical imaging, telecommunications, and security systems. Traditional silicon-based photodetectors have limited sensitivity in the NIR region, necessitating the development of new materials and device structures to enhance performance.

In this study, we focused on designing and developing organic semiconductor-based photomemory devices that can simultaneously perform NIR detection and memory functions. To achieve this, we utilized DPP-DTT as the donor and IEICO-4F as the acceptor materials, aiming to optimize light absorption in the NIR region and improve the device's memory performance. DPP-DTT is a donor material with strong absorption in the NIR region, while IEICO-4F is an acceptor known for its high electron mobility and broad absorption range. The combination of these materials enables efficient NIR detection and charge generation.

Furthermore, to maximize the photomemory performance, we introduced a poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP) layer into the device. PVDF-HFP is a polymer with excellent dielectric properties and charge-trapping capabilities, effectively trapping electrons and holes to provide long-term non-volatile memory performance. This trapping mechanism allows the device to store charges generated by light stimuli for an extended period, maintaining data even after the light source is removed. As a result, the device's ability to record and retain information in the NIR region is significantly enhanced.

In conclusion, this study demonstrates that organic semiconductor-based NIR photomemory devices have great potential as low-power, non-volatile memory devices capable of operating effectively across a wide wavelength range.

This research was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (Ministry of Science and ICT) (No. NRF-2022H1D8A3038633).

Biography

Min Ju Jung currently an undergraduate student at Pukyong National University in South Korea, majoring in Chemical Engineering. I am conducting research as an undergraduate researcher in the NIR laboratory. My research focuses on developing transistors using organic semiconductors, including phototransistors, photodetectors, and exploring doping techniques in transistors. I am particularly interested in the applications of organic electronics in advanced optoelectronic devices.

FORMATION OF CARBON NANOMATERIALS-BASED HYBRIDS AND THEIR APPLICATION FOR ELECTROMAGNETIC WAVE SHIELDING EFFECTIVENESS

Sung-Hoon Kim and Jun-Woo Lim

Silla University, South Korea

Abstract

Background: Producing a hybrid of carbon nanotubes (CNTs) and carbon nanofibers (CNFs) is known to be very difficult because the metal catalysts for CNTs growth could easily diffuse into the inside of carbon substrate during a reaction. Therefore, researchers have carried out to prevent the dissolution of a metal catalyst into the inside of carbon substrate during the reaction.

Objective: The detailed mechanisms of the selective or nonselective hybrid formation of carbon-based nanomaterails, the main electromagnetic wave shielding mechanism of the formed hybrids, and the application for the commercial heating films are suggested and discussed.

Methods: A thermal chemical vapor deposition system was employed for the formation of carbon nanomaterials-based hybrids. The morphologies of the samples and elemental analysis of the samples was performed using energy dispersive X-ray spectroscopy. Resistivity values were obtained using a four-point probe. The SE values of the c-NF samples were measured using the waveguide method with a vector network analyzer.

Results: Hybrids comprising tiny CNFs on the carbon microcoils (CMCs) and/or individual carbon fibers (i-CFs) in c-NFs were fabricated. The selectivity of the hybrid formation of tiny CNFs was controlled by incorporating hydrogen gas flow and introducing a cyclic process. The selective formation of tiny CNFs is ascribed to the different intrinsic material characteristics of the CMCs and i-CFs. The total SE values for native c-NFs greatly increased following hybrid formation across operating frequencies in the 8.0–12.0 GHz range.

Conclusion: The total SE values for native c-NFs greatly increased following hybrid formation across operating frequencies in the 8.0–12.0 GHz range. The total SE values of the conventional heating film were significantly enhanced by the incorporation of 5 wt% hybrids of CNFs–CMCs. The cause for this could be attributable to the numerous small-sized CNFs intersect with one another and the intrinsic characteristics of CMCs.

Biography

Prof. Sung-Hoon Kim is a renowned materials chemist who has largely influenced his field and aided in the development of new novel nanomaterials. Dr. Kim received a Ph.D. in Chemistry in 1993 from Seoul National University in South Korea. Additionally, Dr. Kim went on to earn another Ph.D. in Advanced Electronics & Optical Science in 2005 from Osaka University in Japan. From 1988 to 1998, he was a Senior Researcher in the New Materials Laboratory of Samsung Advanced Institute of Technology (SAIT). In 1996, he was also an Adjunct Research Associate in the Materials Research Laboratory of The Pennsylvania State University in the United States. Dr. Kim was also a Visiting Scientist at North Carolina State University in the United States from 2001 to 2003. Since 1998, Dr. Kim has been a Full Professor in the Department of Engineering in Energy & Applied Chemistry at Silla University in South Korea.

PREPARATION OF EFFECTIVE HEAVY METAL SORBENTS FROM SODIUM POLYSULFIDE AND EPICHLOROHYDRIN PRODUCTION WASTES

Yerlan Abdykalykov Nurzhanuly[1], NA Korchevin[2], AM Nalibayeva[1] and AK Zhangabayeva[1]

[1]D.V. Sokolsky Institute of Fuel, Catalysis and Electrochemistry, Kazakhstan
[2]A.E. Favorsky Irkutsk Institute of Chemistry SB RAS, Russia

Abstract

Background: The property of organosulfur compounds to form strong coordination bonds with heavy metal ions makes it possible to create effective adsorbents based on them that meet new environmental standards and which can be obtained from waste products of organochlorine compounds, namely epichlorohydrin.

Objective: The purpose of this study is to obtain solid granular sulfur-containing sorbents of heavy metals using epichlorohydrin production waste.

Methods: Fractions of organochlorine wastes, the main component of which was 1,2,3-trichloropropane, were used to obtain sorbents. Sodium polysulfide was obtained by dissolving elemental sulfur in an aqueous solution of sodium hydroxide in the presence of a reducing agent (hydrazine hydrate). The preferred formation of sodium polysulfide Na2Sn with a given value of n was determined by the molar ratio S : NaOH and corresponded to the series: 1:1 – Na2S2, 3:2 – Na2S3, 2:1 – Na2S4. In order to perform the formation of granules in the course of polycondensation, to a polysulphide solution obtained were introduced polycondensation centres presented by finely grinded petroleum coke (with the grain diameter $d \leq 0.15$ mm).

Results: The polycondensation of sodium polysulphide with organochlorine wastes containing 1,2,3-trichloropropane results in obtaining a cross-linked polymer that forms the granules of a sorbent together with the particles of petroleum coke. With increasing the length of the polysulphide chain, the polymer becomes more “loose”, thereby the content of residual chlorine and the sorbent microporosity level exhibit a decrease. The maximum porosity of the polymer is observed at n = 3, which may be due to the active participation of 1,2,3-trichloropropane as a bifunctional monomer contributing to the “moving apart” of polymer layers.

The maximum activity is demonstrated by sorbents with the highest micro- and macroporosity. For all cations under consideration, the highest sorption capacity was observed in the case of solutions with pH = 3. The sorption process itself was accompanied without changing the pH of the solution, which may indicate a complex-coordination mechanism of the sorption process. The sorption isotherm obtained for the extraction of mercury ions in the form of $Hg(NO_3)_2$ has a characteristic appearance corresponding to the Langmuir isotherm, which indicates the process of monomolecular adsorption on the active centers.

Conclusion: Thus, the developed method of obtaining sorbents from organochlorine production wastes makes it possible to solve an important environmental problem - wastewater treatment of a number of metalworking plants from heavy metal compounds.

Funding: This research is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP23489131).

Biography

Yerlan Abdykalykov Nurzhanuly works as a junior researcher at the D.V.Sokolsky Institute of Fuel, Catalysis and Electrochemistry, Laboratory of Applied Research. He is currently engaged in research on the development of methodology for the synthesis of new heteroatomic derivatives of 3-aminopropyltriethoxysilane and 3-aminopropylsilatran for their possible application as new precursors for functional coatings. He is also involved in a project aimed at developing oriented methodology for sulphurisation of organohalogen polyelectrophiles (including organochlorine waste) with elemental sulphur in hydrazine hydrate. His research interests include synthesis of various organic and organoelement compounds with improved properties and development of surface functionalized materials.

ADSORPTION CHARACTERISTICS OF A SULFUR-CONTAINING OLIGOMER BASED ON CHLOREX

AM Nalibayeva[1], NA Korchevin[2], A Bold[1] and EN Abdikalykov[1]

[1]D.V. Sokolsky Institute of Fuel, Catalysis and Electrochemistry, Kazakhstan
[2]A.E. Favorsky Irkutsk Institute of Chemistry SB RAS, Russia

Abstract

Background: Due to the increasing volume of global sulfur production, the attention of researchers in the field of organic chemistry is directed to the search for new approaches and methods for the synthesis of organosulfur compounds and the study of their properties. Today, more than 90% of sulfur is produced as a by-product of oil and gas refining in hydrotreating processes and during the utilization of sulfur dioxide in non-ferrous metallurgy processes. Oil and gas and metallurgical companies are interested in projects focused on processing associated sulfur into new popular products with high added value. Such products include sorbents of valuable metal cations. The high affinity of sulfur atoms for ions of noble and heavy metals makes it possible to create new effective and selective sorbents and extractants.

The objective of the present research is to obtain new sorbents based on polyorganopolysulfide derivatives and to study their sorption properties in relation to heavy metals.

Methods: The preparation of a sulfur-containing oligomer based on β,β–dichlorodiethyl ether (chlorex) using elemental sulfur in the hydrazine hydrate–water–KOH system is carried out in one reaction vessel in two stages: reductive activation of sulfur and polycondensation of chalcogenide anions with chlorex. Sorption of metal ions (Hg^{2+}, Cd^{2+}, Zn^{2+}, Pb^{2+}, Ni^{2+}, Cu^{2+}) from solutions was carried out under static conditions.

Results: The sulfur-containing oligomer is capable of extracting ions of metals such as mercury (87%), cadmium (73%), zinc (100%), lead (100%), copper (64%) and nickel (100%) from aqueous solutions with high efficiency. The adsorption activities were in mg/g: 380 (Hg^{2+}), 227 (Cd^{2+}), 370 (Zn^{2+}), 344 (Pb^{2+}), 176 (Cu^{2+}) and 417 (Ni^{2+}).

Conclusion: The research results show the possibility of practical use of a sulfur-containing oligomer obtained from available and man-made raw materials for the extraction of toxic heavy metals from technological solutions and for wastewater treatment of enterprises.

Funding: This research is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP23489131).

Biography

Arailym Nalibayeva is a leading researcher at the Laboratory of Applied Research at the D. V. Sokolsky Institute of Fuel, Catalysis and Electrochemistry (Kazakhstan, Almaty). She has experience in research in the field of organic chemistry of phosphorus, sulfur and silicon. Her research is currently focused on the development of environmentally friendly technologies for the synthesis of sulfur and organosilicon compounds, as well as resource-saving technologies for the processing of sulfur-containing waste into multi-purpose products (extractants and sorbents of heavy metals).

Day-2
Keynote Presentations

INVESTIGATION OF HEAT TREATMENT ON DRY SLIDING WEAR BEHAVIOUR OF THIXOFORMED GNPs-A356 MATRIX COMPOSITES

Mohd Shukor Salleh , Nur Farah Bazilah Binti Wakhi Anuar and Mohd Zaidi Omar

Universiti Teknikal Malaysia Melaka, Malaysia

Abstract

Background: The addition of reinforcement particles improves not only the microhardness of the composite but also the wear resistance of the matrix. Graphene is widely employed as reinforcement material with self-lubricating properties to improve the wear resistance of aluminium metal matrix composites.

Objective: To investigate the effect of T6 heat treatment on mechanical properties, microstructure and dry sliding wear behaviour of thixoformed GNPs-A356 aluminium composites.

Methods: The GNPs-A356 aluminium composites were fabricated by stir casting process for the subsequent thixoforming process. The feedstock of composites was reheated to 50% liquid fraction temperature as determined from the DSC analysis graph before being rammed into the mould. The thixoformed composites were subjected to a standard T6 heat treatment process. The microstructure and hardness were examined in detail. The dry sliding wear was performed using pin-on-disc with a 50 N normal load, 3000 m sliding distance and 1 m/s sliding speed.

Results: Adding GNPs significantly affected the microstructure after the thixoforming process and increased the hardness properties from 63 HV for A356 alloy to 95.39 HV for the thixoforming composite. The subsequent T6 heat treatment rounded the Si particles and increased the hardness value to 107.45 HV. The wear rate and CoF of thixoformed composites showed a significant reduction after T6 heat treatment.

Conclusion: Adding the GNPs, thixoforming and heat treatment process makes about 70.5% enhancement in hardness properties compared to that of as-cast A356 alloy. Moreover, the volume wear loss, specific wear rate and COF of thixo-T6 composite decreased by 28.9%, 29% and 5.5%, respectively, compared to that of as-cast A356 alloy.

Biography

Mohd Shukor Salleh has expertise in semisolid metal processing for aluminium alloys. A few years ago, he focused on the investigation of the mechanical properties of a thixoformed graphene-reinforced aluminium alloy composite. His new technique to produce aluminium alloy composites for thixoforming helps the automotive industry fabricate parts with high mechanical properties. He is actively involved in teaching, research activities, and administration as a deputy dean of research and postgraduate studies. He was also actively involved in the publication of high-impact journals and published three books on material processing. He is also actively involved with industry by offering consultation related to material processing.

Day-2
Oral Presentations

AMBIENT AIR-PROCESSED CSPBI3-BASED PEROVSKITE SOLAR CELL VIA SEMI-SPUTTERING DEPOSITION AND NUMERICAL STUDIES OF Cs3Sb2I9-BASED PEROVSKITE SOLAR CELL

Hasina Huq and Shamik Data

The University of Texas Rio Grande Valley, USA

Abstract

Commercialization of Perovskite solar cells as a clean energy source can augment the reduction of carbon footprint [1,2,3]. $CsPbI_3$, a well-known perovskite material, has been synthesized in ambient air and high-humidity conditions and utilized as the active layer in a perovskite solar cell. The rest of the solar cell layers have been sputer-deposited. This solar cell with a p-i-n configuration ITO/NiOx/$CsPbI_3$/ZnO/Au exhibited a champion efficiency of x%. Nonetheless, lead incorporation in the conventional Pb-cation-based perovskites poses an environmental threat. The physical proximity of living organisms to lead point sources exhibits a wide spectrum of negative consequences. In this study, we have also explored the photovoltaic performance of the $Cs_3Sb_2I_9$ as an absorber using SCAPS-1D software. A planar, regular architecture with device configuration of FTO/TiO_2/ $Cs_3Sb_2I_9$/NiOx/Au has been proposed and numerically simulated. The best-optimized device yielded a maximum power conversion efficiency of 17.49%, open-circuit voltage Voc of 1.4 V, short-circuit current Jsc of 15.33 mA/cm^2, and fill factor FF of 80.95%.

Biography

Hasina F. Huq is a Full Professor (tenured) and Chair (2019- present) in the Department of Electrical and Computer Engineering at the University of Texas-RGV (UT-RGV). After receiving her B.Sc. in Electrical Engineering from BUET in 1999, she joined Virginia Polytechnic Institute and State University (Virginia Tech) for M.S. degree. Dr. Huq got her Ph.D. in Electrical Engineering from the University of Tennessee, Knoxville (2006). She was collaborating with Oak Ridge National Laboratories ORNL, Knoxville, TN for her research work. Her teaching and research interests include electronics, wide-bandgap semiconductor devices, and VLSI & integrated circuits (IC) design. Her research work in these areas has been published widely in peer-reviewed journals as well as in conference proceedings (more than 80). She served as a Principal investigator/co-principal investigator to many multi-year grants from the US Department of Defense (DoD), the National Science Foundation (NSF), Department of Education (DoEd). She also received a grant from Advanced Micro Devices (AMD). She served as an NSF ADVANCE STEM fellow at UTPA/UTRGV. Dr. Huq served as the ECE Graduate Program Coordinator(Sep 2015-2019) in the ECE Dept. at UTRGV. She was involved in developing the comprehensive assessment plan for the MSE in EE program. It includes (but not limited to) program evaluation, yearly report, SLO revision, development of graduate policy, graduate brochure/ promotional items design, active recruitment efforts.

Huq developed NSF funded 'Sputtering System Research Lab' and "Microelectronics Research Laboratory, at UTRGV. She is the recipient of the NanoHUB Education Scholarship (Purdue University), Network for Computational Nanotechnology award, Faculty Research Council (FRC) award, Summer Research Initiative award, Undergraduate Research Initiative (URI) award and Title V- HSI award Dr. Huq served as an ABET Coordinator for the ECE department at UTPA. Dr Huq's graduate and undergraduate students are working in world's leading companies, such as Intel, Reytheon, Texas Instrument, General Motors (GM), General Electric (GE), Samsung, Boeing, Caterpillar, FreeScale, IBM and so on. Her graduate students are pursuing their PhDs at top universities in the USA. She has supervised more than twenty-five graduate students for their thesis/research. She also served on the three PhD dissertation committees. She is a member of IEEE, a sustainable member IEC, and a member of Electrical and Computer Engineering Department Heads Association (ECEDHA).

TAILORING COMPOSITE MATERIALS FOR ENHANCED EM POLLUTION MITIGATION: THE ROLE OF CARBON BLACK AND COBALT

Yi-Jen Huang, Yu-Cheng Kuo and Jung-Hsuan Hsu

National Chin-Yi University of Technology, Taiwan

Abstract

Background: The pervasive use of wireless technologies has led to the emergence of electromagnetic pollution, which poses significant risks to human health and the environment. To mitigate this problem, researchers are exploring various techniques, particularly microwave absorbers. However, creating absorbers that can function across multiple frequencies remains a pressing challenge.

Objective: The objective of this study was to investigate the effectiveness of three unique forms of carbon black (C002, C121, and JE9600) and cobalt nanoparticles integrated into epoxy composites to absorb electromagnetic waves. Each carbon black type has distinct permittivity traits, and cobalt's magnetic permeability underpins its ability to capture electromagnetic waves through 2–6 GHz.

Methods: The composite material used in this study was a mixture of polymer matrix and fillers in different concentrations. The permittivity and electromagnetic permeability of the composite were analyzed using the Agilent 8510C vector network analyzer and CST software.

Results: The study revealed a clear link between increased dielectric loss tangents and enhanced absorption efficiency. JE9600 demonstrated excellent absorption capabilities as higher concentrations shifted towards lower frequency bands, improving absorption efficiency.

Conclusion: The research highlights the potential of tailoring carbon black/Co/epoxy composites to meet specific electromagnetic wave absorption requirements, which can greatly reduce EM pollution. This discovery provides a promising avenue for developing materials with superior broad-spectrum absorption capabilities.

Biography

Yi-Jen Huang, a faculty member at the National Chin-Yi University of Technology, has dedicated his career to exploring the intersections of materials science and environmental sustainability. With a focus on creating innovative materials such as electromagnetic wave absorbers, piezoelectric nanocomposites, and catalysts for pollution reduction, his work aims to make significant strides in reducing environmental impact while advancing technological applications. Dr. Huang's approach to research emphasizes collaboration and a deep respect for the natural world, guiding his investigations into materials that offer high performance and ecological harmony.

SYNTHESIS OF THE TARGETED METAL-ORGANIC FRAMEWORK AS A NOVEL STRATEGY FOR IMPROVING ANTITUMOR THERAPEUTIC EFFICACY

Xiao Fu

Shandong First Medicine University, China

Abstract

Background: Autophagy is an intracellular biological process that involves capturing and degrading intracellular components to sustain metabolism and homeostasis. Especially in the late stage of tumorigenesis, autophagy contributes to the survival and growth of the tumors and promotes the aggressiveness of the tumors by facilitating metastasis.

Objective: To examine the association between household-level variables and under-5 mortality in Nigeria.

Methods: The overactivation of autophagy is also one of the important reasons for the drug resistance of the tumor.

Nanoparticles (NPs) can induce autophagic process via certain components and morphologies, providing a new perspective for establishing tumor therapy strategies. Here, we report the preparation of targeted nanoparticles (NPs) encapsulated with paclitaxel (PTX) and propranolol (PRN) into poly(ethylene glycol) (PEG)-mediated zeolitic imidazolate framework-8 NPs to reverse the adverse effects of autophagy, where PEG improves the stability and dispersity of ZIF-8 NPs. PTX and Zn2+ released from the ZIF-8 NPs induce autophagy which could promote the survival of tumors. Propranolol (PRN), as a novel safe potential chemo-sensitizer, can act like a “valve” to block the fusion of autophagosome and lysosomes, and autolysosome degradation.

Results: The combinational application of PRN results in a boost of autophagosomes which directly suppresses the delivery of nutrients for tumor cells and changes the pro-survival mechanism of autophagy which promotes the cell-killing effect.

Conclusion: In addition, these nanoparticles could cause an increase in intracellular ROS levels significantly and further induce apoptosis and autophagy of tumor cells.

Biography

Xiao Fu, Associate Professor at the School of Stomatology, Shandong First Medical University, received his PhD degree from the Department of Chemistry, Shandong University in 2020. He is mainly engaged in cross-over research on colloid and interface chemistry and biomedicine, using polymers (such as polyethylene glycol, polyphenols, proteins) to construct colloidal particles and hydrogels with controllable physical and chemical properties. To explore the interaction of colloidal particles with biological systems and their applications in drug delivery, tumor therapy and osteogenesis promotion.

DYNAMIC TESTING OF SELF-HEALING ASPHALT CONCRETE WITH ENCAPSULATED MODIFIER

Inozemtsev Sergei, Le Huu Tuan and Korolev Evgeniy

Moscow State University of Civil Engineering (National Research University), Russia

Abstract

Background: To increase the durability of asphalt concrete, modifiers are traditionally used. A new type of modifier is capsules with a useful substance inside, which allow obtaining asphalt concrete with self-healing ability.

Objective: To establish the influence of the encapsulated modifier on the dynamic properties of self-healing asphalt concrete.

Methods: The SMA beam specimens were tested for fatigue life using a 4-point bending test in accordance with AASHTO T 321-14. The beam was subjected to repeated bending loads 250,000 times at a frequency of 5 Hz, providing a deflection of 0.27 mm, at a temperature of 10°C.

Results: The study developed asphalt concrete (stone mastic asphalt concrete) compositions containing an encapsulated modifier. The work considered capsules containing sunflower oil and capsules containing AR-polymer. Traditional asphalt concrete and asphalt concrete with capsules were studied using the 4-point bending method of samples to determine dynamic properties. It was established that the rigidity of traditional stone mastic asphalt concrete after 250 thousand cycles of exposure decreases by 40%, and after 7 days of rest it is restored and amounts to 81% of the initial value. The rigidity of self-healing stone mastic asphalt concrete with encapsulated AR-polymer after 250 thousand cycles of exposure decreases by 32%, and after 7 days of rest it is restored and amounts to 93% of the initial value. Repeated tests of samples after self-healing allow us to predict the number of cycles before the material is destroyed (the rigidity is 50% of the initial value). The destruction of traditional stone mastic asphalt concrete will require 3.5 million cycles, and the destruction of self-healing asphalt concrete, which contains encapsulated AR polymer, will require 17.5 million cycles.

Conclusion: It has been proven that self-healing of asphalt concrete using encapsulated AR polymer is more intense than traditional SMA. The use of encapsulated AR-polymer allows to increase the number of cycles that SMA can withstand before destruction.

Biography

Inozemtsev Sergei is an Associate professor, PhD 2017-Present: Co-executor of research in the framework of the State task 7.6250.2017 / 8.9 “Theoretical and empirical models of functional composites based on primary nanomaterials”. Co-executor of applied scientific research funded by the Federal Target Program “Research and Development in the Priority Directions of Development of the Scientific and Technological Complex of Russia 2014-2020” in the framework of the project “Development of a New Technology for Energy- and Resource-Efficient Nano-Modified Composite Materials for Construction under Operating Conditions of the Pacific Region regional raw materials of Russia and Vietnam”. Head of the RSF grant within the framework of the 2019 competition “Initiative research by young scientists” of the President’s program of research projects implemented by leading scientists, including young scientists on the topic “Self-healing composites with an organic thermoplastic matrix for road construction, resistant under variable impact temperature, moisture and solar radiation”. Presidential Scholarship Fellow (SP-5069.2021.1). Head of the RSF grant within the framework of the 2022 competition “Initiative research by young scientists” of the the Presidential Program of Research Projects Implemented by Leading Scientists, including Young Scientists on the topic “Development of methods for designing self-healing thermoplastic composites for pavement”.

PREDICTING FLOW-RELATED DYNAMIC RECRYSTALLIZATION PARAMETERS AND GRAIN SIZE EVOLUTION IN HOT FORGING OF SCR420HB USING A DIRECT METHOD

Mohd Kaswandee Razali and Man Soo Joun

Gyeongsang National University, Republic of Korea

Abstract

Background: The microstructure of metallic materials is pivotal, influencing crucial properties like strength, elongation, ductility, toughness, corrosion resistance, fatigue, and wear resistance, all essential for industrial applications. In hot metal forming, it's vital to create precise microstructure evolution methods customized to various forming conditions affected by factors such as strain, strain rate, and temperature.

Objective: To accurately predict microstructure evolution grain size predictions under different forming conditions using direct method

Methods: The direct method involves calculating flow-related dynamic recrystallization (DRX) kinetic parameters (such as εp and ε0.5) directly from flow stress curves. Importantly, this direct method eliminates the need for additional mathematical modeling, leveraging an accurate flow stress description based on a comprehensive and enhanced flow stress model. We demonstrate the practical acquisition of constants and validate the efficacy of the direct approach by applying this direct method to study the DRX behavior of SCR420HB automobile gear steel.

Results: During the optimization process, the material constants were adjusted as design variables to minimize the error between experimental and predicted grain sizes at specific sample points. The optimized material constants were then used to predict grain size after all stages, and the results were compared with experimental values to validate the obtained constants. The comparison demonstrated that the model accurately predicts grain size with an acceptable error when utilizing the obtained material constants.

Conclusion: Comparisons among our current approach, traditional methods, and experimental data highlight the superior accuracy of the direct method in predicting DRX kinetics grain sizes during microstructural evolution of SCR420HB automobile gear steel.

Biography

Mohd Kaswandee Razali is a Software Developer and Senior Researcher at Metal Forming Research Corporation (MFRC) in South Korea. He graduated from Gyeongsang National University (GNU) for his Master degree and Ph.D. His Ph.D. thesis topic was "Mechanical and Metallurgical Characterization of Metals with High Practicability and Compatibility with Finite Element Method". After his Ph.D, he has experienced as a Post-Doctoral fellow at GNU for two years before becoming full time employee at MFRC. He has constructed international cooperative network as technical support based on the Advisor for metal Forming Design EXperts (AFDEX), involving ALTAIR (USA/Global), JSOL(Japan), BRIMET(China), ARAI/DHIO(India), MARii/UiTM(Malaysia), Morphotec(Mexico), ADS(Indonesia) and Machsoft(Thailand). He is a dedicated and results-oriented professional with a strong background in metal forming simulations. With over 3 years of experience, he has demonstrated expertise in Computer-Aided Engineering (CAE), Computer Aided Design (CAD), numerical simulations, finite element method, optimization, Fortran and visual studio programming, etc. His career is characterized by a commitment to achieving excellence and driving business success through innovative strategies and effective leadership.

Coalesce Research Group

10th International Conference on

Materials Science & Engineering

October 17-18, 2024 | ANA Crowne Plaza Narita, Tokyo, Japan

CARBON QUANTUM DOTS FROM WASTE MATERIALS FOR METAL ION SENSING

Nigamuni Binu Parlindie Senanayake, François Malherbe, Daniel Eldridge

Swinburne University of Technology, Australia

Abstract

Background: The development of innovative processes to mitigate environmental issues associated with biomass waste is a key aspect of modern circular economies. Beyond the clear environmental benefits, converting waste into valuable commodities plays a significant role in sustainable resource management.

Objective: This study aims to develop a sustainable method to convert waste (coffee grounds and cigarette filters) into value-added products like hydrochar (HC) and carbon quantum dots (CQDs), which can find applications in wastewater treatment and metal ion sensing.

Methods: The waste materials were hydrothermally treated to produce hydrochar, which was further processed with an alkaline peroxide solution to enhance the yield of CQDs.

Results: The CQDs showed improved water dispersibility over the hydrochar, and fluoresced either blue-green (CG-CQD from waste coffee grounds) or blue (CF-CQD from unburnt cigarette filters) under UV excitation (λ = 365 nm). CG-CQD have an 8% quantum yield and exhibited excitation-independent properties from 290 nm to 350 nm and excitation-dependent emission from 350 nm to 500 nm. FTIR evidenced the presence of hydrophilic groups such as –OH, –COOH, –CO, and $–NH_2$ on the CQD surfaces, corroborated by a zeta potential of –30- 40 mV. TEM revealed that both CQD materials were spherical, either ~7 nm or ~15 nm in diameter for the CG-CQDs and CF-CQDs respectively. XRD data highlighted the binary, crystalline and amorphous, nature of the particles. Fluorescence was insensitive to changes in ionic strength (NaCl), relatively constant across a pH range of 5 to 10, and was able to detect the presence of metal ions, including copper(II) in M quantities.

Conclusion: CG-CQDs demonstrated sensing capabilities suitable for detecting select metal ions at concentrations below relevant drinking water standards.

Biography

Senanayake is a graduate of the Institute of Chemistry Ceylon, Sri Lanka. She holds a professional degree in Chemistry, with over three years of industry experience and nearly two years of full-time research. She completed an Honours project titled "Urea Assisted Nanoparticle Deposited Biochar: A Potential Material for Wastewater Purification". Later Mrs. Senanayake joined Ranvel Lanka Holdings (Pvt) Ltd Sri Lanka as a Research & Development Executive Chemist to gain valuable industry experience in applied research. She is now a Ph.D. candidate at Swinburne University of Technology, developing novel approaches to synthesise value-enhanced carbon quantum dots (CQDs) from waste materials for applications in pollutant sensing and wastewater remediation.

ELECTROSPUN POLYCAPROLACTONE (PCL) NANOFIBERS CONTAINING ENDOPHYTIC FUNGI METABOLITE-BASED ANTIBACTERIAL ADDITIVES FROM AUSTRALIAN NATIVE PLANTS FOR WOUND DRESSING APPLICATIONS

Meysam Firoozbahr, Peter Kingshott, Enzo A Palombo and Bita Zaferanloo

[1]Swinburne University of Technology, Australia

[2]ARC Training Centre in Surface Engineering for Advanced Materials (SEAM), Swinburne University, Australia

[3]ARC Training Center for Biofilm Research and Innovation, Swinburne University of Technology, Australia

Abstract

Wound care has recently encountered significant challenges due to the increase in antimicrobial resistance (AMR) and the specific requirements for managing chronic wounds. An efficient wound dressing is typically tailored with bioactive agents to address the specific challenges posed by bacterial infections. Consequently, antimicrobial agents and their use as additives in wound dressings have attracted considerable interest from researchers. However, the rise of AMR necessitates the exploration of new antibacterial compounds to combat bacterial infections such as Methicillin-resistant Staphylococcus aureus (MRSA).

Endophytic fungi, known for being a sustainable source of bioactive compounds, including antibacterial agents, are considered a promising source for producing these compounds. This research examines and appraises the antibacterial activity and additive characteristics of bioactive polycaprolactone (PCL) nanofibers that incorporate endophyte-based antibacterial agents as an effective treatment for bacterial infections on wound surfaces.

After testing 32 fungal strains isolated from 13 Australian native plants, the antibacterial activity of metabolite extracts was investigated using qualitative and quantitative screening against strains of Staphylococcus aureus and MRSA. The most active samples were selected for further processing. PCL as an FDA approved polymer was used in the electrospinning process for further experiments. After optimizing the parameters for electrospinning, the final bioactivity, morphology, and surface characteristics of the fibers were examined using cytotoxicity assays, antibacterial activity assays, XPS, and SEM. Additionally, fiber functionality and release profiles of each fiber sample were scrutinized by exposing a specific amount of the fibers in media in various time frames to gain a better understanding of these novel additives. This research underscores the potential of endophytic fungi from Australian plants as sources of substances effective against common wound pathogens.

Background: Several factors can contribute to the development of non-healing wounds in patients. These factors include aging, chemotherapy, radiotherapy, immunosuppressive medications, systemic malignancies, and diabetes. Among these factors, diabetes is the most common cause of non-healing wounds in clinical settings. Given all these factors, the importance of functional wound dressings has become more significant than ever. Currently, there is a growing interest in wound dressings with the capability of locally controlled drug delivery to accelerate wound healing. A key factor in achieving functional wound dressings is the incorporation of antibacterial agents, which can prevent bacterial infections during the healing process and address issues related to antimicrobial resistance (AMR) and systemic toxicity.

In the context of AMR, it is important to emphasize that the effective release of antibacterial agents at concentrations above the minimum inhibitory concentration (MIC) is a critical step in preventing infection during the wound healing process. Therefore, antibacterial delivery has emerged as a prominent area of research and development for the biotechnology and pharmaceutical industries.

Furthermore, investigating cytotoxicity in an in vitro experiment is valuable for determining the therapeutic window in the application area. To gain a deeper understanding of the effects of secondary metabolites on entire organisms, cytotoxicity can be assessed using the whole organisms of Artemia salina larvae, a test commonly known as the Brine shrimp lethality test (BSLT). BSLT is a versatile bioassay capable of detecting cytotoxicity of the compounds in the extract.

Objective: To scrutinize the processability and characteristics of PCL nanofibrous mats containing antibacterial compounds extracted from endophytic fungi of the Australian native plants.

Methods: Ethyl acetate extracts of 32 fungal strains from Australian native plants were tested for their antibacterial activity using the disc diffusion assay and the MIC test against Methicillin-sensative and Methicillin-resistant strains of S. aureus. The most active extracts were incorporated into a 12% w/v polycaprolactone (PCL) prespinning solution at various concentrations and then electrospun to produce nanofibrous mats. The characteristics of the fibers, such as morphology and average diameter, were observed using scanning electron microscopy (SEM). Differences in fiber diameters were assessed using conductivity tests. Finally, cytotoxicity tests, including MTT and BSLT assays, were performed to demonstrate the functionality of the fibers in the targeted application by determining the therapeutic window amounts.

Results: Among the tested endophyte metabolite extracts, EL19 and EL24 demonstrated the highest activity against the chosen bacteria, with MIC values of 78 μg/mL against both S. aureus ATCC25923 and MRSA M180920. The optimization process of electrospinning began with solvent selection, and the optimized spin parameters were determined as follows: 12% w/v PCL in a methanol: chloroform (1:4) spinning solution, 21 kV voltage, and a 20G needle positioned 10 cm from the stationary collector. Using these parameters, a lower average fiber diameter was observed for samples containing higher concentrations of the antibacterial additives, resulting in a greater surface area for the fibers with additives. Conductivity tests on the electrospinning solution confirmed that higher concentrations of additives corresponded to lower electrical resistance.

The cytotoxicity tests yielded varying results. The MTT assay indicated higher cytotoxicity effects than the BLST assay. The MTT assay revealed cytotoxic concentrations even at the MIC level, whereas the BLST assay showed low cytotoxicity at concentrations as high as 6× MIC. These findings provide valuable insights into the functionality of the fibers.

Conclusion: To conclude, after investigating the antibacterial activity and therapeutic ability of the metabolite extracts, the samples of EL19 and EL24 demonstrated a great potential for wound care management of PCL nanofibrous mats

Biography

Meysam Firoozbahr completed his B.Sc. in Polymer Engineering in 2016 at the University of Tehran. He is currently in his fourth year of a Ph.D. program at Swinburne University of Technology, Melbourne, Australia, where he focuses on the medical applications of endophyte metabolite-based electrospun fibers, particularly for wound dressings. His research interests include polymer wound dressings, biomedical applications of endophytic fungi, antimicrobial technologies, and nanofabrication. As a material scientist, he is passionate about exploring various aspects of the polymer industry in different biomedical applications, such as implants and wound bandages. Additionally, he has a keen interest in the indigenous culture of Australia. His project involves using specific Australian native plants with ethnomedicinal history, drawing on the accumulated knowledge of Indigenous Australians through thousands of years of experience.

CHALLENGES AND SOLUTIONS REGARDING THE FATIGUE BEHAVIOUR OF THERMAL DIRECT JOINTS MADE OF TITANIUM AND CF-PAEK FOR AEROSPACE APPLICATIONS

Förster Benjamin, Müller Markus and Langer Maurice
Fraunhofer-Institute for Material and Beam Technology IWS, Germany

Abstract

In addition to the requirement to reduce greenhouse gas emissions, aircraft manufacturers face rising production costs as a result of higher-performance and lighter, but also more cost-inten- sive materials. The use of fibre composites, in particular, has gained importance over the last decade and is being increasingly adopted. However, for some applications, a complete re- placement of conventional metallic construction with fibre-reinforced plastic composites is not expedient. This applies to aircraft seat rails, which are often made entirely of aluminium or titanium. In the LuFo VI.2 ZEUS project, this is largely replaced by a CF-LM-PAEK pro- file, with only the load-bearing part made of titanium. A seat rail is subjected to a high load of at least 63 kN at the connection to the seat. In addition, the properties of the joint must closely match the material properties of the fibre composite. In order to fulfil this requirement profile, thermal direct joining is used to join the titanium seat rail crown and the CF-LM-PAEK stiff- ening profile. To do this, the metallic composite partner is first structured using a laser. In the actual joining process, metal and FRP are brought together and the metal component is heated, causing the thermoplastic interface to melt and penetrate the rough surface of the metal. Initial tests at coupon level show that the joint achieves the reference strength of the fibre composite material, which is 45 MPa in shear tension. Despite the anisotropy of the hy- brid joint, up to 32 MPa is also achieved in normal tension. The fatigue strength of the com- posite is also analysed. The non-optimised composite shows a failure on the metal side due to the notch effect of the laser-structured surface. Appropriate countermeasures can significantly increase the fatigue behavoir of the joint, making it suitable for use in aviation applications in particular.

Biography

Benjamin Förster studied automotive engineering and vehicle construction at the HTW Dres- den and TU Bergakademie Freiberg. He is also a specialised international welding engineer. As a research associate at the Fraunhofer IWS, he is responsible for the research, further de- velopment and application of the thermal direct joining process for applications in the aero- space, automotive and packaging industries as well as chemical and plant engineering with more than three years of experience in this field.

POLYMER NANOCOMPOSITE MATERIALS FOR APPLICATION X: THE ROLE OF NANOSCALE DIMENSION

Ioannis Zuburtikudis

Abu Dhabi University, UAE

Abstract

Background: Richard Feynman's renowned lecture, "There's Plenty of Room at the Bottom: An Invitation to Enter a New Field of Physics," delivered at the annual American Physical Society meeting at Caltech on December 29, 1959, ignited discussions on the distinctive behavior of matter at the nanoscale—where it defies the characteristics of individual atoms or bulk forms.

In my research, I aim to identify and comprehend the implications of nano-scaled dimensions on material properties. I leverage these insights to adapt and influence the design and engineering of advanced materials, surfaces, and processes, with the potential to yield valuable products.

Objective: To prepare and test polymer nanocomposite materials and compare them with their conventional counterparts, which have micron-sized particle reinforcements. To produce polymeric nanocomposites tailored to particular applications related to health, food, energy, and the environment.

Methods: Melt intercalation is employed to disperse nano-spheres, platelet-like (nano-discs) and nanotubes in the matrix of various, bio-based thermoplastic polymers, while a variety of experimental techniques is used for their characterization and testing. X-Ray Diffraction and Electron Microscopy are used for the investigation of the structure of the prepared hybrid materials, while thermal analysis (Differential Scanning Calorimetry, Thermogravimetry) is used for the exploration of their thermal properties. Depending on the application, relevant techniques are employed for testing their properties. Examples are mechanical properties, biocompatibility and gas permeability testing. In addition, electrospinning is used for producing such polymeric materials in nano- or sub-micron fiber form.

Results: The presentation will showcase selected results from our work on (i) bio-based, thermoplastic polymer nanocomposites, (ii) polymeric nanofibers through electrospinning, (iii) polymer-based superhydrophobic coatings, (iv) Carbon nanofibers, and (v) nanocomposite membranes for water treatment.

Conclusion: The polymer nanocomposite materials in any form (bulk or fibrous mat) exhibit better properties than their conventional counterparts and only for a small percentage (~3% w/w) of the nano- reinforcement.

Biography

In his research, Ioannis Zuburtikudis seeks to identify and understand the effects of nanoscale dimensions on material properties and use these insights to adapt and influence the design and construction of advanced materials, surfaces, and processes that can lead to valuable products for sustainable development. In Greece, he founded and developed the NanoMaterials & Manufacturing Processes Laboratory (NanoMaMa Lab, www.nanohybrid.eu), dedicated to researching polymeric nano(bio)composites and nanofibers for biomedical, food, and energy applications. In the UAE, Ioannis continues his research in polymer nanotechnology, seeking to address problems of particular interest to the country. For example, his recent funded research projects address the application of nanocomposites based on carbon nanostructures (CNSs) such as C nanofibers (CNFs), C nanotubes (CNTs), and graphene oxide (GO) for water/wastewater purification and desalination. The attachment of specific green solvents (ionic liquids, deep eutectic solvents) to these CNSs to produce advanced adsorbents, mainly for water applications, is also the subject of his current interests and work, always using the statistical methodology of experimental design. Finally, recycled plastics such as PET for the production of high value-added C-nanofibers with a wide range of applications is another focus of his research in the UAE, expressing his interest and commitment to the circular economy and sustainable development.

TFN NANOFILTRATION MEMBRANES CONTAINING GO NANOPARTICLES WITH ENHANCED WATER SELECTIVITY AND ANTI-FOULING PROPERTIES.

Fotios Panagiotou[1,2], Ioannis Zuburtikudis[1], Hadil Abu Khalifeh[1], Enas Nashef[3] and Valadoula Deimede[2]

[1]Abu Dhabi University, UAE
[2]University of Patras, Greece
[3]Khalifa University, UAE

Abstract

Background: Water scarcity is a threat to billions of people worldwide and is expected to become worse due to the climate change and the rise of the world population. Desalination technologies are expected to play a significant role in alleviating the aforementioned problem, but they suffer from high energy consumption. In order to minimize the energy consumption of the desalination sector new membrane based technologies emerge as an alternative to traditional desalination technologies.

Objective: To fabricate nanofiltration (NF) thin film nanocomposite (TFN) membranes containing graphene oxide (GO) and functionalized GO with enhanced water selectivity and anti-fouling properties.

Methods: An ultrafiltration porous substrate was synthesized from a polysulfone containing pyridine units with the use of non-solvent induced phase separation (NIPS). That substrate was used to fabricate NF membranes utilizing the surfactant-assembly regulated interfacial polymerization (SARIP) between piperazine (PIP) and trimesoyl chloride (TMC). The GO and the functionalized with an ionic liquid GO nanoparticles (GO-IL) were dispersed into the PIP solution and thus incorporated into the selective layer of the TFN membranes. The properties of the fabricated TFN membranes were investigated via FT-IR, XPS, water contact angle, AFM and SEM, while the performance was evaluated by conducting filtration experiments at 7 bar pressure with the use of dead – end stirred cell.

Results: The combination of SARIP along with the incorporation of GO and GO-IL greatly increased the crosslinking degree of the polyamide, the hydrophilicity and the roughness of the selective layer. The TFN membrane containing the pristine GO exhibited very high salt rejections (98.8% Na_2SO_4, 99.5% $MgSO_4$, and 47.0% NaCl) with an adequate water permeability (4.2 L m^{-2} h^{-1} bar^{-1}), while exhibiting higher fouling resistance against bovine serum albumin (BSA).

Conclusion: The combination of SARIP and GO nanoparticles can lead to NF membranes with very high-water selectivity and enhanced anti-fouling properties.

Acknowledgement: This research is supported by ASPIRE, the technology program management pillar of Abu Dhabi's Advanced Technology Research Council (ATRC), via the ASPIRE "AARE (ASPIRE Awards for Research Excellence)" and through grant no. AARE20-246 to Ioannis Zuburtikudis of Abu Dhabi University.

Biography

In his research, Ioannis Zuburtikudis seeks to identify and understand the effects of nanoscale dimensions on material properties and use these insights to adapt and influence the design and construction of advanced materials, surfaces, and processes that can lead to valuable products for sustainable development. In Greece, he founded and developed the NanoMaterials & Manufacturing Processes Laboratory

(NanoMaMa Lab, www.nanohybrid.eu), dedicated to researching polymeric nano(bio)composites and nanofibers for biomedical, food, and energy applications. In the UAE, Ioannis continues his research in polymer nanotechnology, seeking to address problems of particular interest to the country. For example, his recent funded research projects address the application of nanocomposites based on carbon nanostructures (CNSs) such as C nanofibers (CNFs), C nanotubes (CNTs), and graphene oxide (GO) for water/wastewater purification and desalination. The attachment of specific green solvents (ionic liquids, deep eutectic solvents) to these CNSs to produce advanced adsorbents, mainly for water applications, is also the subject of his current interests and work, always using the statistical methodology of experimental design. Finally, recycled plastics such as PET for the production of high value-added C-nanofibers with a wide range of applications is another focus of his research in the UAE, expressing his interest and commitment to the circular economy and sustainable development.

MACHINE LEARNING APPROACHES TO ACCELERATE THE COMPUTATION OF FINITE TEMPERATURE PROPERTIES OF SOLID MATERIALS

Pinku Nath[1], Yuki Ide[1], Jose J Plata[2], Yasuhide Inokuma[1,3] and Masaharu Yoshioka[1,4]

[1]*Institute for Chemical Reaction Design and Discovery (WPI-ICReDD), Hokkaido University, Japan*
[2]*Universidad de Sevilla, Spain*
[3]*Division of Applied Chemistry, Faculty of Engineering, Hokkaido University, Japan*
[4]*Graduate School of Information Science and Technology, Japan*

Abstract

Accurately predicting the properties of solids at finite temperatures is a computationally intensive task. Calculating thermodynamic, mechanical, and thermal transport properties simultaneously can greatly increase the computational cost. Traditionally, different computational setups are required to predict these three types of properties or domains. Moreover, the information generated while computing one domain is generally not utilized in the other two. Besides the high computational cost, traditional methodologies often overlook the need for incorporating high-temperature corrections that stem from the anharmonicity of the material. To tackle these challenges, an automated and accelerated computational framework has been developed to enable the computation of finite properties of the three above-mentioned domains simultaneously. This new approach utilizes interdomain data efficiently and combines accelerated methodologies such as machine learning regression for the extraction of high-order force constants and the quasi-harmonic three-phonon method to reduce the computational cost without compromising accuracy. Temperature-dependent phonons are included in the calculation to include strong anharmonic effects. The methodology can be used with either classical interatomic potential or DFT-based codes.

Biography

Pinku Nath serves as an assistant professor at the Institute for Chemical Reaction Design and Discovery (ICReDD) at Hokkaido University, Japan. As a computational materials scientist, he specializes in creating algorithms and scientific software aimed at speeding up the computation of various properties of solid materials without sacrificing accuracy. Additionally, he is an expert in knowledge engineering and management. His is also working on integrating human knowledge with chemical reaction dynamics to expedite chemical reaction processes through the use of ontological concepts.

Virtual Oral Presentations

INVESTIGATION THE EFFECT OF COMBINED QUENCHING AND DEEP CRYOGENIC TREATMENT ON WEAR BEHAVIOR OF MARTENSITIC DUCTILE IRONS

S Gvazava[1], N Khidasheli[1], ADL Batako[3], M Chikhradze[2], G Zakharov[2] and M Donadze[1]

[1]*Georgian Technical University, Georgia*
[2]*Ferdinand Tavadze Metallurgy and Materials Science Institute, Georgia*
[3]*Liverpool John Moores University, UK*

Abstract

Background: Studying the transformation peculiarities of high-carbon austenite by the shift mechanism is an effective strategy for improving the friction characteristics of high-strength cast iron, since the lower bainitic and martensitic phases provide significant strengthening of the metal-base of alloy. To eliminate the brittle fracture of high-carbon iron alloys and to determine their potential effectiveness, it is necessary to control the phase composition and morphology of structural components.

For this purpose, the influence of time and temperature factors on the morphology of martensitic binders and its volume ratios was studied.

Objective: Boron microalloyed high-strength cast iron was selected as the research object and was thermally treated in different modes in order to vary its structure. In particular, direct quenching in oil, water and deep cryogenic treatment in liquid nitrogen were used. The study of the tribotechnical characteristics of the polished samples were carried out without preliminary loosening and during frictional loading, their structure in contact zone suffered dynamic strain aging.

Methods: Microstructural characterizations were carried out by optical microscopy, X-RAY diffraction. Frictional characteristics of experimental cast irons were studied under dry friction conditions with sliding vector speed of 2.1 m/s.

Results: Hardness of martensitic cast irons with different morphologies and volume fractions, kinetics of change of friction coefficient and intensity of wear are studied. It has been shown that the structural characteristics and quantity of martensitic phase significantly affect the frictional fracture mechanism of ductile cast irons.

Conclusion: It is determined that the duration of austenitization and the cooling rate of the alloy have significant influence on the volume of martensite formed because of hardening and its morphological characteristics. Deep cryogenic treatment of boron microalloyed high-strength cast irons leads to the formation of finely dispersed martensite and inhibits the formation of block residual austenite. The combination of direct quenching and deep cryogenic treatment processes provides an improvement in the frictional characteristics, which is caused by the homogenization and stabilization of the structure.

Biography

Salome Gvazava is a young scientist and Ph.D student of the Faculty of Chemical Technologies and Metallurgy of the Technical University of Georgia. Currently, she holds the position of senior researcher of the Laboratory of “Metallurgy, Protection of Metals from Corrosion” of - Ferdinand Tavadze Metallurgy and Materials Science Institute. She is the winner of the competition for funding doctoral educational programs by the Shota Rustaveli Georgian National Science Foundation (PHDF23-308). She is an author of 23 scientific papers in highrank publications, participated in 13 international conferences & symposiums. She is a member of the World Association of Ceramicists. Salome Gvazava's field of scientific interests is the study of corrosion and frictional rupture processes of alloys, thermodynamics of phase transformations of high-carbon alloys and the study of the structure and functional properties of high-strength cast irons. She collaborates with Liverpool John More University (LJMU), as confirmed by her scientific papers.

EXTRACTION AND CHARACTERIZATION OF CELLULOSE NANO CRYSTALS FROM DURIAN PEEL WASTE THROUGH OXIDATION METHOD

Henny Pratiwi, Kusmono and Muhammad Waziz Wildan

Universitas Gadjah Mada, Indonesia

Abstract

Background: Recently, the isolation of nanocellulose has been widely discussed by researchers around the globe. Numerous approaches, including mechanical, chemical, and a combination of mechanical and chemical procedures, have been used to extract cellulose nano crystals (CNCs) from natural materials. One of the chemical processes that uses the oxidation approach to isolate CNCs from natural materials is ammonium persulfate (APS). More simply than with other methods, APS oxidation allows for the extraction of nanocellulose while requiring less energy and producing less pollution than acid hydrolysis. In Indonesia, durian peel is a plentiful organic waste, however it is not currently being used to its full potential.

Objective: To extract and characterize cellulose nano crystals from durian peel waste through APS oxidation method.

Methods: In this study, CNCs from durian peel waste were isolated by chemical oxidation. This process involved two stages of a chemical process, namely bleaching followed by oxidation of ammonium persulfate (APS). The CNCs was extracted from durian peel waste by oxidation process using 1 M APS solution at 80°C for 16 hours. The resulted CNCs was characterized by Fourier transformed infrared spectroscopy (FT-IR), X-ray diffraction (XRD), thermogravimetric analysis (TGA), and transmission electron microscopy (TEM).

Results: The resulting CNCs was needle-like shapes with a width of 5.91 ± 1.97 nm, a length of 110.58 ± 16.17 nm, and an aspect ratio of 21.49 ± 7.58. The results of FT-IR characterization on CNCs showed a reduction in the intensity of the hemicellulose and lignin peaks, indicating effective removal of these two materials. This is supported by the XRD results where the crystallinity index of durian peel powder increased significantly from 40.06% to 81.62%. From the TGA analysis, the thermal stability was found to increase due to the chemical isolation.

Conclusion: APS oxidation was a remarkable method for increasing the value of durian peel waste into high-value nanocellulose without adversely impacting the environment; regardless, future studies should address the issue of improving yield and aspect ratio through some experimental modifications. Overall, the obtained CNC from durian peel waste had great potential for reinforcing the material of bio-nanocomposites.

Biography

Henny Pratiwi has her expertise in nanocellulose and natural fiber composites. In 2019, she joined Universitas Negeri Yogyakarta, Indonesia, where she supervises research activities in natural fiber composites and teaches material science to bachelor students in engineering.

RAPID AND HIGHLY EFFICIENT REMOVAL OF AQUEOUS PERFLUOROOCTANOIC ACID USING DEEP EUTECTIC SOLVENTS FOR SUSTAINABLE WATER REMEDIATION

Sana Eid, Tarek Lemaoui, Ahmad S Darwish, Fawzi Banat, Shadi W Hasan and Inas M AlNashef

Khalifa University, UAE

Abstract

Background: Perfluorooctanoic acid (PFOA) is a persistent and prevalent contaminant in water, posing environmental challenges due to its resistance to degradation. Current methods for removing PFOA are limited in terms of efficiency and sustainability, necessitating the exploration of more effective solutions.

Objective: This study aims to explore the use of deep eutectic solvents (DESs) as a sustainable and efficient alternative for the extractive removal of PFOA from water. The goal was to identify a DES that could outperform traditional solvents like toluene, with a focus on extraction performance and environmental safety.

Methods: Ten candidate DESs were evaluated based on several criteria: extraction efficiency, density, viscosity, environmental impact, and hydrophobicity. Trioctylphosphine oxide and lauric acid (TOPO:LauA, 1:1) emerged as the top-performing solvent.

Results: TOPO:LauA achieved an outstanding single-stage extraction efficiency of 99.74%, surpassing the benchmark solvent, toluene, which achieved 82.26%. The DES maintained its high performance under diverse conditions, such as varying pH, temperature, and solvent-to-feed ratios. The solvent also exhibited durability, with no degradation over seven reuse cycles, and excellent selectivity for PFOA in complex wastewater.

Conclusion: The development of TOPO:LauA represents a breakthrough in PFOA extraction, offering a more efficient, sustainable, and scalable alternative to traditional solvents and methods like adsorption or membrane separation. This innovation holds significant promise for improving water treatment technologies, addressing a critical environmental need.

Biography

Sana Eid is a PhD candidate in Chemical Engineering at Khalifa University, currently in her eighth semester. She holds a Bachelor of Science in Chemical Engineering from Abu Dhabi University and a Master of Science in Water Resources Engineering from the United Arab Emirates University. Her doctoral research is centered on the use of green solvent-based materials, particularly deep eutectic solvents, for the extraction of perfluorooctanoic acid (PFOA) from wastewater.

REAL-TIME MONITORING OF CARDIOVASCULAR COMPLICATIONS USING PYROELECTRIC NANOGENERATORS

Mariana Rocha[1], Marta Nunes[1], Andreia T Pereira[2,3], Inês C Gonçalves[2,3] and André Pereira[1]

[1]IFIMUP –Institute of Physics for Advanced Materials, Nanotechnology and Photonics, Department of Physics and Astronomy, Science Faculty, University of Porto, Porto, Portugal
[2]INEB – Instituto de Engenharia Biomédica, University of Porto, Portugal
[3]i3S - Instituto de Investigação e Inovação em Saúde, University of Porto, Portugal

Abstract

Background: Cardiovascular diseases (CVD) are the primary cause of death globally, with an estimation of 17.9 million deaths/year. Stenting is the standard procedure used to widen narrowed or obstructed arteries (expected global market of ~19.8 billion € in 2030). Considerable post-implantation complications such as stent restenosis, thrombosis, and infection lead to their failure in up to 30% of the cases. This highlights the critical role of development of implantable sensors for diagnosis of stent- related complications. Smart stents with micro/nano-electromechanical sensing and communication systems have been developed for early failure diagnosis. These sensors mainly measure pressure/blood flow and required external batteries for their operation, limiting their implantability.

Objective: This work proposes the development of self-powered sensors based on pyroelectric effect (conversion of thermal to electrical energy) implemented at the stent surface, and produced using low-cost, easy implementable and industrially scalable coating methods.

Methods: The nanostructured PVDF films were prepared using the solvent casting method and using several solvents to study the effect of them in the sensor's performance.

Results: Were obtained several sensors with being the sensor prepared with N-Methyl-2-pyrrolidone presenting an output of $\Delta V = 14$ mV ($\Delta T \sim 40$°C).

Conclusion: The sensors based in pyroelectric nanomaterials present high sensibility to detect local temperature variations of biological events, namely clotting, biofilm formation which are associated to the restenosis of Stents. Through the development of novel stents equipped with sustainable and autonomous power sources has the potential to significantly improve patient outcomes, minimize complications, and revolutionize the field of interventional cardiology.

Acknowledgment: This work was financially supported by FCT through projects UIDB/04968/2020 (DOI: 10.54499/UIDP/04968/2020), UIDP/04968/2020 (DOI: 10.54499/UIDB/04968/2020) and Pyro4Cardio (DOI: 10.54499/2022.04242.PTDC). MR also thank FCT for the Junior Research Contract with ref. 2022.04179.CEECIND/CP1719/CT0006 in the scope of 5th Individual Call to Scientific Employment Stimulus.

Biography

Mariana Rocha is a Junior Researcher @IFIMUP/FCUP (2022.04179.CEECIND) and Visiting Researcher @i3S. Finished her PhD in Sustainable Chemistry in 2018. Recently, Mariana Rocha is developing new materials, namely pyroelectric nanomaterials with high performance with the focus on the biomedical sensors.

HIGHLY SENSITIVE LSPR GAS SENSORS USING SCALABLE PVD-FABRICATED PLASMONIC NANOCOMPOSITES

NM Figueiredo, DI Meira, M Proença, MS Rodrigues, J Borges, F Vaz, T Kubart and A Cavaleiro

University of Coimbra, Portugal

Abstract

Background: Plasmonic nanostructures supported on solid surfaces are used in various applications; however, they often exhibit poor adhesion and lack chemical and thermal stability, which compromise the overall performance and longevity of many localized surface plasmon resonance (LSPR)-based products.

Objective: To develop highly stable and sensitive LSPR sensors that can be easily scaled for mass production.

Methods: Highly stable gold nanoparticle (Au NP) nanocomposites were fabricated using two approaches: (i) deposition of Au nanolayers with thicknesses below the percolation limit, followed by encapsulation with a top oxide layer; (ii) deposition of Au nanolayers with thicknesses above the percolation limit, followed by a thermal embedding process at a temperature above the substrate's glass transition temperature (Tg).

Conclusion: In the first nanocomposite design, Au NPs of different sizes, shapes, and concentrations were incorporated into the coatings. For shorter deposition times, the Au NPs were predominantly spherical, resulting in narrow LSPR absorption peaks. As the Au deposition time increased, ellipsoidal Au NPs with decreasing aspect ratios were obtained, leading to broader, red-shifted LSPR absorption bands. Highly sensitive LSPR sensors were achieved, with refractive index sensitivity (RIS) values exceeding 1000 nm/RIU.

In the second nanocomposite design, as the Au content increased, strong optical scattering bands with increasing width and red-shifted LSPR peak positions were observed. Highly robust LSPR sensors were developed. When using liquids, RIS values between 150-360 nm/RIU were obtained for samples with narrower LSPR extinction bands. When using gases, an excellent correlation was established between light intensity and the refractive index of the gas mixture, demonstrating the potential for label-free gas sensing.

Biography

Dr. Nuno Figueiredo is a Junior Researcher at the University of Coimbra (UC), working in close collaboration with Instituto Pedro Nunes (IPN) under the scope of various research projects and student supervision. He has published 30 papers in international journals and has worked on 2 European and 10 national projects in the fields of nanotechnology and materials science, focusing on tribological, decorative, plasmonic, antimicrobial, antifingerprint, and bio/gas sensing applications. He has gained expertise in the optical simulation (both analytically and numerically) of complex nanoparticle systems and in the development of plasmonic nanostructures through sputtering techniques. He is currently the Principal Investigator (PI) of a national project aimed at developing decorative metallic and non-metallic protective coatings with multifunctional properties for polymeric parts in the automotive industry.

OPTIMIZING CZTS SOLAR CELLS: ENHANCING EFFICIENCY WITH RGO AND TIO_2 FOR SUSTAINABLE ENERGY SOLUTIONS

Fatihi Dounia, Abderrafi Kamal and Adhiri Rahma

Hassan II University of Casablanca, Morocco

Abstract

Background: Copper Zinc Tin Sulfide (CZTS) solar cells are an emerging technology in renewable energy, offering low-cost and environmentally sustainable solutions. CZTS uses abundant materials like zinc (Zn) and tin (Sn), making it more affordable than other thin-film solar technologies. However, challenges such as resistive losses caused by molybdenum disulfide (MoS_2) formation and the use of toxic cadmium sulfide (CdS) as a buffer layer limit its efficiency and environmental safety.

Objective: This study aims to enhance CZTS solar cell performance by optimizing the absorber layer, introducing reduced graphene oxide (rGO) as a back-surface field (BSF) layer, and replacing CdS with titanium dioxide (TiO_2) as a safer, more efficient buffer layer.

Methods: Using SCAPS simulation software, key parameters such as quantum efficiency, electron affinity, and carrier transport were evaluated. The study focused on how rGO could improve charge collection by reducing recombination losses at the back interface and how TiO_2's wide bandgap (~3.2 eV) could increase light absorption and reduce parasitic losses.

Results: Incorporating rGO enhanced electrical conductivity and charge mobility, while replacing CdS with TiO_2 boosted light absorption and minimized recombination. These improvements resulted in significantly higher CZTS cell efficiency and reduced environmental impact.

Conclusion: Optimizing CZTS solar cells with rGO and TiO_2 offers a promising path to improved performance and sustainability, making them a viable option for future clean energy applications.

Biography

Fatihi Dounia, acquired a Bachelor's degree in Physics in 2017 and a Master's degree in Renewable Energy and Energy Systems in 2019 from Hassan II University, Faculty of Science Ben M'Sik in Casablanca, Morocco. Currently, she is a Ph.D. student at the same university, conducting continuous research in the energy field. Her main research area of interest is the application and improvement of solar energy-based systems. Additionally, she is currently under the MAECI scholarship in Italy. https://orcid.org/0000-0002-6949-0779.

INVESTIGATION OF THE ELECTRICAL AND MAGNETIC BEHAVIOR OF $Bi_{1.34}Fe_{0.66}Nb_{1.34}O_{6.35}$ SYNTHESIZED VIA SOL-GEL TECHNIQUE

Susana Devesa[1], Carlos Oliveira Amorim[2], João Horta Belo[3], João P Araújo[3], Sílvia Soreto Teixeira[2], Manuel PF Graça[2] and Luís Cadillon Costa[2]

[1]*University of Coimbra, CEMMPRE, ARISE, Department of Mechanical Engineering, Portugal*
[2]*University of Aveiro, i3N, Physics Department, Campus Universitário de Santiago, Portugal*
[3]*Institute of Physics of Advanced Materials, Nanotechnology and Photonics (IFIMUP), Department of Physics and Astronomy, Faculty of Sciences, University of Porto, Portugal*

Abstract

Background: Recent advancements in solid-state physics and materials engineering are centered on developing innovative dielectric materials, with bismuth-based pyrochlores already being applied in communications technologies due to their superior dielectric properties and relatively low sintering temperatures.

Objective: The objective of this study is to investigate the structural, morphological, electrical, and magnetic properties of $Bi_{1.34}Fe_{0.66}Nb_{1.34}O_{6.35}$ ceramics synthesized using the sol-gel method and sintered at 500°C.

Methods: $Bi_{1.34}Fe_{0.66}Nb_{1.34}O_{6.35}$ powders were prepared using the sol-gel method and sintered at 500°C. The structural analysis was carried out through X-ray diffraction (XRD) and scanning transmission electron microscopy (STEM) with energy-dispersive X-ray spectroscopy (EDS), while the morphological characteristics were examined using scanning electron microscopy (SEM). The complex permittivity was measured over a frequency range of 100 Hz to 1 MHz, as a function of temperature, using the impedance spectroscopy (IS) technique and the magnetic properties were inspected with a Quantum Design MPMS3 superconducting quantum interference device (SQUID) magnetometer.

Results: Rietveld refinement of XRD data revealed the presence of a cubic phase within the Fd-3m space group, with a crystallite size of 42 nm. TEM further confirmed these findings and the sample's morphology, observed through SEM, showed submicron spherical particles.

The dielectric properties suggested the material's potential for energy storage due to its lower dielectric loss relative to the dielectric constant.

Regarding the magnetic characterization, $Bi_{1.34}Fe_{0.66}Nb_{1.34}O_{6.35}$ ceramic exhibits paramagnetic behavior across most of the measured temperature range, with a Néel temperature around 8 K. The SQUID magnetometry also identified a secondary high-Curie temperature ferrimagnetic phase, likely vestigial maghemite, however, with an estimated fraction below 0.03 wt.%.

Conclusion: The sample possesses a relatively stable dielectric constant and low loss tangent across a wide range of frequencies, making it suitable for potential energy storage applications. The low sintering temperature employed in this study could be advantageous for various technological applications, particularly in cofired dielectric components.

Biography

Susana Devesa holds a degree in Physics and Chemistry, a Master's in Applied Physics, a Master's in Civil Engineering, and a PhD in Physics

Engineering. She is currently a researcher in the Mechanical Engineering Department at the University of Coimbra and a member of the interdisciplinary R&D Unit "Centre for Mechanical Engineering, Materials and Processes" (CEMMPRE).

Her main research interests are quite diverse and encompass several critical areas. These include the synthesis and characterization of advanced ceramic materials and metal oxides, which are vital for numerous applications in modern technology. Furthermore, she is particularly interested in the development of flexible and sustainable functional films that can be utilized in various industries, such as electronics and environmental technology. In addition to these pursuits, she is also involved in the electrodeposition and thorough characterization of functional coatings, which play a significant role in enhancing the performance and durability of various substrates.

INFLUENCE OF MG DOPING ON THE STRUCTURAL AND MECHANICAL PROPERTIES OF MOCVD-GROWN GAN THIN FILMS

Zohra Benzarti

University of Coimbra, Portugal

Abstract

Background: GaN is a wide-bandgap semiconductor with promising applications in optoelectronic devices, high-power electronics, and sensors. However, its properties can be significantly influenced by doping with impurities. Mg doping is a common technique to introduce p-type conductivity into GaN, enabling the fabrication of efficient light-emitting diodes (LEDs) and laser diodes (LDs).

Objective: This study aimed to investigate the effects of Mg doping on the structural, electrical, and mechanical properties of GaN thin films grown on sapphire substrates using metal-organic chemical vapor deposition (MOCVD). The specific objectives were:

1. To achieve p-type conductivity in Mg-doped GaN films.
2. To characterize the structural properties of Mg-doped GaN using HRXRD and Raman spectroscopy.
3. To assess the mechanical properties of Mg-doped GaN using nanoindentation.

Methods: GaN thin films were grown on sapphire substrates using MOCVD. Mg doping was introduced by varying the [Mg]/[TMG] ratio. The structural properties were characterized using HRXRD and Raman spectroscopy. The electrical properties were determined by Hall effect measurements. The mechanical properties were evaluated using nanoindentation.

Results: Mg doping successfully induced p-type conductivity in GaN films. A higher hole concentration was achieved with increasing Mg doping concentration. HRXRD analysis revealed an increase in dislocation densities in Mg-doped GaN. Raman spectroscopy confirmed the presence of biaxial stress in the Mg-doped films. Nanoindentation measurements showed a significant enhancement in hardness and Young's modulus with Mg doping.

Conclusion: Mg doping effectively tailored the structural, electrical, and mechanical properties of GaN thin films. The results demonstrate the potential of Mg-doped GaN for various applications, including optoelectronic devices and high-power electronics.

Background: Over 2 000 under-5-year-olds die daily in Nigeria from vaccine-preventable diseases, placing the country as the third largest contributor to the global under-5 mortality rate. Nigeria is at serious risk of not meeting the Millennium Development Goal (MDG) of reducing child mortality by two-thirds (i.e. from an under-5 mortality rate of 93/1 000 in 1990 to 31/1 000 in 2015).

Objective: To examine the association between household-level variables and under-5 mortality in Nigeria.

Methods: Data were drawn from the 2008 Nigeria Demographic and Health Survey, which elicited information on demographic and health indicators at the national and state levels. A nationally representative sample of 36 800 households was selected. Data were collected from 33 385 women of reproductive age (15 - 49 years) and who had given birth to at least one live infant in the 5 years preceding the survey. Data were analysed using a multilevel-model approach.

Results: In total, there were 104 808 live births; 18 121 (17.29%) children died as under-5s and 86 687 (82.71%) survived. Poverty, number of children ever born in a household, number of under-5s in the household, place and region of residence, maternal and paternal age, and maternal and paternal education level were critical determinants of under-5 mortality.

Conclusion: The rate of under-5 mortality remains high in Nigeria. This will not be resolved until household-focused interventions are implemented using a tailored framework, and the need to improve maternal education in the country is addressed.

Biography

Prof. Dr. Zohra Benzarti is a professor in the Department of Physics at the Faculty of Science of Sfax, University of Sfax in Tunisia (FSS-USF). She received her PhD from the University of Tunis El-Manar (Tunisia) in 2006. In 2017, she obtained the diploma “Habilitation à Diriger des Recherches” (HDR) in Physics of Materials from the University of Monastir in Tunisia. She is currently a senior researcher in the Department of Electronics, Telecommunications, and informatics and Aveiro Institut of Materials at the University of Aveiro in Portugal. Since the early 2000s, she has been working on the fabrication of III-nitride thin films by metal organic vapour deposition (MOCVD) and molecular-beam epitaxy (MBE) techniques, and their multiphysics characterization. She is interested in the correlation between nanomechanical and physical properties of thin film nitride semiconductors. She also worked on the development of multifunctional materials: elaboration of nanomaterials and piezoelectric nano-composites: ZnO doped transition metals and rare earths, hybrid and ceramic perovskites for light sensors, photovoltaic cells, White LEDs and energy storage devices.

ELECTROSPUN POLYMERIC MEMBRANES FOR TISSUE ENGINEERING AND CELL GROWTH

Maria Helena Ambrosio Zanin

Instituto de Pesquisas Tecnológicas do Estado de São Paulo – IPT Bionanomanufacture Unit, Brazil

Abstract

Background: Electrospun nanofibrous scaffolds have great potential to be applied in tissue engineering to recover or replace damaged tissues as they can provide physical, chemical and mechanical features suitable for cell growth, functioning as a temporary structure. They are known for mimicking the body's natural extracellular matrix (ECM) with their nonwoven fibrillar structures with high porosity and surface area that facilitates cell attachment and diffusion of nutrients from the blood.

Objective: Analyzing the influence of different thicknesses of PCL/gelatin scaffolds on the main physicochemical properties, obtained by increasing the electrospinning time in order to obtain simple and optimized models for applications in tissue engineering using Human umbilical vein endothelial cells (HUVEC) and Induced pluripotent stem cell (iPSC).

Methods: The biopolymers poly(ε-caprolactone) (PCL) PCL/gelatin and PCL scaffolds with different thicknesses were prepared by electrospinning technique, considering parameters studies, such as different time lengths and so on and the cell viability assays were performed with HUVEC and (iPSC) to evaluate the viability on the developed scaffolds.

Results: Cell viability were not affected to the longer electrospinning time according to the established studies with the Human umbilical vein endothelial cells (HUVEC) and Induced pluripotent stem cell (iPSC).

Conclusion: The findings of this work intend to help the optimization of the scaffold according to its application, considering the influence of the thickness depending on the final use. Longer electrospinning time may not be advantageous for cell application, while intermediate thicknesses must deliver electrospinning nanofiber scaffolds with good physicochemical properties, good support to grow cells with a good performance and optimal cost–benefit.

Biography

Chemical Engineer with PhD on Chemical Process to develop new materials from University of Campinas (Brazil), visiting researcher at the Fraunhofer Gesellschaft - Institut für Chemische Technologie - ICT of Pfinztal, Germany, Postdoctoral at National Renewable Energy Laboratory - NREL, Colorado – USA and currently senior researcher at Chemical Processes and Particle Technology Laboratory at the Bionanomanufacturing in the Instituto de Pesquisas Tecnológicas do Estado de São Paulo (IPT). Extensive experience in R&D projects developing new materials focused on the technology of encapsulation developing micro and nanostructured particles, electrospinning technique to develop micro and nanofibers based on polymers and also surface modification to improve a desired functional property. All the technology focused on development of new materials opening also possibilities to the innovation products.

SPINESYNC: ENABLING SELF-TRACKING OF PROGRESSION OF PARKINSON'S-INDUCED KYPHOSIS BY LEVERAGING AN IMU-EMBEDDED WEARABLE DEVICE

Rohan Ramachandran

University School Of Nashville, USA

Abstract

Background: Parkinson's disease (PD) is the second most common neurodegenerative disorder, affecting over 10,000,000 people worldwide. 86% of PD patients suffer from kyphosis, or curvature of the thoracic spine. Unlike an HbA1C test for diabetes or a lipid panel for cholesterol, PD patients lack a similarly objective tool for tracking kyphosis, a proxy for progression of PD. Calculation of the Cobb angle using x-rays is the most accepted method for measuring kyphosis, but high cost, radiation exposure, procedural error, and low patient compliance hinder its clinical adoption.

Objective: In this work, we propose a noninvasive, IMU-embedded, wearable neoprene device to enable self-guided kyphosis tracking and spine visualization.

Methods: The system's performance was validated by testing the device on 20 kyphotic spinal positions (trials) using an anatomically-accurate skeleton, half directly on the spine, and the other half conducted by adding an interstitial layer simulating human flesh.

Results: In each trial, we classified the difference between the Cobb angle as measured by the device and calculated through a photograph as the Cobb error (CE). The mean Cobb error was found to be 2.295 degrees (95% CI 1.17-3.425). We performed a One Sample T Test (interobserver radiograph error= 3.3º, H0: CE = 3.3º, Ha < 3.3º, p<0.037).

Conclusion: Based on the results of the one-sample t-test, we rejected H0, concluding that the device accurately tracks kyphosis, more so than a radiograph when including interobserver error. Future applications include scoliosis tracking, gauging efficacy of physical or pharmaceutical therapy interventions, quantification of employee workload in industries using physical labor, and motion tracking in athletics.

Biography

Rohan Ramachandran is a researcher passionate about leveraging wearable technology to address neurodegenerative diseases. Their research primarily focuses on developing innovative, patient-centric solutions that promote self-management of chronic conditions. Currently a student at University School of Nashville, Rohan Ramachandran has worked on various projects involving IMU-based devices, with a particular emphasis on Parkinson's disease and postural tracking. Their interest spans biomedical engineering, human-computer interaction, and data analysis, driven by the goal of improving quality of life for individuals with neurodegenerative diseases.

Virtual
Poster Presentations

HIGH-PERFORMANCE PIEZO-RESPONSIVE MEMBRANE FOR EFFICIENT DYE DEGRADATION AND SUSTAINABLE WATER TREATMENT

Indrajit Mondal, Pabitra Kumar Paul and Sukhen Das

Jadavpur University, India

Abstract

Background: The increasing prevalence of water pollution and dye contamination poses significant environmental challenges. This study introduces a novel eco-friendly piezo-responsive membrane designed for effective dye degradation and sustainable wastewater treatment.

Objective: To evaluate the performance of a piezo-responsive membrane embedded with cobalt chromate quantum dots (CCOQDs) in degrading dye solutions.

Methods: A solution-casting technique was used to fabricate membranes with varying concentrations of CCOQDs (0%, 10%, and 20%) in a Poly (vinylidene fluoride-hexafluoropropylene) (PVDF) matrix. The membrane's piezoelectric properties and dye degradation efficiencies were assessed under ultrasonic stimulation. Reactive oxygen species (ROS) generation and total organic carbon (TOC) removal were also measured. Real-world tests on drinking water and wastewater were conducted to evaluate practical applications.

Results: The membrane with 10% CCOQDs (PCCO 10) displayed a β-phase fraction of 75.93%, dielectric constant of 56.22, and piezoelectric coefficient (d33 = 65.1 pC/N), demonstrating substantial piezocatalytic activity. Degradation rates reached 98.7% for Congo red (CR), 89.9% for Methylene blue (MB), and 87% for a mixed dye solution within 50 minutes. The membrane removed 81.98% of TOC in 75 minutes. Its catalytic efficiency, selectivity, and stability were optimized by adjusting conditions, such as using an alkaline pH solution, 60 W ultrasonic power, and 1 ppm dye concentration. In practical applications, degradation efficiencies of 94.65% and 98.31% were achieved for drinking water and wastewater, respectively. Additionally, the flexible PCCO 10 membrane proved highly reusable, maintaining 97.2% efficiency after four cycles, and retained its structural integrity under various low-frequency stimulations like centrifugation, vortexing, and stirring, confirming its robust piezocatalytic activity for CR degradation. Moreover, the degradation products were identified through LC-MS analysis, and a pot study confirmed that these byproducts did not exhibit phytotoxic effects on neem (*Azadirachta indica*) plants.

Conclusion: Therefore, this multifunctional, free-standing membrane presents a sustainable and highly effective alternative for wastewater treatment.

Biography

Indrajit Mondal is a dedicated researcher specializing in the development of advanced materials for environmental applications. With a strong focus on piezo-responsive technologies, he is committed to addressing the pressing challenges of water pollution and dye contamination. His work integrates innovative methodologies to create eco-friendly solutions that promote sustainable wastewater treatment. Drawing from years of experience in research and application, Indrajit utilizes a multidisciplinary approach, combining principles from materials science, nanotechnology, and environmental engineering. His expertise includes the fabrication and evaluation of multifunctional membranes, particularly those incorporating quantum dots and other nanomaterials. Through rigorous experimentation and real-world testing, Indrajit has made significant contributions to the field, demonstrating the effectiveness of these materials in degrading hazardous dyes and improving water quality. His research not only aims to enhance environmental health but also to ensure the safety and viability of ecosystems. With a passion for innovation and sustainability, Indrajit continues to explore new pathways for improving environmental practices, solidifying his role as a leader in the field of eco-friendly material development.

PIEZO-DRIVEN ANTIBACTERIAL CHITOSAN/ ZrO_2 MEMBRANE FOR RAPID AND REUSABLE COLIFORM BACTERIAL DISINFECTION

Piyali Halder, Brajadulal Chattopadhyay and Sukhen Das

Jadavpur University, India

Abstract

Background: The increasing prevalence of bacterial infections, compounded by antibiotic and multidrug resistance (MDR), underscores the need for innovative therapeutic approaches. Piezodynamic therapy has emerged as a promising strategy, utilizing mechanical stimuli to swiftly and non-invasively target bacterial contaminants.

Objective: This study introduces a novel ZrO_2 nanoparticle-loaded chitosan (ZO@CHS) membrane designed to harness piezodynamic effects for antibacterial applications against both Gram-positive (*E. faecalis*) and Gram-negative (*E. coli*) bacteria.

Methods: The ZO@CHS membrane was fabricated by integrating ZrO_2 nanoparticles into a chitosan biopolymer matrix. Piezo-voltage generation, bacterial elimination efficiency, and reactive oxygen species (ROS) production were evaluated under mechanical stimulation (finger tapping and ultrasound at ~15 kHz). Photoluminescence spectroscopy was used to monitor ROS, and bacterial morphology was examined via FESEM. Reusability tests were conducted over five cycles, and biocompatibility was assessed through hemolysis rate measurements.

Results: The membrane generated a significant piezo-voltage of 4.47 V upon mechanical stimulation. Mild ultrasound exposure enhanced ROS production, leading to the elimination of over 96% of *E. coli* and 97% of *E. faecalis* within 20 minutes. The membrane demonstrated excellent structural integrity and retained over 95% antibacterial efficiency after five reuse cycles. Additionally, the hemolysis rate was low at 0.11%, highlighting its biocompatibility and potential for in vivo applications.

Conclusion: The ZO@CHS membrane shows great promise for both healthcare and industrial applications, with its self-cleaning properties and robust antibacterial performance making it suitable for industries such as pigment manufacturing. Its combination of high piezocatalytic efficiency, reusability, and biocompatibility positions it as a strong candidate for addressing bacterial contamination challenges.

Biography

Piyali Halder is a dedicated researcher focused on the development of advanced antibacterial materials, particularly through the application of piezodynamic therapy. With a strong emphasis on combating the growing challenges posed by bacterial infections and antibiotic resistance, she explores innovative solutions that utilize mechanical stimuli to effectively target and eliminate bacterial contaminants. Piyali specializes in the integration of nanomaterials, specifically transition metal oxide nanoparticles, into biopolymer matrices, such as chitosan, to create multifunctional membranes. These membranes leverage piezoelectric properties to generate reactive oxygen species (ROS) under mechanical stimulation, enhancing their antibacterial efficacy against both Gram-positive and Gram-negative bacteria. With a comprehensive background in materials science and nanotechnology, she employs a rigorous experimental approach that includes piezo-voltage generation studies, bacterial morphology assessments, and biocompatibility evaluations. Her research demonstrates not only high antibacterial efficiency and structural integrity but also low hemolysis rates, suggesting strong potential for in vivo applications. Passionate about advancing healthcare and industrial applications, Piyali continues to investigate the practical uses of piezodynamic membranes in various sectors, including pigment manufacturing and environmental health. Her work exemplifies a commitment to addressing critical public health challenges through innovative material development and application.

Virtual
Video Presentation

VISCOELASTIC FUTURE IN CHIRAL FERROELECTRIC AND ANTIFERROELECTRIC LIQUID CRYSTALS

Dorota Dardas

Polish Academy of Sciences, Poland

Abstract

Knowledge of viscoelastic properties in chiral liquid crystals is a complex and fundamental issue. The main problem is the multitude of physical parameters that needed to determine the value of elasticity and viscosity constants. There are experimental methods for measuring viscoelasticity constants which exploit various phenomena for deformation detection. Commonly in measurements an strong external electric or magnetic field is applied. The viscoelastic behaviors obtained in measurements using a low electric field will be demonstrated. The observation have been also realized before and after photobleaching with a polarizing microscope, simultaneously using the method of numerical analysis of two-dimensional colored textures. Results obtained with an optimised method for determining viscoelastic properties in chiral liquid crystals will be presented and analysed.

Bookmark Dates

12th International Conference on

MATERIALS SCIENCE & ENGINEERING

September 25-26, 2025 | London, UK

Contact Us:

Lisa Allan | Program Manager

materialscience@forumcouncil.org

Phone: +1-718-543-9362

WhatsApp: +1-803-824-1151