



Peers Alley Media:
1126 59 Ave East, V5X 1Y9
Vancouver BC, Canada

MARCH 30-31

2026

ROME, ITALY

8th Edition Of

ADVANCED
MATERIALS SCIENCE
WORLD CONGRESS

SCIENTIFIC PROGRAM

DAY 01

MONDAY

MARCH 30, 2026

08:00-08:30

Registrations

08:30-08:40

Inaugural Ceremony

Moderator

Gary J. Dickelman, *EPSScentral LLC, USA*

Topics: Materials Science and Engineering | Nanomaterials and Nanotechnology | Smart Materials | Biomaterials | Energy Materials | Crystallography | Graphene Technology | Chemistry | Carbon and 2D Materials | Semiconductors | Optics | Green Technologies | Metals and Alloys | Perovskites | Artificial Intelligence | Robotics | Catalysis

Distinguished Speaker Talks

Session Chair

Karen K. Leonas, *North Carolina State University, USA*

Session Chair

Arturo Gómez-Ortega, *SECIHTI-Centro de Ingeniería y Desarrollo Industrial (CIDESI), México*

08:40-09:00

Title: On an Optimal AI Framework for Materials Research, Discovery and Application

Gary J. Dickelman, *EPSScentral LLC, USA*

09:00-09:20

Title: Performance Evaluation of Hydronic Air Coil for Building Heating with Nanofluids of Varying Concentrations *via* theoretical Analysis and Experimental Characterization

Debendra K. Das, *University of Alaska Fairbanks, USA*

09:20-09:40

Title: Influence of Differential Speed Rolling and Post Annealing on the Formability of Mg-Based Alloys

Christopher L. Hale, *North Carolina A&T State University, USA*

09:40-10:00

Title: Toward Sustainable Dyeing: Achieving Targeted Shades and Fastness through Chemical and Technological Integration

Karen K. Leonas, *North Carolina State University, USA*

10:00-10:20 Title: Lightweight Spur Gears with Cellular Cores: Design, Simulation and Validation through Additive Manufacturing

Arturo Gómez-Ortega, *SECIHTI-Centro de Ingeniería y Desarrollo Industrial (CIDESI), México*

GROUP PHOTO 10:20-10:30

REFRESHMENT BREAK 10:30-10:50

10:50-11:10 Title: Smart Materials Based Semiconductors to be used in Photo-Electrocatalysis for Environmental Applications

Fernando Cruz de Moraes, *Federal University of São Carlos, Brazil*

11:10-11:30 Title: Synergetics of Fracture and Evolution of Interrelationship with Multi-Level Self-Organizing Processes in Material Destruction

Ahad Janahmadov, *Azerbaijan National Academy of Aviation, Azerbaijan*

11:30-11:50 Title: Wireless Communication Protocols for the IoT-How to Choose the Best Option?

Luiz Carlos Branquinho Caixeta Ferreira, *Federal Institute of Education, Science and Technology of Southern Minas Gerais, Poços de Caldas Campus, Brazil*

11:50-12:10 Title: Hybrid of F-doped SnO₂ Aerogel and Pt Nanoclusters for High-Efficiency Hydrogen Evolution

Hyung-Ho Park, *Aerogel Materials Research Center, Yonsei University, South Korea*

12:10-12:30 Title: Charged Water Radical Clusters as the Soft Nanomaterial for Energy, Chemistry, Medicine and Life Sciences

Huanwen Chen, *Jiangxi University of Chinese Medicine, China*

12:30-12:50 Title: Development of Manufacturing and Recycling Processes on Breeding Functional Materials for Fusion Applications

Jae-Hwan Kim, *National Institutes for Quantum Science and Technology, QST, Japan*

GROUP PHOTO 12:50-13:00

LUNCH BREAK 13:00-13:40

13:40-14:00

Title: To Study, Effect of Oxidizing Agent, on Electrochemical Supercapacitor Properties of NiO-Polyaniline Composite

Munish Pandey, *K. M. Agrawal College, India*

14:00-14:20

Title: Automatic Play-Field Analyzing and Player Tracking in Broadcast Tennis Video using Improved Kalman Filter

M. Archana, *Annamalai University, India*

14:20-14:40

Title: Graphene Oxide/Goethite-Chitosan Composite for the Optimization of Arsenic (III) Adsorption from Polluted Aqueous Solutions

Hari Mohan Meena, *Department of Chemistry, Hansraj College, University of Delhi, India*

14:40-15:00

Title: Intelligent Packaging Hydrogel Incorporating *Nerium oleander* Anthocyanin to Preserve Chicken Meat

Sirajunnisa Abdul Razack, *Acharya Institute of Technology, India*

15:00-15:20

Title: Functional Defect-Rich Oxide Nanoparticles for Industrial and Biomedical Applications

Maksim Aleksandrovich Pugachevskii, *Southwest State University, Russia*

15:20-15:40

Title: Anti-Neoplastic Activity of Selected Essential Oil (EO)-Loaded in Niosomes Against HepG2 and YAC-1 Cells: An *in vitro* Study

Kalaiselvi Aasaithambi, *JSS Academy of Higher Education and Research, India*

15:40-16:00

Title: TPP-Chitosomes as Effective Carriers for Protecting Enriched Bioactive Extracts

Milena Martelli Tosi, *University of São Paulo, Brazil*

REFRESHMENT BREAK 16:00-16:20

Title: Adsorption Performance of Rare Earth Elements using a Phosphoric Group-Functionalized Magnetic Nanomaterial

Carlos Basualto Flores, *Universidad de Chile, Chile*

Title: Use of Mesenchymal Stem Cells in a Dog with Bone Marrow Hypoplasia: Case Report

Weli Cristina Bessi dos Santos, *Veterinary Hematology Hemoclinic, Brazil*

16:20-16:50
(Posters)

Title: Naturally Cross-Linked Matrices: The Effect of Extract from Polish Plum Waste as a Novel Cross-Linking Agent on the Functional Properties of Hydrogels

Natalia Baka, *Cracow University of Technology, Poland*

Title: Investigation of the Pro-Aging Properties of Extracts from Food Industry Waste as a Source of Bioactive Functional Materials

Aleksandra Kamienik, *Cracow University of Technology, Poland*

Title: Phytochemical Composition of Extracts from Fruit and Vegetable Processing Waste for Functional Material Applications

Magda Ptaszkiewicz, *Cracow University of Technology, Poland*

16:50-17:10

Title: Ferromagnetic Materials for MTJ Based Energy Efficient Non-Volatile Memory

Prasanna Kumar Misra, *Indian Institute of Information Technology, Allahabad, India*

17:10-17:30

Title: Coir Fibre Reinforced Ceiling Board Development with Overview of Mechanical, Thermal, and Physical Aspects

Darshani Asha Madarasinghe, *University of Moratuwa, Sri Lanka*

17:30-17:45

Title: Long-Lasting Antimicrobial Coatings for Real-World Applications: PVB Nanocomposites with Multifunctional Performance

Mindaugas Ilickas, *Institute of Materials Science, Kaunas University of Technology, Lithuania*

17:45-18:00 Title: Effect of Thermal and Thermochemical Treatment on Complex AlSi10Mg Structures Fabricated by Laser Powder Bed Fusion (LPBF)

Ines Carolina Ortega Portilla, *SECIHTI-Centro de Ingeniería y Desarrollo Industrial (CIDESI), México*

18:00-18:20 Title: Evidence of the Main Role of Minority Current Carriers in the Occurrence of Superconductivity

Yurii Uhryn, *Ivan Franko Drohobych State Pedagogical University, Ukraine*

18:20-18:35 Title: Development of Phosphazene Nanostructures Encapsulated with Natural Polymers as Drug Carriers for Colon Cancer

İlknur Atli, *Canakkale Onsekiz Mart University, Turkey*

NETWORKING

END OF DAY 1

SCIENTIFIC PROGRAM

DAY 02

TUESDAY

MARCH 31, 2026

HALL-01

08:30-08:40

Introduction

Moderator **Gary J. Dickelman**, *EPSScentral LLC, USA*

Topics: Materials Science and Engineering | Nanomaterials and Nanotechnology | Smart Materials | Biomaterials | Energy Materials | Crystallography | Graphene Technology | Chemistry | Carbon and 2D Materials | Semiconductors | Optics | Green Technologies | Metals and Alloys | Perovskites | Artificial Intelligence | Robotics | Catalysis

Distinguished Speaker Talks

Session Chair **David Estrada**, *Boise State University, USA*

Session Chair **Lucjan Kozielski**, *Institute of Materials Engineering, University of Silesia in Katowice, Poland*

Session Chair **Simona Perone**, *Istat and Sapienza University of Rome, Italy*

08:40-09:00
Title: Photonic Quantum Telecommunication for Multi-Agent Systems: Free-Space Links, Topologies and Fidelity under Noise

Stefalo N.N. Acha, *North Carolina A&T State University, USA*

09:00-09:20
Title: Recent Advances in Lead-Free Ceramics Materials for Energy Storage

Lucjan Kozielski, *Institute of Materials Engineering, University of Silesia in Katowice, Poland*

09:20-09:40
Title: Blockchain and Artificial Intelligence: The New Frontiers of Sustainability. How Emerging Technologies Can Revolutionize Advanced Materials Demand and Verification in the Sustainability Landscape

Simona Perone, *Istat and Sapienza University of Rome, Italy*

09:40-10:00 Title: 2-Dimensional and Layered Materials for Applications in Energy, Water and Healthcare

David Estrada, *Boise State University, USA*

10:00-10:20 Title: Microstructural Design and Tribological Performance of a Cu Based High-Entropy Composite Coating

Stefan Lucian Toma, *Gheorghe Asachi Technical University of Iasi, Romania*

GROUP PHOTO 10:20-10:30

REFRESHMENT BREAK 10:30-10:50

10:50-11:10 Title: First-Principles Insights into Borocarbonitride Anodes for Sodium-Ion Energy Storage

Siamkhanthang Neihzial, *Dhanamanjuri University, India*

11:10-11:30 Title: A Novel Billhook Shaped 2-Element MIMO Array for Sub 6 GHz Millimetre Wave Application

Jaimon Yohannan, *Amaljyothi College of Engineering, APJKTU, India*

11:30-11:50 Title: Dynamic Analyses (Modal and Forced Vibration) in a Railway Vehicle Model with 25 Degrees of Freedom

Fernando Luiz Martinechen Beghetto, *Federal University of Technology, Brazil*

11:50-12:10 Title: Ionization Dynamics in Matter with Resonant Nanoantennas Irradiated by Intense Laser Shots

Konstantin Zsukovski, *Wigner Research Centre for Physics, Hungary*

12:10-12:30 Title: Conversion of Indanone-Derived Geminal Azidofluorides to Isoquinolines or Benzoyl Fluorides

Fanhong Wu, *Shanghai Institute of Technology, China*

12:30-12:50 Title: BI-LSTM Enhanced Learning Based Outage Performance Analysis for Aerial Reconfigurable Intelligent Surface Assisted Communication Systems

Kumud S. Altmayer, *University of Arkansas at Little Rock, USA*

GROUP PHOTO 12:50-13:00

LUNCH BREAK 13:00-13:40

13:40-14:00	<p>Title: New Models of University for the Digital Society</p> <p>Maria Amata Garito, <i>International Telematic University UNINETTUNO, Italy</i></p>
14:00-14:20	<p>Title: Influence of Higher GGBFS Content on the Performance of Concrete Pavement Incorporating Processed Coarse RAP</p> <p>Dinesh Ganvir, <i>CSIR-Central Road Research Institute, New Delhi, India</i></p>
14:20-14:35	<p>Title: DDPG-PER for an IRS-Aided Secure Wireless Communication</p> <p>BOUROUINA Anfal, <i>LCSI Laboratory, Higher School of Computer Science (ESI), Algeria</i></p>
14:35-14:50	<p>Title: Leveraging Asymmetric Cycling Protocols for Fast Charging of LFP-Li Metal Batteries</p> <p>Connor Welty, <i>CIC EnergiGUNE, Spain</i></p>
14:50-15:05	<p>Title: Time-Dependent Rheological Evolution of Cement Paste under Dynamic Shear Conditions</p> <p>Astha Sharma, <i>Indian Institute of Technology Indore, India</i></p>
15:05-15:20	<p>Title: Influence of the Parameters of the Topological Optimization Method: Sequential Element Rejection and Admission in the Design of Metamaterials</p> <p>Mariela Gómez Castañeda, <i>Centro de Ingeniería y Desarrollo Industrial (CIDESI), SECIHTI, México</i></p>
15:20-15:40	<p>Title: Electrical Conductivity of Nanofluids with Carbon Nanotubes</p> <p>Valery Ya. Rudyak, <i>Novosibirsk State University of Architecture and Civil Engineering, Russia</i></p>
15:40-16:00	<p>Title: Anticancer Evaluation and Drug Delivery of New Complexes Based on the Chelate of Alendronate onto Hydroxyapatite Nanoparticles</p> <p>Sahar I Mostafa, <i>Mansoura University, Egypt</i></p>

REFRESHMENT BREAK 16:00-16:20

16:20-16:35 Title: Development of Neutral Zone-Based Lumbar Support Robotic Device Utilizing an Electroadhesive Clutch

Garam Lee, *Seoul National University, South Korea*

16:35-16:50 Title: In-Plane Tensile Effect Induced Ultralow Friction in Suspended Hexagonal Boron Nitride

Kai Chen, *Southeast University, China*

POSTER PRESENTATIONS (16:50-18:20)

P001 Title: $\text{TiO}_2\text{-C}_3\text{N}_4$ Nanocomposites for Visible-Light-Driven Photocatalytic Air Purification

Ângela Martins Lima, *INL – International Iberian Nanotechnology Laboratory, Portugal*

P002 Title: Engineering Sustainable Fluorine-Free Hydrophobic Coatings for Painting Equipment Protection

Juliana Patricia da Silva Sousa, *INL – International Iberian Nanotechnology Laboratory, Portugal*

P003 Title: Functionalisation-Driven Control of ZnO Tetrapod Networks for Enhanced Electronic Performance

Mindaugas Ilickas, *Institute of Materials Science, Kaunas University of Technology, Lithuania*

P004 Title: Nanoemulsions Based on Extracts Obtained from Fruit and Vegetable Biomass

Magdalena Chrobak, *Cracow University of Technology, Poland*

P005 Title: Nanostructured Lipid Carriers Based on Extracts Obtained from Fruit and Vegetable Biomass

Zuzanna Orzechowska, *Cracow University of Technology, Poland*

P006 Title: Oleogels Based on Extracts Obtained from Fruit and Vegetable Biomass

Lidia Faron, *Cracow University of Technology, Poland*

P007 Title: Hydrogels Based on Extracts Obtained from Fruit and Vegetable Biomass

Oliwia Kubiczek, *Cracow University of Technology, Poland*

P008 Title: Hybrid Systems Based on Extracts Obtained from Fruit and Vegetable Biomass

Adrianna Podlewska, *Cracow University of Technology, Poland*

P009 Title: From Vegetable Biomass to Bio-Patch/Mask: Physicochemical and Structural Characterization of Carrot-Derived Transdermal Hydrogel Systems

Sandra Komaniecka, *Cracow University of Technology, Poland*

P010 Title: Optimization of the Chemical Cross-Linking Reaction of Protein Polymers using Plant Biomass Extracts

Kacper Odziomek, *Cracow University of Technology, Poland*

NETWORKING

END OF DAY 2

HALL - 02

INTRODUCTION

Session Chair **Munish Pandey**, *K. M. Agrawal College, India*

09:20-09:40 Title: Engineering Modifications in Flow Channels for Enhancing Performance of Flow Batteries

Milan Kumar, *Rajiv Gandhi Institute of Petroleum Technology, India*

09:40-10:00 Title: Phytochemistry of *Campaluna lactiflora*: Quantitative Analysis of Bioactive Compounds, Synthesis and Characterisation of Silver Nanoparticles, Investigation of their Biological Activities

Ramazan Erenler, *Tokat Gaziosmanpasa University, Turkey*

10:00-10:20 Title: Precipitation-Engineered Sulfonated Polystyrene Nanoparticles with Tunable Surface Charge for Efficient Removal of Cationic Dyes and Phenolic Contaminants from Water

Tamer Mahmoud Tamer Abdelrazik, *University of Cyprus, Cyprus*

GROUP PHOTO 10:20-10:30

REFRESHMENT BREAK 10:30-10:50

10:50-11:10 Title: Phytochemical Profiling and Biological Activity Evaluation of *Centaurea stapfiana*

Esmá Nur Gecer, *Tokat Gaziosmanpasa University, Turkey*

11:10-11:30 Title: The Skin as a Reflection of our Lifestyle

Juergen Lademann, *Charité – Universitätsmedizin Berlin, Germany*

11:30-11:50 Title: Female Computer Teachers Training by the (TAWOCK) Model

Remsh Nasser Alqahtani, *King Saud University, Saudi Arabia*

11:50-12:10 Title: CRISPR-Cas9 Mediated Disruption of Virulence Genes in Uropathogenic *Escherichia coli*: Towards Antibiotic Free Therapeutics

Tajo Abraham, *Sir Syed College, Taliparamba, Kannur University, India*

12:10-12:30 Title: Surface Chemistry-Driven Chlorobenzene Adsorption on Activated Carbons from HCl Streams

Tânia Raquel Rodrigues Grainha, *INL – International Iberian Nanotechnology Laboratory, Portugal*

12:30-12:50 Title: Sulfur-doped ZnO as Cathode Interlayer for Efficient Inverted Organic Solar Cells

Georgios Manginas, *General Secretariat for Information Systems and Digital Governance, Greece*

GROUP PHOTO 12:50-13:00

LUNCH BREAK 13:00-13:40

13:40-14:00 Title: Optimizing Thermoelectric Potential: Low-Temperature Annealed Sb-doped CuInS₂ vs. Cr-doped GaAs: Measurement, Modeling and Materials Comparison

Nawel Khaldi, *Research and Technology Center of Energy (CRTE_n), Borj-Cedria Science & Technology Park, Tunisia*

14:00-14:20 Title: Experimental Investigations of Tooth Pitch Variation and Cutting Parameters on Tool Wear and Cutting Forces in Flat End Milling of Fe–Ni Alloy Supra50

Mihed Ben Said, *National Engineering School of Sfax (ENIS), University of Sfax, Tunisia*

14:20-14:35 Title: Comparison of Mechanochemical Synthesis and Co-Precipitation to Obtain Composites of Yellow Clay, Hydroxyapatite and *Clitoria ternatea* L .

Klaudia Kowalska, *Maria Curie-Sklodowska University, Poland*

14:35-14:50 Title: Study of the Synthesis, Dispersion and Theoretical-Experimental Analysis of Multiple-Wall Carbon Nanotubes in Portland Cement to Improve the Corrosion Resistance of Embedded Steel

Miguel Angel Gómez Aristizábal, *National University of Colombia, Manizales Campus, Colombia*

14:50-15:10 Title: Synthesis and Investigation of Some Conductive Polymers on the Base of Aromatic Diamines

Narine Durgaryan, *Yerevan State University, Armenia*

15:10-15:30 Title: Boosting Mixed-Matrix Membrane Efficiency with Sulfonated Zn-MOFs for Direct Methanol Fuel Cells

Randa Eslah Khalifa Ghonim, *Polymer Institute, Slovak Academy of Sciences, Slovakia*

15:30-15:50 Title: Standards for the use of Sustainable Green Finishing Material and their Impact on Internal Spaces from Economic, Social and Environmental Point of View

Sammer Hendawi Salem, *October High Institute for Engineering and Technology, Egypt*

15:50-16:05 Title: Optimization of Water Softening by Donnan Dialysis using Fujifilm Cation-Exchange Membranes

ABBES Maroua, *University of Gafsa, Tunisia*

REFRESHMENT BREAK 16:05-16:25

16:25-16:40 Title: Tailoring Processing Techniques to Tune Crystal Phase of Odd-Numbered Nylons for Mechanical Energy Harvesting

Swagata Banerjee, *Indian Institute of Technology Delhi, India*

16:40-17:00 Title: Behaviour of Hinges in a Building with and without Lateral Load Resisting System Provided at Ends - Pushover Analysis

Deepa S, *DACG Government Polytechnic, Chickamagalore, India*

17:00-17:20 Title: Multimodal Fusion in Machine Learning: A Comprehensive Approach using Linguistics, Visuals and Metadata

Gautam Pal, *Indian Institute of Management Ranchi, India*

17:20-17:35	Title: Multimodal Double-Helix Fiber Sensor for Independent Pressure and Strain Detection in Wearable Sensory Applications Tsogbayar Dashdende , <i>Hanyang University, Republic of Korea</i>
17:35-17:50	Title: Assessment of Pseudo-Random Number Generator Influence on Dosimetric Parameters for Linac Head Simulation in GATE/GEANT4 Meriem Tantaoui , <i>Hassan II University, Morocco</i>
17:50-18:05	Title: Theoretical Perspective to the Juggling Sequence Rotation Performance Pattern from System Memory Locality Reference Viewpoint Joseph Agarohenefuoma Erho , <i>Niger Delta University, Nigeria</i>

NETWORKING

END OF DAY 2

BOOKMARK YOUR DATES

9th Edition of

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March 2027 | Vienna, Austria

DAY 01



8TH EDITION OF

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MARCH 30-31, 2026 | ROME, ITALY

SPEAKER TALKS



On an Optimal AI Framework for Materials Research, Discovery, and Application

Gary J. Dickelman

EPSScentral LLC, USA

Integrating generative AI in Advanced Materials Science has fostered unprecedented capabilities—DeepMind’s GNoME and FermiNet, “self-driving” laboratories, Graph Neural Networks, Accelerated Multiscale Simulations, and more—while exposing significant interpretability gaps and systemic risks. This paper examines the dual trajectory of AI in materials research, juxtaposing breakthroughs in molecular design, high-dimensional quantum state modeling, and accelerated candidate screening with the hazards of opaque decision-making, little understood failure modes, and potential adversarial exploitation. The paper surveys current interpretability and risk-mitigation techniques—including uncertainty quantification, symbolic–subsymbolic hybrids, provenance tracking, red-teaming protocols, and modular, sandboxed deployment frameworks—evaluating their efficacy in reducing model brittleness while preserving generative performance. The paper further critiques the limitations of large language and diffusion models in capturing physical and causal constraints intrinsic to materials systems and argues that achieving artificial general or superintelligence in this domain may necessitate a pivot toward embodied, developmental architectures inspired by Alan Turing’s “child-machine” paradigm. Drawing on academic literature, real-world case studies, and science-fiction narratives, the paper suggests AI governance strategies, education and workplace learning guidance, and vaccination-style alignment methodologies to preempt rogue behaviors and unintended consequences. By articulating cogent predictions and practical remedies, this work aims to guide the Advanced Materials Science community in further harnessing AI’s potential responsibly, ensuring that future innovations remain aligned with human and scientific values.

Presenter:

Gary J. Dickelman

EPSScentral LLC, USA



Performance Evaluation of Hydronic Air Coil for Building Heating with Nanofluids of Varying Concentrations *via* Theoretical Analysis and Experimental Characterization

Debendra K. Das and **Roy Strandberg**

Department of Mechanical Engineering, University of Alaska Fairbanks, USA

Heat transfer and pumping power evaluations of nanofluids in building heating air coils were performed in two stages. In the first stage, detailed theoretical analyses of two nanofluids were conducted. One was the aluminum oxide nanoparticles dispersed in 60% ethylene glycol and 40% water by mass, and the second was copper oxide nanoparticles dispersed in the same base fluid. The concentrations of nanoparticles of 20 to 60 nanometers, average particle diameter, of volumetric concentrations of 1, 2, 3, and 4% were considered. The analyses employed previously developed correlations for nanofluid thermophysical, fluid dynamic, and heat transfer properties. Theoretical models were developed to characterize the performance of hydronic finned tube air heating coils with these nanofluids and to compare the nanofluids' performance with that of their base fluids. Several aspects of heat transfer performance were analyzed, including heating output, frictional pressure loss, and associated pumping power. The results from these theoretical analyses showed that selected nanofluids can improve heating output, reduce required liquid pumping power, or reduce the size of heating equipment. Overall, the analyses predicted that the nanofluids examined exhibit superior heat transfer performance to that of the base fluids under certain conditions. In the second stage of this research, experiments were performed on nanofluids of aluminum oxide nanoparticles with 1, 2 and 3% volumetric concentration in a 60% ethylene glycol base fluid in a liquid-to-air heat exchanger coil. Surprisingly, the experiments revealed that nanofluids did not perform as well as expected based on previous theoretical analysis. Upon examination, it was discovered that nanofluids were losing their dispersion stability very quickly, leading to agglomeration and settling, resulting in the decline of their superior thermal performance.

Presenter:

Debendra K. Das

University of Alaska Fairbanks, USA



Influence of Differential Speed Rolling and Post Annealing on the Formability of Mg-Based Alloys

Christopher Hale, Zhigang Xu and Jag Sankar

North Carolina A&T State University, USA

Differential speed rolling (DSR) has been recognized as a unique processing technique in recent years, which has been used to plastically deform Mg-based alloys and to investigate the role of dynamic recrystallization (DRX) and its influence on both microstructure and mechanical properties. In this study, Mg-2Al-0.5Ca-0.5Mn (AXM20504) was solution-heat-treated (T4 condition) and subjected to single-pass DSR at both 20 and 40% thickness reductions, followed by post-annealing at temperatures of 350, 400, and 450 °C for the durations of 20, 40, and 60 min to evaluate the onset and development of static recrystallization (SRX) and its overall effect on the formability of Mg-based alloys. The results demonstrate how post-annealing yields nearly complete SRX at 400 °C for 60 min and 450 °C for 40 min with a significant improvement in ductility, increasing from 5% to 12% while maintaining an average tensile strength above 200 MPa. Thus, the improvement in mechanical properties demonstrates that post-annealing can deliver significant potential in terms of the enhanced formability of Mg alloys used in sheet metal forming applications.

Presenter:

Christopher L. Hale

North Carolina A&T State University, USA



Toward Sustainable Dyeing: Achieving Targeted Shades and Fastness through Chemical and Technological Integration

Karen K. Leonas¹ and **Nina Cohen²**

¹North Carolina State University, USA

²Microban International, USA

Advances in textile chemistry and dyeing technology are enabling more sustainable coloration processes for cotton with reactive dyes. Conventional methods often require liquor ratios of 20:1, generating high effluent loads and salt concentrations exceeding 80 g/L. Emerging approaches such as foam finishing and low-liquor dyeing systems reduce water usage by up to 70–80% and significantly decrease auxiliary chemical demand. Modifications in reactive dye structures, including bifunctional and low-salt chemistries, have improved fixation efficiencies to over 80%, thereby minimizing hydrolyzed dye and reducing wastewater treatment burdens. Additionally, digital dosing and process monitoring technologies enhance reproducibility, lower reprocessing rates, and ensure shade precision within $\Delta E < 1.0$. These innovations not only improve color fastness to washing and rubbing but also contribute to measurable reductions in chemical oxygen demand (COD) and greenhouse gas emissions. The integration of advanced chemistry and application technology demonstrates a viable pathway toward achieving both targeted color performance and sustainable textile production.

Presenter:

Karen K. Leonas

North Carolina State University, USA



Lightweight Spur Gears with Cellular Cores: Design, Simulation, and Validation through Additive Manufacturing

Arturo Gomez-Ortega¹, Christian Felix-Martinez¹, Saúl Piedra¹, James Perez-Barrera² and Juan Manuel Gonzalez-Carmona¹

¹SECIHTI-Centro de Ingeniería y Desarrollo Industrial (CIDESI) México

²Departamento de Termofluidos, Facultad de Ingeniería Universidad Nacional Autónoma de México (UNAM), México

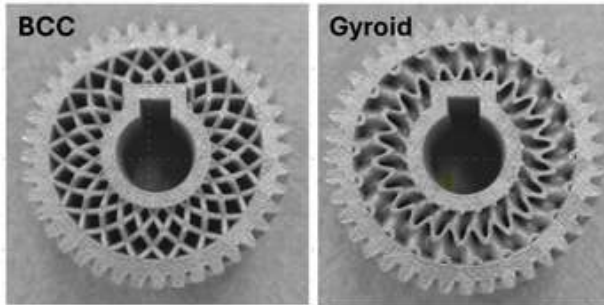
The integration of additive manufacturing (AM) and computational design enables the development of mechanical components with tailored geometries and improved structural efficiency. This study presents a comprehensive numerical analysis of spur gears incorporating cellular cores based on Triply Periodic Minimal Surfaces (TPMS) and lattice architectures. The main objective is to explore lightweighting strategies that preserve mechanical performance and provide reliable design criteria prior to experimental validation and real implementation.

A two-stage numerical investigation was conducted using finite element modeling and a systematic Design of Experiments (DoE) to evaluate the influence of cell topology, volume fraction, and spatial distribution parameters (radius, height, and arc count) on the mechanical response. Six cellular configurations were analyzed—three TPMS (Gyroid, Schwarz-P, Diamond) and three lattice types (Cubic, BCC, FCC). Results showed that the volume fraction is the dominant factor affecting stiffness and von Mises stress, while TPMS geometries consistently exhibited superior stress distribution and lower displacement compared to strut-based lattices for equivalent mass reductions.

The findings highlight that, beyond weight reduction, the selection of cellular topology and geometric configuration significantly affects the stress pathways and structural efficiency of the gear. These insights establish a framework for design optimization and material selection before proceeding to fabrication and testing.

Overall, this study demonstrates that simulation-driven design and parametric exploration of cellular architectures can effectively guide decision-making in the development of lightweight, high-performance gears. The pro-

posed methodology provides a valuable reference for future experimental and industrial applications of additive manufacturing in aerospace, automotive, and power-transmission systems.



Presenter:

Arturo Gómez-Ortega

SECIHTI-Centro de Ingeniería y Desarrollo Industrial (CIDESI), México



Smart Materials Based Semiconductors to be used in Photo-Electrocatalysis for Environmental Applications

Fernando Cruz de Moraes and **Maria Helena Alves Feitosa**

Department of Chemistry, Federal University of São Carlos
Brazil

In recent years, several materials with semiconductor properties have been widely investigated in photo-electrocatalysis for environmental applications. In this work, the light absorber hematite ($\alpha\text{-Fe}_2\text{O}_3$) was modified with bismuth compounds (BiOI@BiOBr). The resulted semiconductor material was deposited over a conductive glass surface (FTO) and the fabricated photoanode $\text{FTO/Fe}_2\text{O}_3/\text{BiOI@BiOBr}$ was used in electrochemical advanced oxidative processes (EAOPs) for studies of degradation of ciprofloxacin as an emerging contaminant. All steps of the synthesis of the $\text{Fe}_2\text{O}_3/\text{BiOI@BiOBr}$ was characterized using TEM microscopy, XRD, XPS, Ramam, optics and electrochemical characterizations. These characterizations led to understanding how the material works. In special, the diffuse reflectance experiments reveals that the charge transfer mechanism in the photoanode semiconductor material occurred by a Z-scheme recombination process. The EAOPs method based on the $\text{FTO/Fe}_2\text{O}_3/\text{BiOI@BiOBr}$ photoanode was carried out using a reactor containing ciprofloxacin solution under an applied potential at 2.0 V with ultraviolet-C radiation. After one hour, the antibiotic molecule was degraded more than 90.0 %, being mineralized close to 52.0 %. The oxidation process proved to be efficient yielded a kinetic constant $k = 3.7 \times 10^{-2} \text{ min}^{-1}$ and a half-life of 18.7 minutes. The mass spectroscopy experiments demonstrated that the ciprofloxacin oxidation process led to the formation of seven main by-products, in which the degradation path was proposed in two steps.

Presenter:

Fernando Cruz de Moraes

Federal University of São Carlos, Brazil



Synergetics of Fracture and Evolution of Interrelationship with Multi-Level Self-Organizing Processes in Material Destruction

A. Janahmadov¹, K. Nabizade² and M. Javadov²

¹Azerbaijan National Academy of Aviation, Azerbaijan

²Azerbaijan Engineering Academy, Azerbaijan

The paper presents a synergetics model of fracture, which allows to reveal fundamental mechanical characteristics of materials through critical parameters that control bifurcation points. The systems are developed that demonstrate an evolution of the relationship with the multi-level self-organizing processes during the material fracture processes.

It is established that due to the accumulation of deformation energy at the different scale levels, the initial microcracks appear in the fracture process under the loading of a solid body. The microcracks quickly grow due to the structurally unstable state of the dissipative structure, the transitive dissipative phase occurs and meso-cracks are being formed. The microscopic fracture with an increase of the external load turns into the mesoscopic, leading further into the destruction of the body into parts.

It is established that the plastic deformation and fracture have an adaptive-dissipative nature. The examined processes occur away from the thermodynamic equilibrium, accompanied by a manifestation of the system instability in the form of deformable metal at the critical points, and reflect the general properties of the nonlinear dynamics.

The application of synergetics and mesomechanics approaches in establishing the connection between the fundamental characteristics of fracture at the micro-, meso-, and macro-levels is the key to understanding the physical nature of destruction and the influence of fluctuations on it. At the same time, the identified large-scale levels of fracture and the established criteria for the dissipative properties of the medium at the critical points made it possible to move on to establishing a connection between the dissipative medium and its fractal structure.

Presenter:

Ahad Janahmadov

Azerbaijan National Academy of Aviation, Azerbaijan



Wireless Communication Protocols for the IoT - How to Choose the Best Option?

Luiz Carlos Branquinho Caixeta Ferreira

Federal Institute of Education, Science and Technology of Southern Minas Gerais, Poços de Caldas Campus, Brazil

The development of Internet of Things (IoT) solutions requires knowledge in areas such as microelectronics, telecommunications, computing, and data analysis, making it a complex task for developers. Wireless Sensor Networks (WSNs) are commonly used due to their advantages in installation, maintenance, and ability to reach areas that were previously inaccessible. However, the wide range of wireless communication protocols—each with distinct features—makes it challenging to choose the most appropriate one. This decision is critical, as wireless connectivity is often the weakest link in an IoT solution, being vulnerable to environmental instabilities. This work introduces the Three-Phase Methodology for Projects (TpM-Pro), a framework designed to support developers in selecting the most suitable wireless technologies. TpM-Pro helps organize the analysis of technical parameters that must be considered regardless of the chosen technology. The methodology includes steps such as project and environment analysis, site survey, and management strategies, guiding decision-making in a structured way. Additionally, the presentation offers a direct comparison of various wireless communication technologies and protocols, highlighting their specific characteristics such as range, frequency, data rate, and receiver sensitivity. These comparisons help clarify the trade-offs involved in choosing each option. The paper concludes with a case study that illustrates how TpM-Pro can be applied in practice. This example demonstrates the methodology's effectiveness in supporting the design and deployment of efficient and robust IoT solutions. By following this structured approach, developers can make better-informed decisions when dealing with wireless communication in IoT projects.

Presenter:

Luiz Carlos Branquinho Caixeta Ferreira

Federal Institute of Education

Science and Technology of Southern Minas Gerais

Poços de Caldas Campus, Brazil



Hybrid of F-doped SnO₂ Aerogel and Pt Nanoclusters for High-Efficiency Hydrogen Evolution

Hyung-Ho Park and **Tae Hee Kim**

Aerogel Materials Research Center, Yonsei University
South Korea

Electrochemical water splitting, particularly the hydrogen evolution reaction (HER), is central to sustainable hydrogen production. However, the high cost and scarcity of Pt catalysts demand advanced supports with high surface area, conductivity, and durability.

Here we report a fluorine-doped SnO₂ (F-SnO₂) aerogel as an ultra-light-weight and porous oxide support for Pt nanoclusters. The aerogel, synthesized *via* a sol-gel route, exhibits a large surface area (321 m²·g⁻¹), interconnected meso-/macropores enabling fast ion transport, and excellent mechanical/chemical stability. Atomic-scale fluorine substitution markedly enhances electrical conductivity by tailoring the SnO₂ band structure and lowering charge-transfer resistance.

Pt sputter-deposited onto this framework yields a robust hybrid catalyst (F-SnO₂ @Pt) with outstanding HER activity in acidic media, requiring only 42 mV overpotential at 10 mA·cm⁻². The catalyst surpasses commercial Pt/C in mass activity and turnover frequency, while sustaining performance over 10,000 cycles.

The superior behavior originates from: (1) uniform Pt dispersion on the aerogel matrix, (2) ion-permeable porosity facilitating mass transport, (3) conductivity gains from F⁻ doping, and (4) strong metal-support interactions that tune Pt's electronic states and accelerate water dissociation.

These findings demonstrate that F-doped aerogel frameworks are promising, sustainable catalyst platforms for efficient hydrogen evolution. This work not only advances surface/interface engineering of oxide-metal hybrids but also contributes to the broader goal of scalable green hydrogen technologies for future clean energy systems.

Presenter:

Hyung-Ho Park

Aerogel Materials Research Center, Yonsei University, South Korea



Charged Water Radical Clusters as the Soft Nanomaterial for Energy, Chemistry, Medicine and Life Sciences

Huanwen Chen¹, Xiaoping Zhang¹, Simin Liu¹, Manman Qin¹, Liangliang Liao¹, Ruonan Zhao¹, Xuwen Chen¹, Tenggao Zhu¹, Dapeng Liang², Yutong Han², Xinyu Li² and Bin Hu³

¹The Key Laboratory for Diagnosis, Treatment, and Rehabilitation of Cancer using Chinese Medicine, Jiangxi University of Chinese Medicine, China

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³College of Environment and Climate, Institute of Mass Spectrometry and Atmospheric Environment, Guangdong Provincial Engineering Research Center for On-line Source Apportionment System of Air Pollution, Jinan University China

Charged water radical clusters (CWRCs), particularly stabilized water radical cations ($(\text{H}_2\text{O})_n^{+\cdot}$ ($n=1,2,3$)), emerge as a novel class of soft nanomaterials with transformative potential across disciplines [1-5]. Unlike conventional reactive oxygen species, CWRCs exhibit prolonged stability (>10 ms) [1-2] when confined in supramolecular matrices (e.g., β -cyclodextrin nanocavities, water cluster, etc.), enabling their utilization as programmable energy carriers. In chemistry, CWRCs drive unprecedented reaction pathways—demonstrated in the selective reaction with dinitrogen [1-2], alkanes (e.g., methane is converted to methanol without a catalyst, achieving a remarkable yield exceeding 650 millimoles per hour) under ambient conditions [3-5]. For biomedicine, their membrane-permeable nature facilitates targeted pathogen eradication (under ultrasonic parameters of 40 kHz, 105 W, and 80 min, $\text{H}_2\text{O}^{+\cdot}$ exhibited bactericidal rates of 99.84% against multidrug-resistant *Escherichia coli* and 99.60% against methicillin-resistant *Staphylococcus aureus*) and anti-cancer action (Under ultrasonic parameters of 1 MHz, 1.5 W/cm², and 5 min, the viability of hepatocellular carcinoma cells was reduced to 2.46-11.22%) while sparing healthy cells (Fig 1). Critically, CWRCs regulate redox signalling in neuronal models, mitigating oxidative stress by scavenging superoxide anions.

This work establishes CWRCs as a biocompatible platform unifying energy conversion, green catalysis, precision therapy, and redox biology, heralding a

paradigm shift in nano-functional materials. Ongoing work explores CWRCs in photocatalytic water splitting and neurodegenerative disease models. Scaling *via* microfluidic synthesis confirms industrial viability.

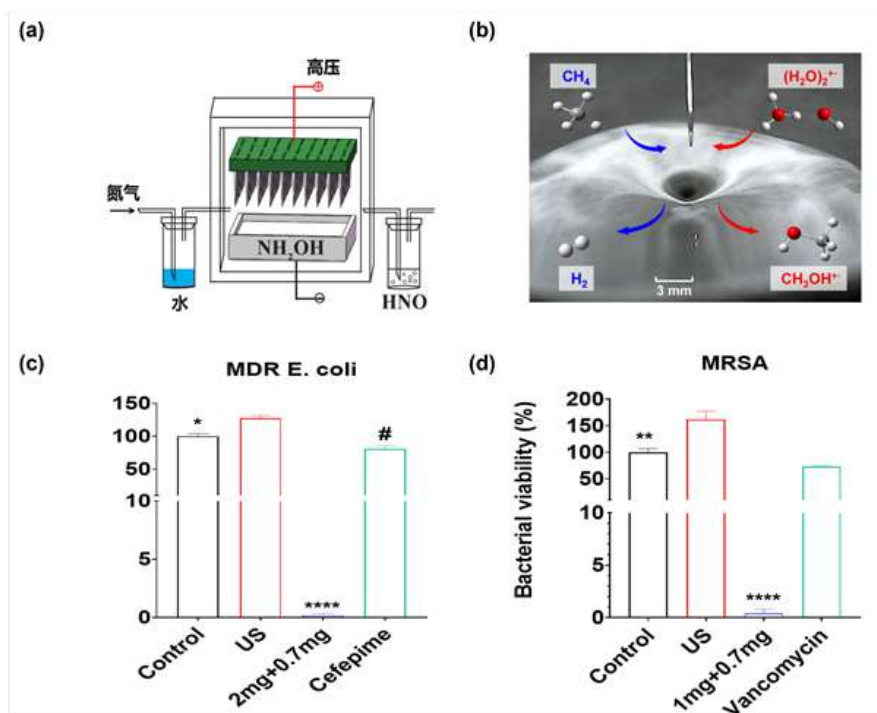


Fig.1 Charged water radical clusters in chemical synthesis and biomedicine. (a) Schematic diagram of the experimental setup for nitrogen-water reaction under ambient temperature and pressure without catalysts; (b) Real-time photographic evidence of vortex formation at the water-gas interface during methane conversion; (c) Under ultrasonic conditions (40 kHz, 105 W, 80 min), H_2O^+ achieved a 99.84% bactericidal rate against multidrug-resistant *Escherichia coli*, while cefepime showed only 19.50% efficacy under identical parameters; (d) At the same ultrasonic settings, H_2O^+ exhibited a 99.60% bactericidal rate against methicillin-resistant *Staphylococcus aureus* (MRSA), compared to 26.62% for vancomycin.

Presenter:

Huanwen Chen

Jiangxi University of Chinese Medicine, China



Development of Manufacturing and Recycling Processes on Breeding Functional Materials for Fusion Applications

**Jae-Hwan Kim, Taehyun Hwang, Yutaka Sugimoto
and Hiroyasu Tanigawa**

Breeding Functional Materials Development Group, National
Institutes for Quantum Science and Technology, QST, Japan

A demonstration (DEMO) fusion reactor requires a huge amount of advanced breeding functional materials (BFMs). Among several designs in Japan suggested so far, a new concept for JA DEMO blanket suggests beryllide blocks with several hundreds tons and Li_2TiO_3 pebbles with approximately several hundreds tons to be loaded to approach the highest packing fraction with 80% which leads to high tritium breeding ratio (TBR) as required with tritium self-sufficiency. Both breeding functional materials, beryllium (in beryllides) and 6-lithium (90% 6-lithium enrichment needed while natural 6-lithium exists with only 7.5%), are strategic substances and considerably costly. In addition, many beryllium and 6-lithium in the spent BFMs will remain at the replacement of blankets every 4-5 years because the structural materials should be replaced due to integrity degradation induced by neutron irradiation damages.

The authors' group has come to dedicate to R&Ds on fabrication and characterizations of these breeding functional materials and also has suggested an innovative recycling process of beryllide (Be_{12}Ti) and Li_2TiO_3 pebbles by treatment combined with microwave heating and chemical reaction. The process has been proved to have many advantages with a higher energy-saving, safer and more simplified process than the conventional process. Moreover, the innovative recycling process was suggested to recycle spent BFMs, which are indispensable for the early realization of fusion reactors.

In this study, current R&Ds on manufacturing and recycling process for the breeding functional materials for fusion applications will be addressed.

Presenter:

Jae-Hwan Kim

National Institutes for Quantum Science and Technology, QST, Japan



To Study, Effect of Oxidizing Agent, on Electrochemical Supercapacitor Properties of NiO-Polyaniline Composite

Munish Pandey and **Sagar Kute**

Department of Physics, K. M. Agrawal College, India

Nickel oxide (NiO) is a promising transition metal oxide for supercapacitor electrodes, but its limited conductivity can hinder performance. In this work, a NiO–polyaniline (PANI) nanocomposite was synthesized using ammonium persulfate (APS) and ferric chloride (FeCl_3) as oxidants. This polymerisation has garnered significant interest for their application in electrochemical devices *via* a chemical bath method. Structural and morphological properties were confirmed by XRD, SEM, and UV–Visible spectroscopy. Electrochemical characterization, using cyclic voltammetry (CV) analysis shows the superior pseudocapacitive performance of the composites FeCl_3 -PANI@NiO demonstrate the highest specific capacitance, which is very noteworthy. It reached 9719.79 F/g at a scan rate of 1 mV/s.

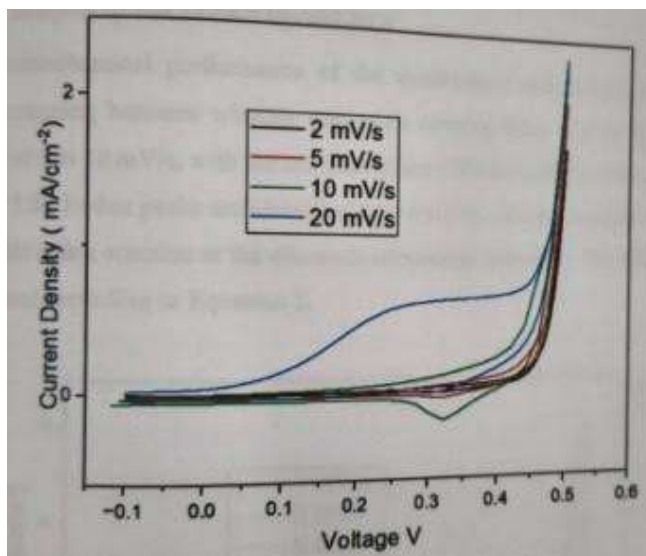


Fig 1. APS-PANI@NiO

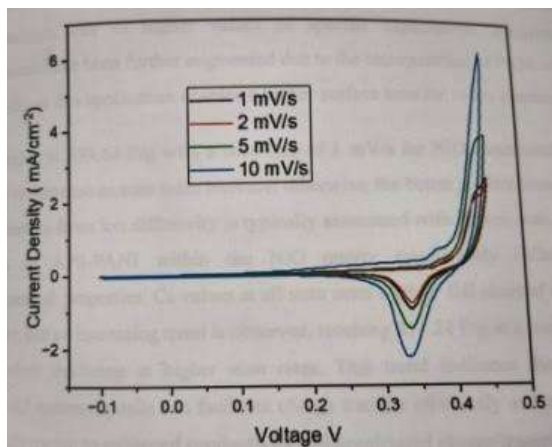


Fig 2. FeCl₃-PANI@NiO

Scan Rate mV	APS-PANI@NIO Cs[F/g]	FeCl ₃ -PANI@NiO Cs[F/g]
1	-	917.98
2	109.28	408.15
5	156.35	328.92
10	817.24	276.60
20	173.87	-

Table 1. Cs values at different scan rate of APS-PANI@NIO and APS-PANI@NIO

In contrast, the APS-PANI@NiO nanocomposite displayed a different trend, with specific capacitance increasing with scan rate up to 10 mV/s; the maximum was 817.24 F/g, indicating excellent charge transfer at moderate scan rates. The enhanced performance is attributed to improved conductivity, larger surface area, and better charge transport due to PANI incorporation. These results highlight PANI@NiO composites as strong candidates for high-performance energy storage devices.

Presenter:

Munish Pandey

K. M. Agrawal College, India



Automatic Play-Field Analyzing and Player Tracking in Broadcast Tennis Video using Improved Kalman Filter

M. Archana

Department of Information and Technology, Faculty of Engineering and Technology, Annamalai University, India

Player tracking in Broadcast Tennis Video (BTV) plays a crucial role in semantic video analysis. However, it presents several challenges due to factors like the small size of players, interference, and noise on the tennis court, all of which can hinder accurate player detection. In doubles matches, player occlusion further reduces tracking accuracy. This paper introduces a contour-based tracking method for singles matches and proposes an improved Kalman filter algorithm specifically designed for robust player tracking in doubles matches. The algorithm dynamically adjusts its parameters based on player detection results. Experimental results demonstrate that the proposed method achieves efficient player tracking in both singles and doubles matches. Performance is evaluated using Multiple Object Tracking Precision (MOTP) and Multiple Object Tracking Accuracy (MOTA) metrics.

Presenter:

M. Archana

Annamalai University, India



Graphene Oxide/Goethite-Chitosan Composite for the Optimization of Arsenic (III) Adsorption from Polluted Aqueous Solutions

Hari Mohan Meena

Department of Chemistry, Hansraj College, University of Delhi
India

Graphene oxide (GO) was cross-linked with goethite (α -Fe(OH)O)-chitosan to produce GO/goethite-CS composites exhibiting diverse morphologies, enhanced surface area, and considerable adsorption efficacy for hazardous As (III) from polluted aqueous solutions. The composite was examined with SEM-EDAX, FESEM, TEM, TGA, FTIR, XRD, VSM, UV-visible, and BET techniques. Anodic stripping voltammetry (ASV) improves the accurate detection and quantification of trace arsenic in aquatic samples. Simultaneously, batch experiments were performed to assess the influence of many variables, including pH, initial concentration, contact time, and temperature, on As (III) adsorption, while also exploring thermodynamics, equilibrium isotherms, and adsorption kinetics. Thermodynamic analyses assessed the spontaneous and endothermic properties of the adsorption process. The peak adsorption of As (III) onto GO/goethite-CS was measured at 98.96 mg/g at pH 6 with a contact duration of 200 minutes. The adsorption isotherm results indicated that the Langmuir model accurately characterized the adsorption of As(III) onto the GO/goethite-CS sorbent. The greatest adsorption capacity (q_{max}) was 368.38 mg/g. The pseudo-second-order kinetic model well represented the experimental data, suggesting that the adsorption of As (III) onto GO/goethite-CS is a chemical process. Reusability experiments showed that the GO/goethite-CS composite may be regenerated with no loss in adsorption capability. The findings indicated that the GO/goethite-CS composite effectively removed As (III) from aqueous solutions, indicating its suitability as a sorbent for polluted water remediation.

Presenter:

Hari Mohan Meena

Department of Chemistry, Hansraj College, University of Delhi, India



Intelligent Packaging Hydrogel Incorporating *Nerium Oleander* Anthocyanin to Preserve Chicken Meat

Sirajunnisa Abdul Razack¹ and Sowmiya Kadalmani²

¹Department of Biotechnology, Acharya Institute of Technology India

²Centre for Biotechnology, Anna University, India

Food packaging material fabrication is one of the essential processes in food industry to maintain ecofriendliness and non-toxicity of readily available food products. In this investigation, an attempt was made to fabricate a completely biodegradable natural polymer based food packaging film infused with bioindicating and, photo and pH sensitive pigment anthocyanin to monitor the consumability of commercially available chicken meat. A starch- CMC based packaging material was prepared after optimizing the component concentrations. Anthocyanins were extracted from the flowers of *Nerium oleander* and incorporated into the film. Characterization of the hydrogel film was performed such as the morphological, physicochemical, mechanical, optical, barrier and biological features. The results showed that the anthocyanins infused inside the hydrogel film were resistant to light. The study of properties of the developed film demonstrated that the polymeric matrix was mechanically strong with effective linkages. It also revealed that it possessed antimicrobial activity against *Staphylococcus aureus*, *Bacillus subtilis* and *E.coli* indicating reduced food spoilage. The film showed retarded optical and moisture barrier features indicating less moisture and light absorption resulting in freshness of the packed meat. When the film was applied on the meat, it revealed that the freshness was successfully demonstrated with the change of color of the film from pale pink to dark yellow. Change in color, mode of indication of spoilage, was due to degradation of meat resulting in release of alkaline ammonia. In conclusion, the fabricated film possessed dual properties of indicating the freshness of the meat and preserving the food with long shelf life.

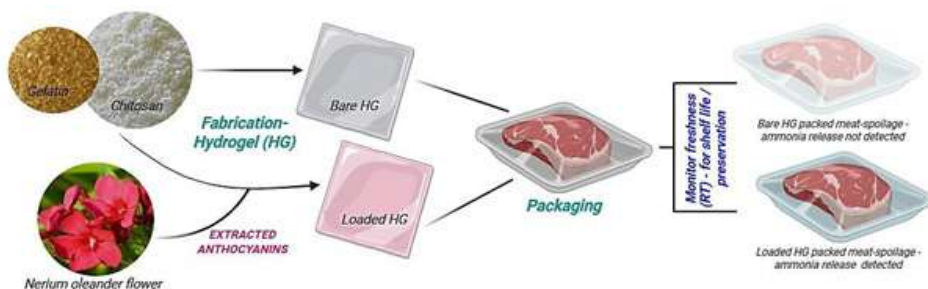


Fig 1: Representation of oleander anthocyanin based intelligent packaging film for monitoring freshness of chicken meat at room temperature. Release of gaseous ammonia indicated spoilage of chicken meat, which was detected by anthocyanin in the film, changing its color and subsequently demonstrating non-consumability of packaged meat. (Image created using BioRender.com)

Presenter:

Sirajunnisa Abdul Razack

Acharya Institute of Technology, India



Functional Defect-Rich Oxide Nanoparticles for Industrial and Biomedical Applications

Maksim A. Pugachevskii¹, Dmitry S. Rasseko¹, Ilya V. Egelskii² and Artem M. Chernov¹

¹Southwest State University, Russia

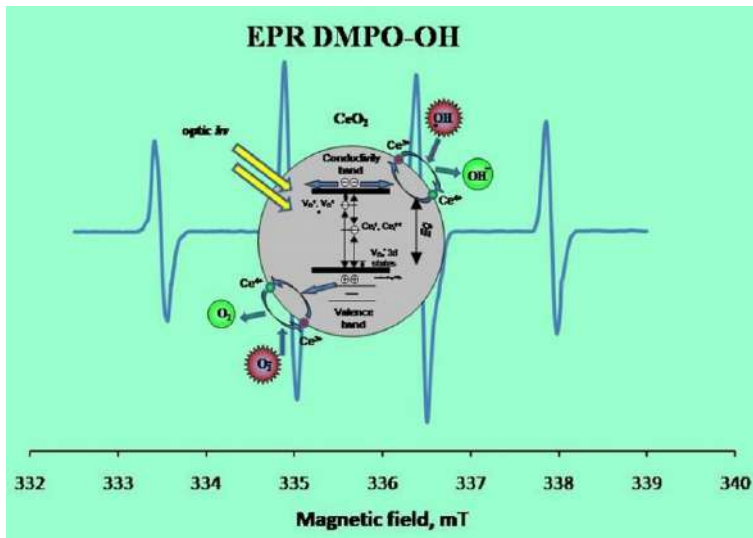
²Moscow Center for Advanced Studies, Russia

Defect engineering is a powerful strategy for enhancing the functional properties of oxide nanomaterials. This work discusses the synthesis, characterization, and multi-faceted applications of defect-rich cerium oxide (CeO₂) and titanium dioxide (TiO₂) nanoparticles produced *via* pulsed laser ablation (PLA). This scalable, “green” technique creates nanoparticles under sharply non-equilibrium conditions, yielding surfaces exceptionally enriched with oxygen vacancies and structural defects.

For CeO₂ nanoparticles, these engineered defects are directly linked to superior antioxidant activity. We demonstrate their effectiveness in scavenging reactive oxygen species (ROS) in both chemical models (Fenton reaction) and biological cell systems using classical and novel methods using EPR spin trap spectroscopy. In human fibroblast cultures, internalized CeO₂ nanoparticles provide statistically significant, time-dependent cytoprotection against oxidative insults from both chemical (Fenton reagent) and physical (ultraviolet irradiation) sources, with viability restored to over 85%. This performance is attributed to the enhanced Ce³⁺/Ce⁴⁺ redox cycling facilitated by the high oxygen vacancy concentration.

Similarly, PLA-synthesized TiO₂ nanoparticles exhibit a defect-stabilized anatase phase with remarkable thermal resistance, delaying the anatase-to-rutile transition to temperatures above 800°C. These defects also govern photocatalytic activity, with as-ablated nanoparticles showing superior dye degradation performance compared to annealed samples, where defect annealing diminishes efficacy.

Collectively, our work establishes a clear structure-property relationship: the defect-rich architecture imparted by laser ablation is the key determinant for enhanced functionality. We showcase the dual utility of these nanoparticles, highlighting their potential in biomedical applications (as novel antioxidant and UV-protective agents) and industrial applications (as stable, high-performance catalysts), underscoring the versatility of defect engineering in advanced material design.



Presenter:

Maksim Aleksandrovich Pugachevskii

Southwest State University, Russia



Anti-neoplastic Activity of Selected Essential Oil (EO)-Loaded in Niosomes Against HepG2 and YAC-1 Cells: An *in vitro* Study

Kalaiselvi Aasaithambi⁶, Janani Muthukumar¹, Rajkuberan Chandrasekaran^{2,3}, Nakkeeran Ekambaram⁴ and Alan Mathew Punnose⁵

¹Department of Biotechnology, Easwari Engineering College India

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³Centre for Natural Products and Functional Foods, Karpagam Academy of Higher Education, India

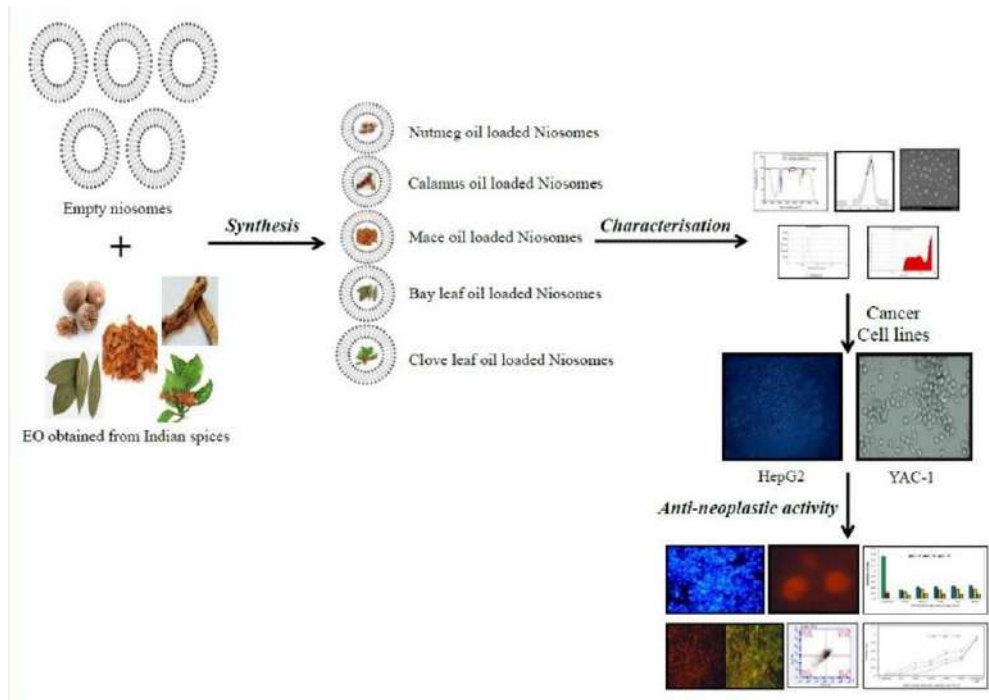
⁴Department of Biotechnology, Sri Venkateswara College of Engineering, India

⁵Centre for Regenerative Medicine and Stem Cell Research Sri Ramachandra Institute of Higher Education and Research (DU), India

⁶Department of Biotechnology, School of Life Science (Ooty Campus), JSS Academy of Higher Education and Research (Ooty Campus), India

Non-ionic surfactant vesicles are gaining significance in the pharmaceutical field and cancer therapy due to their unique features and properties. Niosomes are bilayer-structured vesicles that effectively transport drugs into cells with greater efficiency. In this study, we have selected Indian spice essential oils: bay leaf oil (BLO), clove leaf oil (CLO), nutmeg oil (NMO), mace oil (MAC), and Acorus oil (ACO) for niosome formulation. Using the transmembrane pH gradient method, the niosomes were formulated with high stability, high entrapment, and high permeation. The niosomes were characterized by using scanning electron microscopy to reveal their morphological features. We preliminarily evaluated the niosomes in HepG2 and YAC-1 cells for cytotoxicity using the MTT assay. The assay indicated that the formulated niosomes effectively inhibit the growth of HepG2 and YAC-1 cells at significant IC₅₀ and IC₇₅ concentrations. Additionally, we molecularly annotated the apoptotic patterns of cell death through staining and glutathione biomarkers. Furthermore, we discovered that niosomes induce apoptosis through flow cytometry analysis and that niosomes cause substantial DNA and chromatin damage, as determined by the micronucleus assay. Among the formulated niosomes, CLO-loaded niosomes demonstrated superior performance in inhibiting the growth of HepG2 cancer cells. Thus, the study

concludes that essential oil-loaded niosomes could serve as a highly efficient drug carrier system for multi-drug delivery, holding great promise in cancer drug delivery.



Presenter:

Kalaiselvi Aasaithambi

JSS Academy of Higher Education and Research, India



TPP–Chitosomes as Effective Carriers for Protecting Enriched Bioactive Extracts

Milena Martelli-Tosi^{1,3}, Nadia O. Okamoto-Schalch¹, Maria Eduarda Tofoli¹, Jingwen Chen^{1,2}, Sandra Domenek², Chloé Chevigny² and Giana Almeida²

¹Department of Food Engineering, Faculty of Animal Science and Food Engineering, University of São Paulo, Brazil

²Université Paris-Saclay, INRAE, AgroParisTech, UMR SayFood France

³Department of Chemistry, Faculty of Philosophy, Sciences and Letters of Ribeirão Preto, Brazil

The development of bioactive delivery systems from agro-industrial by-products represents an opportunity to enhance sustainability while adding functional value to food and pharmaceutical applications. This study aimed to formulate and characterize a chitosan suspension enriched with phenolic compounds extracted from grape and coffee by-products and evaluate its suitability as a bioactive coating for liposomes.

Phenolics were extracted using an optimized hydroethanolic method, and the chitosan–phenolic suspension was prepared at controlled pH to ensure polymer–phenolic interaction. Liposomes were produced by thin-film hydration and coated by incubation with the chitosan suspension. Analyses included particle size, ζ -potential, polydispersity index (PDI), phenolic content, FTIR, and SEM. The coating increased particle size and shifted ζ -potential to positive values, confirming electrostatic deposition. FTIR evidenced hydrogen bonding between chitosan and phenolics. The bioactive coating enhanced liposomal stability and provided a substantial phenolic load.

In conclusion, the chitosan–phenolic suspension obtained from pineapple by-products is a promising, sustainable coating material that improves the physicochemical stability and bioactivity of liposomal carriers, supporting its potential for functional food and nutraceutical applications.

Presenter:

Milena Martelli Tosi

University of São Paulo, Brazil



Adsorption Performance of Rare Earth Elements using a Phosphoric Group-Functionalized Magnetic Nanomaterial

Carlos Basualto¹, Fernando Valenzuela¹, Gonzalo Montes², Javiera Catriñir¹, Camila Jara¹ and José Gaete¹

¹Laboratory of Unit Operations and Hydrometallurgy, Faculty of Chemical and Pharmaceutical Sciences, Universidad de Chile Chile

²Minerals and Metals Characterisation and Separation Research Group, Department of Mining Engineering, Universidad de Chile Chile

Waste from electrical and electronic equipment (WEEE) comes from devices whose useful life has ended due to failures or technological obsolescence, a phenomenon driven by increasing technological demand. This has led to a significant accumulation of waste containing hazardous materials, such as heavy metals, whose improper management causes environmental impacts. Among these wastes, LCD screens from televisions, monitors and mobile phones stand out, and their frequent replacement increases WEEE generation. These screens contain rare earth elements (REEs), a group of 17 metals essential for magnets, catalysts, and various electronic devices. Their high demand and limited availability have encouraged interest in recovering them through recycling.

The extraction of REEs from electronic waste is typically carried out through hydrometallurgical processes. First, the materials undergo leaching to dissolve the metals and transfer them into the aqueous phase. Then, separation techniques are applied, among which adsorption stands out for being efficient and less polluting. However, conventional adsorbents have low active surface area, which limits their performance. In contrast, magnetic nanoparticles—especially magnetite—offer high surface area, low cost, and easy separation using magnetic fields. Their stability can be improved through coatings such as TiO₂ and organic functionalization.

This work proposes developing a nanoadsorbent based on magnetite nanoparticles coated with titanium dioxide and functionalized with organophosphorus groups. Functionalization was carried out in two steps: first, glycolic acid (GA) was incorporated onto the surface of the MNP@TiO₂ nanoparticles, followed by phosphorylation with phosphoric acid in the presence of urea, producing the final material MNP@TiO₂-GA-H₃PO₄, as shown in Fig 1.

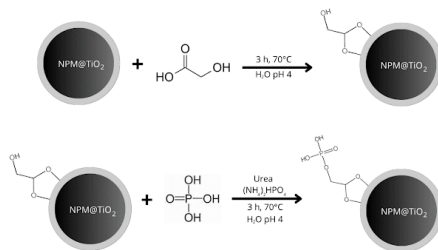


Fig 1. Funcionalization of NPM@TiO₂ with phosphoric acid.

Then, its adsorption capacity for certain rare earth elements such as Y, La, Ce, Pr, Nd, Eu, Sm, and Gd was measured. Among the evaluated adsorption equilibrium models, the Freundlich model showed the best experimental fit, suggesting that adsorption occurs on a heterogeneous surface. Although this model does not provide a specific maximum loading capacity (q_{max}), the values obtained during the study period are shown in Fig 2.

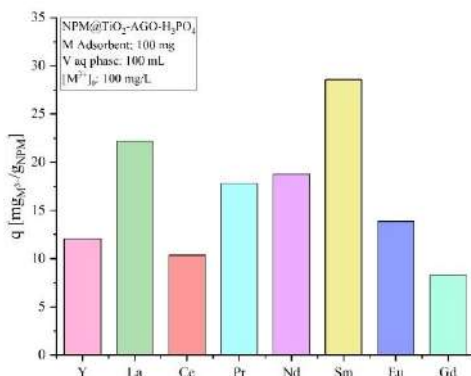


Fig 2. Adsorption capacity of the rare earths: Y, La, Ce, Pr, Nd, Sm, Eu and Gd on NPM@TiO₂-AGO-H₃PO₄.

Considering the interesting results achieved so far, this research considers future stages including kinetic studies and desorption and recycling experiments of these chemically functionalized magnetic nanoadsorbents.

Presenter:

Carlos Basualto Flores

Universidad de Chile, Chile



Use of Mesenchymal Stem Cells in a Dog with Bone Marrow Hypoplasia: Case Report

W. C. B. Santos⁴, Pâmela de Lima Bernardes¹, D. F. Lopes¹, L. P. Alves^{1,2} and L. H. Moreira^{1,2,3}

¹Biomedical Engineering Center, Anhembi Morumbi University, Brazil

²Center of Innovation Technology and Education, São José dos Campos, Brazil

³State University of Londrina, Brazil

⁴Veterinary Hematology Hemoclinic, Brazil

Bone marrow diseases are rare in dogs and cats; however, certain parasitic illnesses that recur in clinical practice can damage bone marrow stem cells, leading to pancytopenia, as in the case of *Ehrlichia canis*. Among therapeutic options for bone marrow diseases, stem cell therapy has been reported as promising. The objective of this work was to report a case of medullary hypoplasia induced by *Ehrlichia canis* infection in a dog treated with allogeneic mesenchymal stem cells derived from adipose tissue, associated with Coenzyme Q10. After diagnosis confirmation, six applications of stem cells (10×10^6 cells/mL) were infused at 30-day intervals, and blood tests were conducted to monitor bone marrow response. Improvements in the erythroid indices were observed after the fifth application of stem cells, concurrently with injectable Coenzyme Q10 at a dose of 5 mg/kg. It was concluded that, up to the fifth session, stem cell therapy alone did not show significant results for medullary hypoplasia secondary to Ehrlichiosis in this specific case. However, the combination of stem cell therapy and Coenzyme Q10 demonstrated a positive and consistent effect on erythroid recovery. When administered together early, these therapies may offer a promising and faster marrow response. Further studies are necessary to validate these findings.

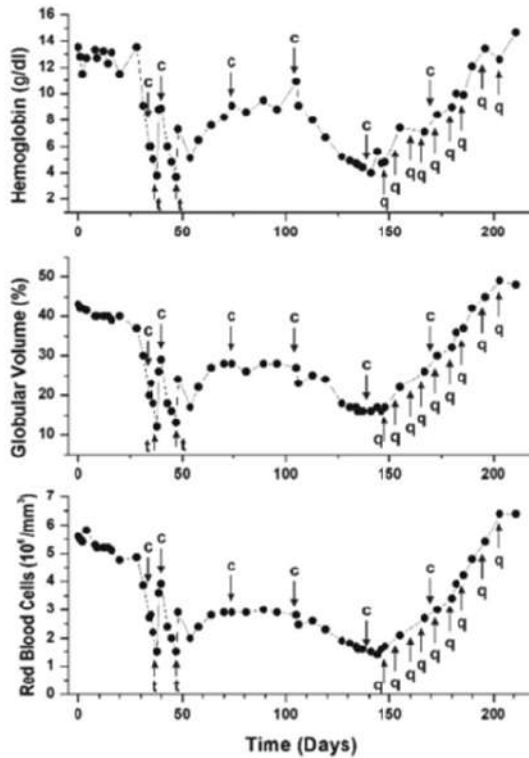


Fig. 1. Erythroid series values from pre-infusion and post-infusion of mesenchymal stem cell therapy and CoQ10 measured in the blood. The letters t = (blood transfusion), c = (stem cell), q = (CoQ10).

Presenter:

Weli Cristina Bessi dos Santos

Veterinary Hematology Hemoclinic, Brazil



Naturally Cross-Linked Matrices: The Effect of Extract from Polish Plum Waste as a Novel Cross-Linking Agent on the Functional Properties of Hydrogels

Natalia Baka¹ and **Katarzyna Bialik-Wąs²**

¹Department of Organic Chemistry and Technology, Faculty of Chemical Engineering and Technology, Cracow University of Technology, Poland

²Department of Polymer Chemistry and Technology, Faculty of Chemical Engineering and Technology, Cracow University of Technology, Poland

The growing interest in sustainable biomaterials has stimulated research on naturally derived cross-linking agents as alternatives to synthetic cross-linkers, which are frequently associated with cytotoxicity and potential environmental hazards [1]. Plum pomace, generated as a by-product during the production of juices, concentrates, or purées, represents a rich source of bioactive compounds, particularly polyphenols, which exhibit strong antioxidant activity [2]. Due to the presence of numerous compounds capable of interacting with polymer chains, such plant-derived materials may play an important role in the formation and stabilization of biopolymer networks. The main objective of this study was to evaluate the potential of plum pomace extracts as natural cross-linking agent and functional additive in hydrogel systems based on gelatin and carrageenan. Hydrogels were prepared using aqueous extract, water-ethanol extract, and lyophilizate obtained from plum pomace. The structural and functional properties of the obtained hydrogels were characterized using Fourier Transform Infrared Spectroscopy (FTIR), swelling capacity measurements, Scanning Electron Microscopy (SEM) and release studies to evaluate molecular interactions, water uptake behavior, microstructural morphology and release profile of compounds from the hydrogels. FTIR analysis confirmed the formation of a cross-linked structure within the hydrogel matrices, indicating interactions between the biopolymer network and bioactive compounds present in the plum pomace extracts. The results of this study demonstrate that plum pomace extracts can act as effective natural cross-linking agents while simultaneously enriching hydrogel matrices with antioxidant bioactive compounds. This approach may contribute to the development of sustainable biomaterials and promote the valorization of plant processing by-products in advanced functional hydrogel systems with potential applications in cosmetic and biomedical fields.

Presenter:

Natalia Baka

Cracow University of Technology, Poland



Investigation of the Pro-Aging Properties of Extracts from Food Industry Waste as a Source of Bioactive Functional Materials

Aleksandra Kamienik, Magda Ptaszkiewicz and Magdalena Malinowska

Faculty of Chemical Engineering and Technology
Cracow University of Technology, Poland

Due to the growing interest in the concept of a circular economy, increasing attention is being paid to the sustainable management and reuse of food industry by-products. Waste generated by the juice industry represents a valuable and largely underutilized source of bioactive compounds, including polyphenols and other substances with potential biological activity. At the same time, the narrative surrounding skin aging has been gradually evolving. The traditional concept of anti-aging, focused on combating the signs of aging, is increasingly being replaced by the idea of pro-aging. This emerging perspective promotes a positive, respectful, and holistic approach to the natural aging process, encouraging the development of cosmetic products that support skin health and vitality rather than attempting to oppose aging itself. The aim of this study was to evaluate the antioxidant and pro-aging potential of extracts obtained from by-products of fruit and vegetable juice production. The research material consisted of pomace from apple and plum fruits, as well as roots of carrot and celery. Total antioxidant activity was assessed using the DPPH method, while the total polyphenol content was determined using the Folin–Ciocalteu method. Chelating properties were evaluated based on the ability of the extracts to form complexes with Fe^{2+} ions. In addition, the inhibition of the elastase enzyme was analyzed in order to assess the potential skin-firming properties of the extracts. The analyses were performed using spectrophotometric methods. The obtained results confirm the high antioxidant and metal-chelating potential of the tested extracts and indicate promising possibilities for their application in the development of pro-aging cosmetic formulations, supporting both sustainable resource management and innovative cosmetic science.

Presenter:

Aleksandra Kamienik

Cracow University of Technology, Poland



Phytochemical Composition of Extracts From Fruit and Vegetable Processing Waste for Functional Material Applications

Magda Ptaszkiewicz, Aleksandra Kamienik and Magdalena Malinowska

Department of Organic Chemistry and Technology, Faculty of Chemical Engineering and Technology, Cracow University of Technology, Poland

Fruit and vegetable processing waste is an important source of bioactive compounds that may find applications in cosmetic and dermocosmetic formulations. In recent years, increasing attention has been paid to the valorization of food industry by-products as sustainable sources of natural active ingredients. Such materials are particularly rich in polyphenols and other phytochemicals known for their antioxidant, anti-inflammatory, and skin-protective properties. The aim of this study was to obtain extracts from selected fruit and vegetable by-products and to evaluate their phytochemical composition and potential as active ingredients for dermocosmetic applications.

Plant materials including apple, plum, carrot, and celery residues were used as research material. The samples were first freeze-dried to preserve their chemical composition. Hydroalcoholic extracts were prepared using a 70% ethanol solution, while oil extracts were obtained using Caprylic/Capric Triglyceride as the extraction medium. The extraction process was supported by an ultrasonic bath to enhance the efficiency of compound extraction. The obtained mixtures were macerated for two days under refrigerated conditions. After filtration, ethanol was evaporated from the hydroalcoholic extracts. Selected samples were further purified using solid phase extraction (SPE) prior to further chemical analysis.

The analysis confirmed the presence of numerous phenolic compounds, including flavonoids and phenolic acids, which are widely recognized for their biological activity. The occurrence of these compounds suggests significant biological potential of the obtained extracts, particularly in relation to antioxidant activity and possible skin-related benefits.

The results indicate that fruit and vegetable processing waste may serve as a valuable and sustainable source of bioactive compounds with potential application in modern dermocosmetic formulations. The valorization of such materials may therefore contribute both to the development of innovative cosmetic ingredients and to the reduction of food industry waste.

Presenter:

Magda Ptaszkiewicz

Cracow University of Technology, Poland



Ferromagnetic Materials for MTJ Based Energy Efficient Non-Volatile Memory

Prasanna Kumar Misra

Indian Institute of Information Technology, Allahabad, India

Magnetic Tunnel Junction (MTJ) composed of ferromagnetic layers with perpendicular magnetic anisotropy are of great interest for achieving high density non volatile memory because of scalability potential and high thermal stability. In the structure ferromagnetic layers are typically separated by a thin insulating layer as shown in Fig. CoFeB/MgO/CoFeB MTJ exhibits best switching performance and tunnel magneto resistance ratio. The Parallel state of the device is detected as 0 and the Antiparallel state is detected by 1. Data is stored utilizing the magnetic orientation of the ferromagnetic layers of MTJs in MRAM. For read operation, a read current is sent through the MTJ in order to read data from an MRAM cell. The relative alignment of the magnetic moments in the ferromagnetic layers affects the MTJ's resistance. For write operation, a magnetic field and a write current is provided in order to write data to an MRAM cell. STT-MRAM operates by passing a spin-polarized current through an MTJ to switch the magnetization of the free layer. It utilizes a bi- directional current through the MTJ for both reading and writing operations.

SOT-MRAM addresses the limitations of STT by decoupling the read and write paths. SOT devices offer significantly faster switching speeds and lower write energy. For instance, proposed SOT-based 8T/9T designs demonstrated a ~35-38% reduction in store delay and improved energy efficiency compared to standard designs. The separate read/write paths improve the static noise margin (SNM) and overall cell stability. Novel 8T designs utilizing STT-SOT hybrid structures have shown resilience against Power Analysis (PA) attacks by reducing the correlation between stored data and power consumption. Use SOT-MRAM if your priority is speed and endurance for high-performance computing (e.g., L1/L2 cache). SOT-based NVSRAMs provide superior delay reduction and stability, making them ideal for high-speed, reliable on-chip memories.

Presenter:

Prasanna Kumar Misra

Indian Institute of Information Technology, Allahabad, India



Coir Fibre Reinforced Ceiling Board Development with Overview of Mechanical, Thermal, and Physical Aspects

D. A. Madarasinghe¹, E.R.K. Chandrathilake¹, Kumari Gamage², N. W.A. Lidula¹ and A. A. P. De Alwis¹

¹University of Moratuwa, Sri Lanka

²Engineering Institute of Technology, Australia

In order to achieve sustainable thermal comfort and energy savings in buildings, controlling heat gains is a crucial area of attention that needs to be addressed. The roof carries about 75% of the thermal energy that is incident on a building envelope. Other than using cooling electrical accessories, low conductive ceiling sheets can be used to regulate the building's heat transmission, improving thermal comfort while saving a substantial amount of energy. Nonetheless, it is urgently necessary to use waste materials in the production of ceiling sheets.

Extruded polystyrene foam (EFF), waste polythene (low-density polyethylene, or LDPE), coconut coir fibers, and polyethylene terephthalate plastic (PET) water bottles are among the waste materials used in this paper's creative roofing sheet development process. There were eighteen different kinds of sheets made by combining three different binding materials in six different mix ratios. SEM photos show that the samples with LDPE and coir fiber had a uniform layer. The measured properties also showed a low void ratio, increased dry density, and decreased water absorption in produced sheets. This study demonstrated how coir fiber and LDPE might be used to create ceiling boards with superior mechanical, thermal, and durability properties.

Presenter:

Darshani Asha Madarasinghe

University of Moratuwa, Sri Lanka



Long-Lasting Antimicrobial Coatings for Real-World Applications: PVB Nanocomposites with Multifunctional Performance

Mindaugas Ilickas¹, Asta Guobienė¹ and Brigita Abakevičienė^{1,2}

¹Institute of Materials Science, Kaunas University of Technology, Lithuania

²Department of Physics, Kaunas University of Technology Lithuania

Durable, long-lasting antimicrobial coatings are essential for reducing pathogen transmission across frequently touched surfaces in healthcare, public, and industrial environments. The WHO projects that by 2050, up to ten million deaths could result from antibiotic resistance, highlighting the urgent need for new and effective antimicrobial agents. Polyvinyl butyral (PVB) has recently emerged as an effective matrix for incorporating diverse antimicrobial agents (various nanoparticles and organic biocides), enabling the development of multifunctional nanocomposite coatings compatible with scalable application to objects such as door handles, medical stainless steel, polymeric packaging, and complex 3D-printed geometries.

PVB-AgNP coatings show strong antiviral activity against SARS-CoV-2 and maintain long-term stability, while enabling integration into customised protective covers produced *via* 3D scanning and additive manufacturing. PVB-biocide coatings (ampicillin sodium salt, benzalkonium chloride, hexadecyltrimethylammonium bromide, sodium pyrithione, triclosan) provide broad-spectrum antimicrobial action, fully inactivating bacteriophage $\phi 6$ and significantly reducing *S. aureus*, *E. coli*, *A. baumannii* and *P. aeruginosa*. Synergistic PVB/ZnO-T/NaPT coatings further enhance efficacy: ZnO-T morphology improves mechanical durability and reactive oxygen species generation, while NaPT disrupts membranes and chelates ions, enabling potent inhibition of Gram-positive and Gram-negative bacteria and fungi such as *C. albicans*.

Across all systems, surface free energy (SFE) emerges as a key predictor of antimicrobial behaviour. In PVB-AgNP coatings, increased SFE correlates with decreased antiviral activity, indicating that more hydrophobic surfaces promote faster viral inactivation. For PVB-biocide coatings, abrasion-induced increases in SFE correspond to reduced antimicrobial efficiency, reflecting altered biocide availability at the surface. In PVB/ZnO-T/NaPT coatings,

smaller ZnO-T particles generate NaPT-induced hydrophilicity that enhances antimicrobial performance, while larger tetrapods retain ZnO-dominated hydrophobicity with weaker activity. Altogether, the relationship between SFE and antimicrobial activity highlights its importance as a practical design parameter. Thoughtful modulation of SFE enables predictable control over coating behaviour, providing a robust pathway for developing durable antimicrobial surfaces.

Presenter:

Mindaugas Ilickas

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Effect of Thermal and Thermochemical Treatment on Complex AlSi10Mg Structures Fabricated by Laser Powder Bed Fusion (LPBF)

C. Ortega-Portilla, A. Gómez-Ortega and J.M. Gonzalez-Carmona

SECIHTI-Centro de Ingeniería y Desarrollo Industrial (CIDESI)
México

Laser Powder Bed Fusion (LPBF) additive manufacturing has emerged as a key technology for producing metallic components with intricate geometries and tailored properties. In this study, thin-walled (~1 mm) Triply Periodic Minimal Surface (TPMS) structures made of AlSi10Mg were fabricated *via* LPBF to explore the influence of subsequent thermal (T6) and thermochemical (nitriding) treatments on their microstructural and surface behavior. These TPMS geometries, characterized by their high surface-to-volume ratio and continuous curvature, were selected to represent complex lightweight designs optimized for applications requiring both high stiffness-to-weight ratios and efficient heat dissipation.

LPBF processing was performed under controlled parameters of laser power, scanning speed, and spot size to ensure dimensional precision and surface integrity. After fabrication, samples underwent a T6 heat treatment followed by plasma nitriding at different exposure times. The combined treatment promoted the formation of a thin aluminum nitride (AlN) layer at the surface, enhancing hardness and wear resistance without compromising the dimensional accuracy of the delicate TPMS walls.

Microstructural characterization through metallographic analysis revealed a refined α -Al matrix with uniformly distributed Si precipitates and a gradual transition between the nitrided layer and the substrate. Microhardness tests confirmed significant surface hardening, while maintaining the mechanical integrity of the thin lattice walls.

The integration of LPBF with post-processing treatments demonstrated a viable strategy to enhance both the mechanical and functional performance of lightweight aluminum components. The results highlight that nitriding effectively complements heat treatment to extend the service life and applicability of LPBF-fabricated AlSi10Mg structures in aerospace, automotive, and advanced engineering systems—particularly in components where thin-walled geometries and surface durability are critical design requirements.

Presenter:

Ines Carolina Ortega Portilla

SECIHTI-Centro de Ingeniería y Desarrollo Industrial (CIDESI), México



Evidence of the Main Role of Minority Current Carriers in the Occurrence of Superconductivity

Yurii Uhryn

Ivan Franko Drohobych State Pedagogical University, Ukraine

We want to prove the seemingly strange fact that the superconducting current in superconductors is carried by minority current carriers, that is, by those carriers whose density is much lower than the density of those we call majority ones. First, let's Fig out how it can happen that minority current carriers make a significant contribution to electrical conductivity in the normal state of conductor or semiconductor? This can be the case if their mobility is significantly greater than the mobility of the major current carriers. If this is the case, then this causes the characteristic dependence of the resistivity of a material on the magnetic field induction. From the analysis of this dependence, we obtained a formula for calculating the mobility of the minority current carriers.

$$\mu = \frac{\sqrt{3}}{B_f} \left(\frac{4\rho_f}{3\rho_0} - 1 \right)$$

Where B_f is flex point of magneto resistivity, ρ_0 and ρ_f is zero field and flex point magnetoresistivity respectively.

First, we tested this formula on a conductor and a semiconductor to make sure it works.

When we calculated the mobility of minority current carriers in a superconductor using this formula, we saw that in a very narrow temperature range of a few tenths of a Kelvin near the critical temperature (but still in the normal state), this mobility rapidly increases by at least an order of magnitude. For example for multilayer superconductor $[\text{YBa}_2\text{Cu}_3\text{O}_7(72 \text{ \AA})/\text{PrBa}_2\text{Cu}_3\text{O}_7(12 \text{ \AA})]_{25}$ with critical temperature nearly 89K, when the temperature decreases from 91 to 92 K, this mobility increases from 7100 to 410000 $\text{cm}^2/(\text{V s})$. In this case, the contribution of minority current carriers to electrical conductivity changes radically: the ratio of electrical conductivity of minority to majority current carriers changes from 0.23 to 16.5. Therefore, we conclude that the sharp drop in the resistance of a superconductor as it cools to its

critical temperature but is still in its normal state is caused by a sharp increase in the mobility of minority current carriers. The following conclusion suggests itself: superconducting current is carried by minority current carriers.

Presenter:

Yurii Uhryn

Ivan Franko Drohobych State Pedagogical University, Ukraine



Development of Phosphazene Nanostructures Encapsulated with Natural Polymers as Drug Carriers for Colon Cancer

Ilknur Atli¹ and Ozgur Ozay²

¹Laboratory of Biomaterials Research, Department of Bioengineering, School of Graduate Studies, Canakkale Onsekiz Mart University, Turkey

²Laboratory of Biomaterials Research, Department of Bioengineering, Faculty of Engineering, Canakkale Onsekiz Mart University, Turkey

Colon cancer is one of the leading causes of cancer-related mortality worldwide, emphasizing the need for effective and targeted drug delivery systems. In this study, monodisperse spherical phosphazene particles were synthesized *via* a polycondensation reaction using hexachlorocyclotriphosphazene (HCCP) and 1,3-bis(aminomethyl)benzene. The synthesized particles exhibited a high drug-loading capacity, with 200 mg g⁻¹ of 5-fluorouracil (5-FU) successfully loaded onto the phosphazene particles. The drug-loaded particles were subsequently encapsulated within a sodium alginate-based natural polymer matrix incorporating 5 mg of quercetin. The drug encapsulation efficiency of the resulting microcapsules was determined to be 85.6%, indicating effective incorporation of the therapeutic agents into the delivery system. The morphological, structural, and thermal properties of the developed system were characterized using transmission electron microscopy, scanning electron microscopy, X-ray diffraction, thermogravimetric analysis, and zeta potential measurements. *In vitro* drug release studies were conducted under simulated gastrointestinal conditions, where quercetin release was examined in gastric and intestinal environments, while 5-FU release was evaluated under simulated colonic conditions. Drug release kinetics were analyzed based on data obtained from different gastrointestinal environments. Following the drug release studies, the cytotoxic effect of the developed system was evaluated on the HT-29 colon cancer cell line. The results demonstrated that the encapsulated phosphazene-based system effectively protected the drug throughout the gastrointestinal tract and enabled controlled drug release at colonic pH. The combined use of phosphazene nanoparticles and natural polymers presents a promising strategy for targeted and effective colon cancer therapy.

Acknowledgement: This study was supported by the Scientific Research Projects Coordination Unit (BAP) of the University of Çanakkale Onsekiz Mart under project number FYL-2026-5521.

Presenter:

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DAY 02



8TH EDITION OF

ADVANCED MATERIALS SCIENCE WORLD CONGRESS

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SPEAKER TALKS



Photonic Quantum Telecommunication for Multi-Agent Systems: Free-Space Links, Topologies and Fidelity under Noise

Stefalo Acha and **Sun Yi**

Department of Mechanical Engineering, North Carolina A&T State University, USA

Quantum telecommunication provides a secure and high-fidelity backbone for multi-agent systems (MAS), enabling distributed decision-making and coordination in settings where resilience and trust are paramount. This work applies quantum teleportation and quantum key distribution (QKD) protocols to represent MAS network topologies - star, mesh, and ring - over free-space optical channels. The objective is to quantify how photonic state transfer, channel noise, and topology choice jointly affect the efficiency and reliability of agent-to-agent quantum communication. Using circuit-level simulations, we model teleportation fidelity and QKD key generation under varying depolarization, attenuation, and timing errors. Bell-test analyses are incorporated to assess entanglement quality, while decoupling strategies are evaluated for noise mitigation. Results indicate that star topologies support efficient central coordination but are highly sensitive to hub decoherence; mesh topologies achieve redundancy and resilience at the cost of resource overhead; and ring topologies balance connectivity with moderate noise tolerance. Across all cases, teleportation fidelity remains above the secure threshold (>0.7) under realistic noise parameters, with QKD success rates modulated by channel length and entanglement purity. A representative Fig compares teleportation fidelity across topologies, while a summary table reports noise thresholds for secure QKD operation. Together, these results demonstrate that free-space optical quantum links can serve as a practical communication substrate for MAS, if topology is matched to task requirements and supported by robust error-mitigation strategies. The results establish a bridge between quantum information protocols and MAS design, pointing toward secure, scalable, and autonomous multi-agent communication networks in photonic platforms.

Presenter:

Stefalo N.N. Acha

North Carolina A&T State University, USA



Recent Advances in Lead-Free Ceramics Materials for Energy Storage

Lucjan Kozielski

Institute of Materials Engineering, Faculty of Science and Technology, University of Silesia in Katowice, Poland

In recent years, the evolution of the economy and society, the fossil energy crisis, climate change, and air pollution have inspired massive efforts to develop clean and renewable energy resources, such as solar, water, wind, and thermal energies. This has led to a high demand for energy-storage systems, such as batteries, fuel cells, electrochemical supercapacitors, and dielectric parallel-plate capacitors. Among these options, fuel cells and batteries offer high energy density (200–1000 Wh/kg, and 10–300 Wh/kg, respectively), but their power densities are quite low (normally below 500 W/kg) because of the slow movement of charge carriers, which limits their application in many high-power systems.

Dielectric ceramics capacitors account for over 25% of the volume and weight of power electronics and pulsed power systems. Thus, it is urgent to develop novel dielectric materials that can significantly increase the energy density of dielectric capacitors. Additionally, for more than a half century, lead (Pb)-based ceramics have been dominating the market because of their excellent dielectric properties. However, due to the potential toxicity of Pb element which may do harm to the nature causing serious environmental issue and human health problems, new alternatives are greatly needed. Therefore, to develop high-performance lead-free dielectric ceramics has become the era requirement for the fast development of pulse power supply systems.

Presenter:

Lucjan Kozielski

Institute of Materials Engineering, University of Silesia in Katowice, Poland



Blockchain and Artificial Intelligence: The New Frontiers of Sustainability. How Emerging Technologies can Revolutionize Advanced Materials Demand and Verification in the Sustainability Landscape

Simona Perone¹ and **Marco Rao²**

¹Istat and Sapienza University of Rome, Italy

²ENEA, Italy

Almost a decade after the Paris Agreement and the launch of the 2030 Agenda, progress toward global sustainability goals remains insufficient: CO₂ emissions continue to rise, and only 15% of the SDGs are currently on track. In this context, emerging technologies such as blockchain and artificial intelligence are redefining how sustainability is monitored, verified, and communicated — with transformative potential across both industry practices and consumer engagement.

This paper explores the intersection of AI, blockchain, and advanced materials, focusing on how these tools can enhance transparency, traceability, and reliability in sustainability-related data and decisions.

We examine how emerging technologies can support sustainability evaluation, either by using blockchain to certify ESG data and ensure tamper-proof supply chain tracking, and by leveraging artificial intelligence to analyse large, heterogeneous datasets — such as ESG reports, satellite imagery, and online sentiment — to more accurately assess companies' environmental and social performance.

We also address critical challenges: algorithmic opacity, rating divergence between ESG providers, fragmented regulatory frameworks, and the growing risk of greenwashing. Without open standards, interoperable metrics, and algorithmic accountability, technology may become more of a distraction than a solution.

We conclude by proposing a multidimensional policy and research agenda aimed at fostering trustworthy, inclusive, and effective sustainability evaluation systems — because when it comes to sustainability, the real challenge isn't just how we measure, but what we choose to measure, and why.

Presenter:

Simona Perone

Istat and Sapienza University of Rome, Italy



2-Dimensional and Layered Materials for Applications in Energy, Water, and Healthcare

David Estrada, Ajay Pratap, Fereshteh Rajabi Kouchi, Hailey Burgoyne, Isaac Estrada, Michael Curtis, Mone't Sawyer and Tony Valayvil Varghese

Micron School of Materials Science and Engineering, Boise State University, USA

Two-dimensional (2D) materials continue to redefine the boundaries of materials science, offering unique physical properties that enable breakthroughs across water purification, healthcare, energy, and electronics. This talk will highlight our recent progress in expanding the design space for additive electronics manufacturing through the synthesis of multifunctional 2D and layered-material inks. These formulations, including black phosphorus, transition metal dichalcogenide alloys, and $Ti_3C_2T_x$ MXenes, have been engineered for applications ranging from silicon photonics and sensors to high-resolution supercapacitors and triboelectric nanogenerators. In parallel, we have demonstrated a flowing electrode capacitive deionization (FECDI) system employing MXene electrodes to efficiently remove ammonia from synthetic wastewater and carbonates from simulated ocean water, underscoring the potential of 2D materials in managing nitrogen and carbon cycles while improving access to clean water. In healthcare, 2D materials' exceptional mechanical and electronic properties are leveraged for musculoskeletal tissue engineering, offering new insights at the interface of biology and nanomaterials (**Fig 1**).

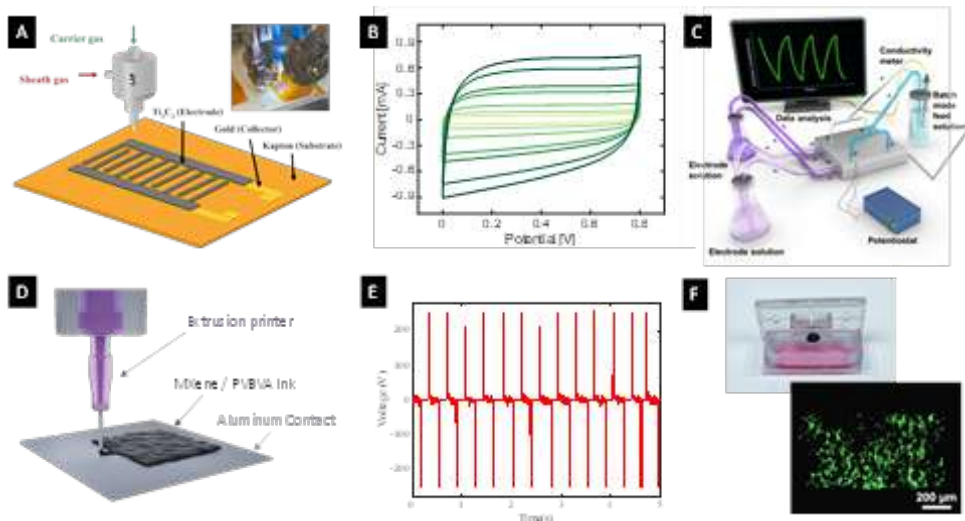


Fig 1. Overview of 2-dimensional materials in energy storage, harvesting, water purification, and tissue engineering. A, B) Schematic and optical image of aerosol jet printed $\text{Ti}_3\text{C}_2\text{Tx}$ supercapacitor and its C-V performance. C) Schematic illustration of flow-electrode capacitive deionization system used with $\text{Ti}_3\text{C}_2\text{Tx}$ flowing electrodes.

Building on these ink-based platforms, we are advancing bottom-up synthesis strategies through metal-organic chemical vapor deposition (MOCVD). Recent progress in multi-wafer growth of WS_2 and MoS_2 has yielded reproducible recipes with strong photoluminescence and wafer-scale uniformity, while extensions to selenide analogues highlight the adaptability of hydride chalcogen precursor strategies. *In situ* photoreflectometry has provided new insights into nucleation and growth dynamics, and direct patterning of TMD films on sapphire eliminates transfer steps, streamlining device fabrication. Together, these results illustrate our trajectory from ink formulation to scalable wafer-level growth, bridging fundamental discovery with industrial application. By leveraging advanced manufacturing techniques, we show 2D materials are poised to deliver transformative solutions across clean water, healthcare, energy, and next-generation electronics.

Presenter:

David Estrada

Boise State University, USA



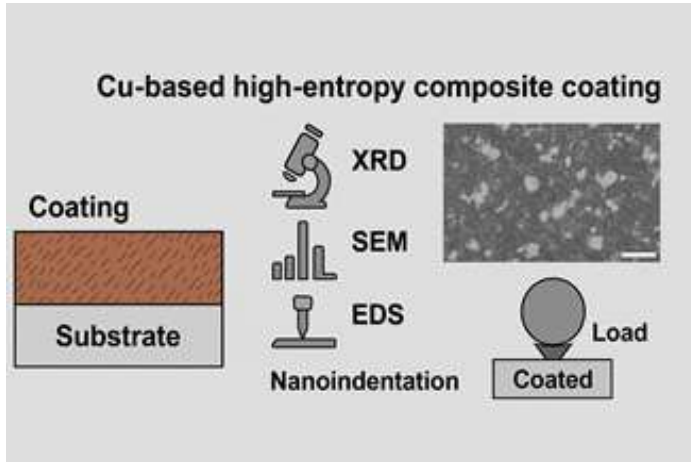
Microstructural Design and Tribological Performance of a Cu-Based High-Entropy Composite Coating

ST. L. Toma¹, D. Chicet², D.C. Cîrlan¹, T. Usatii¹ and G. Bădărău²

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²Department of Materials Science, Faculty of Materials Science
and Engineering, Gheorghe Asachi Technical University of Iasi
Romania

A Cu-based high-entropy alloy (HEA) composite coating was fabricated by twin-wire arc spraying using a pure copper wire and a complex alloyed steel wire containing carbides and alloying elements (Cr, Ni, W, Ti, B, Si). The objective of this study was to design and evaluate a hybrid microstructure combining the self-lubricating properties of copper with the high hardness and wear resistance imparted by intermetallic and carbide phases. SEM and EDS analyses revealed a compact, heterogeneous structure with uniformly distributed Cu-, Cr-, and Ni-rich regions and fine dispersion of hard carbides. X-ray diffraction (XRD) confirmed the presence of multiple HEA-related phases, indicating partial interdiffusion among the metallic constituents during spraying. Microhardness values (HV0.1) ranged from 320 to 410 HV, significantly higher than pure Cu coatings. The obtained results demonstrate the formation of a stable Cu-based HEA composite coating with superior mechanical and tribological performance, suitable for antifriction and wear-resistant applications in energy, automotive, and marine industries.



Presenter:

Stefan Lucian Toma

Gheorghe Asachi Technical University of Iasi, Romania



First-Principles Insights into Borocarbonitride Anodes for Sodium-Ion Energy Storage

Siamkhanthang Neihzial², Swastika Banerjee¹ and Swapan K. Pati³

¹Indian Institute of Technology, Roorkee, India

²Dhanamanjuri University, India

³Jawaharlal Nehru Centre for Advanced Scientific Research, India

The advancement of sodium-ion batteries (SIBs) and sodium-ion capacitors (SICs) faces three major challenges: lower cell voltage, reduced ionic diffusivity, and the larger ionic radius of sodium compared to lithium. Using first-principles calculations, we show that two-dimensional borocarbonitride ($B_xC_yN_z$) with nitrogen-rich trigonal B_xN_z domains (TN) overcomes these limitations and emerges as a superior anode material. The tunability of its electrochemical properties arises from variations in domain shape and B–N charge imbalance, enabling a monolayer TN sheet to accommodate sodium up to $Na_{2.2}C_6$, corresponding to a high specific capacity of 810 mA h g^{-1} , while also supporting lithium storage at 668 mA h g^{-1} . Importantly, the average open-circuit voltage of $\sim 1.25 \text{ V}$ versus Na/Na^+ across a broad stoichiometric range enhances overall cell voltage, while the material's high electronic conductivity and rapid sodium-ion diffusion kinetics ensure excellent rate performance, even outperforming graphite in conventional lithium-ion batteries. In addition, its unique layer-wise sodium accumulation mechanism provides stable charge storage without the rapid voltage decay observed in conventional layered systems, making TN highly promising for SIC applications. These results highlight borocarbonitride-based anodes as a rational pathway toward designing high-capacity, high-rate, and durable sodium-ion storage devices, offering sustainable and efficient alternatives to lithium-ion technology.

Table 1

Computed VIP (AIP) and VEA (AEA) in eV for monolayer $B_xC_yN_z$. Lithiation and de-lithiation energy (LE and DLE) in eV per Li atom are provided for Li-intercalation into the stable AA configuration.

Sheet	VIP (AIP)	VEA (AEA)	LE (eV/Li)	DLE (eV/Li)
H	4.46 (4.86)	2.24 (2.25)	-2.46	-1.63
TN	3.82 (3.50)	2.34 (2.34)	-2.22	-1.41
TB	4.88 (4.56)	3.32 (3.70)	—	—

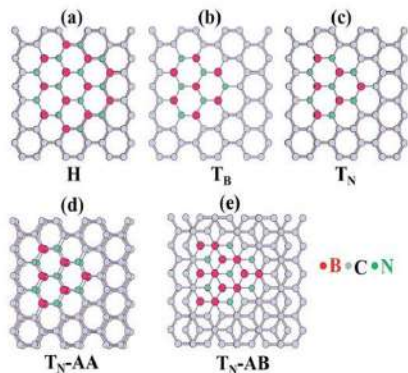


Fig. 1 Different shapes of BN nanodomains embedded on a carbon matrix: (a) $H-B_3N_3$, (b) $T_B-B_7N_7$ and (c) $T_N-B_{11}N_{11}$. H , T_B and T_N are $B_zC_yN_z$ with $x:y:z = 1:3:1$, $7:47:6$ and $6:47:7$, respectively. The colour notation is the following: B: pink; C: grey; N: green. (d), (e) show the two different stacking patterns in the case of a bilayer.

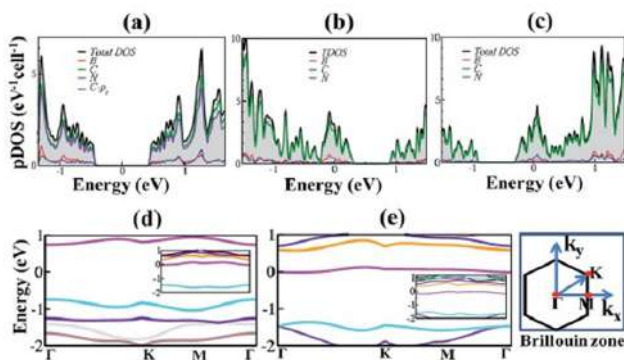


Fig. 2 The total density of states (DOS) and projected density of states ($pDOS$) for pristine H , T_B and T_N sheets (a–c). The Fermi energy (E_F) has been rescaled at zero. The band dispersion (path: $\Gamma-K-M-\Gamma$) in pristine as well as lithiated state of the (d) H and (e) T_N sheets. The inset figures correspond to the Li-adsorbed state. $\Gamma = (0, 0, 0)$, $K = (0, 0.5, 0)$, $M = (0.5, 0.5, 0)$.

Presenter:

Siamkhanthang Neihisial

Dhanamanjuri University, India



A Novel Billhook Shaped 2-Element MIMO Array for Sub 6 GHz Millimetre Wave Application

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²Amaljyothi College of Engineering, APJKTU, India

³Saintgits College of Engineering, India

This paper presents a novel billhook-shaped two-element MIMO antenna array tailored for sub-6 GHz millimeter-wave applications. The proposed antenna, compact in size ($32 \times 67 \times 1.6 \text{ mm}^3$), is fabricated on an FR4 substrate with a dielectric constant of 4.4 and a loss tangent of 0.02. A coplanar waveguide (CPW) feed and a defected asymmetric ground structure are incorporated to enhance impedance bandwidth and gain characteristics. The two radiating elements are separated by 3 mm and positioned out of phase to achieve strong self-isolation without additional decoupling structures. The designed antenna covers an operational bandwidth of 4–5.7 GHz with two resonant frequencies at 4.3 GHz and 5.25 GHz. It achieves a return loss better than -30 dB , a maximum gain of 5.63 dB, and an isolation level of -27 dB . Radiation efficiency exceeds 90% across the operating band, with observed improvements in omnidirectional coverage.

Diversity performance metrics further validate the antenna's suitability for modern wireless systems. The envelope correlation coefficient (ECC) remains below 0.02, the diversity gain (DG) approximates 10 dB, and the mean effective gain (MEG) is less than -3 dB for both elements. The channel capacity loss (CCL) is maintained below 0.4 bits/s/Hz, indicating high spectral efficiency and minimal correlation loss. The compact configuration and broadband characteristics make the proposed billhook antenna an effective candidate for sub-6 GHz 5G communication systems, Wi-Fi 5, and n77/n78 band operations. Future work may explore incorporation of metamaterials or slotted grounds to further suppress mutual coupling and enhance radiation efficiency.

Presenter:

Jaimon Yohannan

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Dynamic Analyses (Modal and Forced Vibration) in a Railway Vehicle Model with 25 Degrees of Freedom

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UTFPR, Federal University of Technology, Brazil
FEUP, Faculty of Engineering of the University of Porto, Portugal

The objective of this work is to study the dynamic characteristics (modes and frequencies of vehicle vibration), as well as the analysis of forced vibration, allowing the simulation of resonance conditions and their critical speeds, important for the study of vehicle stability, safety, and passengers' comfort. The tridimensional model has a passenger car body, two bogies, and four wheelsets. The Fig 1 illustrates the model with its respective 25 degrees of freedom, and the Table 1 presents frequencies, periods and damping ratios.

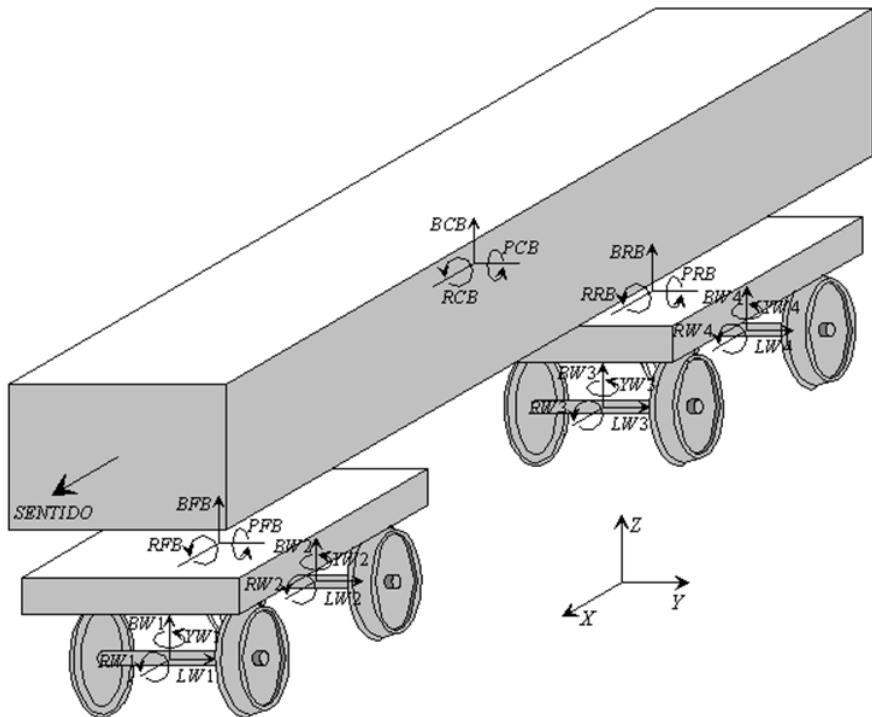


Fig 1. Railway vehicle model

N ^o	ω_n (rad/s)	ω_{d1} (rad/s)	f_n (Hz)	f_d (Hz)	T_n (s)	T_d (s)	ζ_v
1 st	8,165	8,138	1,300	1,295	0,770	0,772	0,082
2 nd	13,923	13,787	2,216	2,194	0,451	0,456	0,139
3 rd	14,84	14,676	2,362	2,336	0,423	0,428	0,148
4 th	15,896	15,694	2,530	2,498	0,395	0,400	0,159
5 th	17,776	17,493	2,829	2,784	0,353	0,359	0,178
6 th	18,365	18,053	2,923	2,873	0,342	0,348	0,184
7 th	52,107	44,474	8,293	7,078	0,121	0,141	0,521
8 th	53,057	44,975	8,444	7,158	0,118	0,140	0,531
9 th	71,926	49,97	11,447	7,953	0,087	0,126	0,719
10 th	80,018	47,991	12,735	7,638	0,079	0,131	0,800

Table 1. Frequencies, periods and damping ratios.

Models of vertical, lateral, and rotational track irregularities are used. In mechanical contact between wheels and rails, the theories of Hertz and Kalker, and also Vermeulen and Johnson are used. The equations of motion of the coupled system are numerically integrated using the Newmark Method, in the MatLab software. In the free vibration analysis, the frequencies and respective modes of vibration of the system were obtained, which presented classical damping. The damping ratios shown increase for higher natural frequencies. In the forced vibration analysis, the critical (resonant) speeds of the vehicle in unfavourable situations were determined. In general, the dynamic responses presented are consistent with the track irregularities models used, presenting a harmonic and periodic behaviour. The amplitudes of the dynamic responses presented in the proposed simulations were relatively small. It is possible to conclude that the railway track irregularities associated with critical traffic speeds produce vibrations in the vehicle. Due to the damping of the system, these vibrations are significantly attenuated on the rigid bodies through the primary suspensions, between the wheels and bogies; and secondary suspensions, between the bogies and the passenger car body.

Presenter:

Fernando Luiz Martinechen Beghetto

UTFPR, Federal University of Technology, Brazil

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Ionization Dynamics in Matter with Resonant Nanoantennas Irradiated by Intense Laser Shots

K. Zsukovszki

Wigner Research Centre for Physics, Hungary

Recent advancements in laser-induced fusion have revealed that resonating dopes in matter can enhance energy absorption from laser waves, facilitating fusion initiation, particularly in laser-driven inertial confinement fusion (ICF). We numerically model and investigate the interaction of intense laser pulses with matter doped with gold nanoparticles of various shapes. Using a kinetic model implemented in EPOCH numerical software, we examine the response of gold-doped matter to short, intense bursts of infrared radiation (~ 800 nm, ~ 100 fs), focusing on electron ejection dynamics, ionization, and energy transfer mechanisms.

Our simulations confirm that nanoantennas significantly enhance energy absorption compared to undoped matter. Among various shapes, dipole and quadrupole nanoantennas outperform spherical nanoparticles in resonance efficiency. Crossed quadrupole nanoantennas maintain resonance regardless of orientation, unlike dipoles, which require alignment with the polarization vector E . Since we use gold dipoles, their resonance is affected by plasmonic effects, making their behavior different from classical dipole antennas. Gold strongly interacts with optical frequencies, leading to localized surface plasmon resonance (LSPR) rather than traditional dipole radiation. In this case the resonance wavelength is shorter than the classical $\lambda_{\text{eff}}/2$ estimate due to plasmonic effects. Energy absorption and resonance condition depends on the nanoantenna size, peaking at ~ 85 nm. Increase of the laser field intensity from weak 4×10^{15} W/cm² to moderate 10^{17} W/cm² results in more than an order-of-magnitude increase in ion energy. The energy of protons is of special interest. Crossed quadrupoles prove the most efficient at producing high-energy protons, outperforming even optimally aligned dipoles.

At high intensities (4×10^{18} W/cm²), energy gain saturates due to conduction electron ejection, disrupting resonance. Dipole nanoantennas lose efficiency earlier than quadrupoles, making the latter more suitable for extreme fields. We track electric fields, currents, and ionization products, confirming that crossed quadrupoles generate higher-energy protons than dipoles or spherical dopes in fields $> 10^{17}$ W/cm². These findings suggest that nano-

antenna doping optimizes energy absorption in laser-matter interactions, making crossed quadrupoles a promising candidate for enhancing ICF fuel ignition and other high-intensity laser applications.

A 3D star-like dipole consists of three perpendicular dipoles intersecting at the center, forming an XYZ configuration. This creates an isotropic-like plasmonic response, meaning the system interacts with light from all directions. Each dipole in the 3D star-like structure strongly couples with the other two, further blue-shifting the resonance compared to a single dipole. In a crossed dipole, two perpendicular resonant modes appear, leading to mode splitting. Less energy is captured from outward unless lengths are optimized. The 3D star-like dipole creates a high-intensity hotspot at the center, where all three dipoles intersect. This results in even stronger near-field localization than 2D crossed dipoles. The 3D dipole system captures energy uniformly from multiple directions.

Comparison with experimental data for the dipole nanoantennas confirms their efficiency. Enhancements of the energies of protons are expected ~1.5 times for the crossed dopes and 2 times for 3D crossed dopes in comparison with dipole nanoantennas in hydrogen rich media.

Presenter:

Konstantin Zsukovski

Wigner Research Centre for Physics, Hungary



Conversion of Indanone-Derived Geminal Azidofluorides to Isoquinolines or Benzoyl Fluorides

Fanhong Wu, Shixun Liu, Xin Xiao, Shibo Xu and Jingjing Wu

School of Chemical and Environmental Engineering and Shanghai Engineering Research Center of Green Fluoropharmaceutical Technology, Shanghai Institute of Technology, China

In the field of organic chemistry, fluorinated compounds have garnered significant attention due to their unique physicochemical properties and broad application prospects. In recent years, the increasing availability of methods for inserting, deleting, or exchanging single atoms within molecular cores has provided new ideas and approaches for synthesizing novel fluorinated compounds. Nitrogen, as a key element in organic molecules, can modulate the polarity, stability, and reactivity of molecules, while also imparting new functional properties. By incorporating nitrogen atoms into the molecular framework of fluorinated compounds, we can further expand the chemical space, leading to the development of compounds with novel structures and functions.

This work presents a method to introduce azide groups as a nitrogen source into pre-synthesized monofluorohaloketones. Selective post-modulation allows for the ready insertion of nitrogen atoms, forming entirely new skeleton-fluorinated isoquinolinols. An analogous process with monofluorohalolamines affords the corresponding isoquinolylamines (Fig. 1). This strategy establishes a novel and efficient route to innovative fluorinated compounds under open-air conditions. We will also discuss the functionalization of drug molecules and present further mechanistic studies.

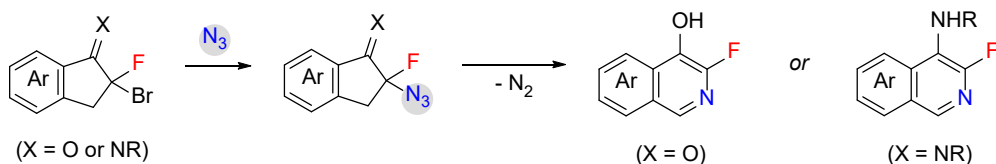


Fig. 1 Conversion of indanone-derived geminal azidofluorides to isoquinolinols or isoquinolylamines

Presenter:

Fanhong Wu

Shanghai Institute of Technology, China



BI-LSTM Enhanced Learning Based Outage Performance Analysis for Aerial Reconfigurable Intelligent Surface Assisted Communication Systems

Kumud S. Altmayer and **H. M. L. Rizzo**

Department of Engineering Technology, University of Arkansas at Little Rock, USA

This paper presents a novel framework for analyzing the outage performance of aerial re-configurable intelligent surface (ARIS)-assisted communication systems. ARIS, carried by unmanned aerial vehicles (UAVs), provides flexible and dynamic signal reflection, which is particularly useful for improving wireless connectivity in environments with blockages. Unlike traditional analytical methods for outage probability (OP) that are often complex and intractable for mobile ARIS systems, our approach leverages a Bidirectional Long Short-Term Memory (Bi-LSTM) deep learning model to overcome this challenge.

Our proposed method models the dynamic 3D spatial movement of the ARIS and the resulting channel state information (CSI) as a time-series sequence. To account for realistic conditions, we define the air-to-ground communication links using a composite fading channel that combines Nakagami-m small-scale fading with inverse-Gamma large-scale shadowing. We also develop a new mathematical framework to derive a tight, approximate closed-form formula for the outage probability.

In the offline phase, the Bi-LSTM model is trained on a dataset of real-value channel state estimations. During the online phase, the trained model uses its bidirectional learning capability to analyze channel information and accurately predict the outage performance in real-time. This provides a significant advantage by capturing long-term dependencies and improving predictive accuracy. Simulation results demonstrate that our proposed Bi-LSTM model outperforms other models in analyzing the outage probability for ARIS systems, highlighting its potential for optimizing and managing future wireless networks.

Presenter:

Kumud S. Altmayer

University of Arkansas at Little Rock, USA



New Models of University for the Digital Society

Maria Amata Garito

International Telematic University UNINETTUNO, Italy

The aim of the work titled “New Models of University for the Digital Society” is to present models of digital technology utilization in the complex world of universities to activate face-to-face and distance teaching and learning projects. Academic training can no longer be conducted locally without considering the global context that digital technologies have consolidated as the reality in which twenty-first century individuals operate and interact. Today, the common challenge for universities worldwide is how to best adapt to the digital society and create integrated and open teaching and learning systems within the context of a globalized economy. The transformation of universities is no longer a choice but an indispensable necessity. New generations of students cannot do without using the Internet to follow courses and develop knowledge and skills. The essay “New Models of University for the Digital Society” aims to present concrete models of how traditional and digital universities have been able to reinvent themselves by creating new international alliances to establish a global network of universities on the internet. These universities combine their knowledge, share curricula, and create digital content in dedicated learning environments designed with new psychopedagogical theories appropriate to technological evolution. The organizational models of digital universities are also structured to truly respond to the challenges and needs of a globalized and interconnected society.

Presenter:

Maria Amata Garito

International Telematic University UNINETTUNO, Italy



Influence of Higher GGBFS Content on the Performance of Concrete Pavement Incorporating Processed Coarse RAP

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¹CSIR-Central Road Research Institute, New Delhi, India

²Thapar Institute of Engineering and Technology Patiala, India

Due to a scarcity of virgin aggregates, the use of reclaimed asphalt pavement (RAP) as a substitute for natural aggregates has gained popularity in sustainable concrete pavement research. Despite the fact that RAP is recycled in asphalt pavement, there is still excess RAP, and its use in concrete pavements has expanded in recent years. According to a survey, 95 percent of India's pavements are bituminous pavement. As a result, the maintenance and reconstruction of such pavements generate RAP, which can be reused in concrete pavements as well as surface course, base course, and subbase of flexible pavements. Various studies on the properties of reclaimed asphalt pavement and its optimal requirements for usage in concrete has been conducted throughout the years. In this study a total of four different mixes were prepared by partially replacing natural aggregates by RAP in different proportions. It was found that with the increase in the replacement level of Natural aggregates by RAP the mechanical and durability properties got reduced. In order to increase the mechanical strength of mixes 60% Glass Granulated Blast Furnace Slag (GGBS) was used and it was found that with replacement of cement by 60% of GGBFS, there was an enhancement in the mechanical and durability properties of RAP inclusive PQC mixes. The reason behind the improvement in the properties is due to the processing technique used in order to remove the contaminant layers present in the coarse RAP aggregates. The replacement level of Natural aggregate with RAP was done in proportion of 20%, 40% and 60% along with the partial replacement of cement by 60% GGBFS. It was found that all the mixes surpassed the design target value of 40 MPa in compressive strength and 4.5 MPa in flexure strength making it much more economical and feasible. The study concludes that incorporating higher GGBFS content with processed coarse RAP significantly enhances the mechanical performance and durability of concrete pavement. This combination also contributes to reduced cement consumption and improved sustainability, making it a viable and eco-efficient solution for concrete pavement.

Presenter:

Dinesh Ganvir

CSIR-Central Road Research Institute, New Delhi, India



DDPG-PER for an IRS-Aided Secure Wireless Communication

Bourouina Anfal, Amina Lammari and Bessah Naima

LCSI Laboratory, Higher School of Computer Science (ESI)
Algeria

Improving the security of communications data in a wireless network is one of the most important uses of reconfigurable intelligent surfaces (IRS), especially in next generation networks like 6G. In this context, we propose an approach based on a deep reinforcement learning (DRL) algorithm to determine the optimal phase shift of IRS elements. We used the Deep Deterministic Policy Gradient (DDPG) variant, which adapts to continuous data and improves the secrecy rate by considering, in the algorithm, the best sample obtained *via* a Prioritized Experiment Replay (PER).

Presenter:

BOUROUINA Anfal

LCSI Laboratory

Higher School of Computer Science (ESI), Algeria



Leveraging Asymmetric Cycling Protocols for Fast Charging of LFP-Li Metal Batteries

Connor Welty¹, Giorgio Baraldi² and Jokin Rikarte¹

¹CIC EnergiGUNE, Spain

²Basquevolt, Spain

Lithium metal batteries (LMBs) suffer from cycle life limitations due to non-uniform lithium deposition and irreversible lithium loss. While recent work has shown that asymmetric cycling (slow charge/fast discharge) can mitigate these issues by promoting dense lithium plating and dendrite focused stripping, this strategy limits the deliverable capacity of the LFP cathode. Lithium kinetics and diffusion are hindered at the high discharge rates required to benefit from asymmetric cycling which leads to a low energy density. Here, we propose a novel staircase discharge protocol, where the discharge current progressively steps down in 6 stages. This method preserves the dendrite stripping benefits of fast discharge at high state of charge (SOC), while allowing for slow intercalation of Li-ions back into the cathode at low SOC. Compared to symmetric constant current cycling, the staircase discharge protocol improves cycle life, and compared to asymmetric constant current cycling it increases the deliverable capacity. The staircase discharge protocol reduces inactive lithium accumulation and maintains a smoother lithium interface over 200+ cycles. These findings provide a practical and implementation-ready approach for extending the cycle life of LMBs, including in anode-free configurations.

Presenter:

Connor Welty

CIC EnergiGUNE, Spain



Time-Dependent Rheological Evolution of Cement Paste under Dynamic Shear Conditions

Astha Sharma and **Sandeep Chaudhary**

Department of Civil Engineering, Indian Institute of Technology Indore, India

The time-dependent rheological behavior of cement paste plays a crucial role in the performance of modern construction processes such as 3D printing, self-compacting concrete, and pumping operations. Cement paste undergoes continuous changes in flow behavior due to the combined effects of shear rate, particle interactions, and early hydration, making reliable characterization challenging. This study investigates the simultaneous evolution of reversible thixotropic rebuilding and irreversible hydration-driven structuration in cement paste under dynamic shear conditions. Cement pastes with w/c ratios ranging from 0.40 to 0.55 were studied using a distinct cyclic shear protocol designed to simulate realistic processing environments for over 30 minutes. This approach enabled time-resolved assessment of both material breakdown and rebuilding under sustained deformation. The results show that lower w/c ratios show faster and stronger structural rebuilding due to denser particle packing and accelerated formation of hydration products, as shown in Fig. 1. Structuration was found to be sensitive to shear rate, with intermediate to high shear conditions promoting enhanced particle contact and early hydrate network formation. Microstructural and mineralogical analyses using SEM, EDS, and XRD confirmed the progressive consumption of clinker phases and gypsum and the formation of ettringite, calcium silicate hydrate, and portlandite during the early hydration period, correlating well with the observed rheological evolution. The study provides a clear framework linking shear history, w/c ratio, rheological behavior, and early hydration mechanisms. The proposed shear protocol and rheological parameters offer practical guidance for optimizing cement paste behavior in rheology-sensitive construction applications during the critical early-age window.

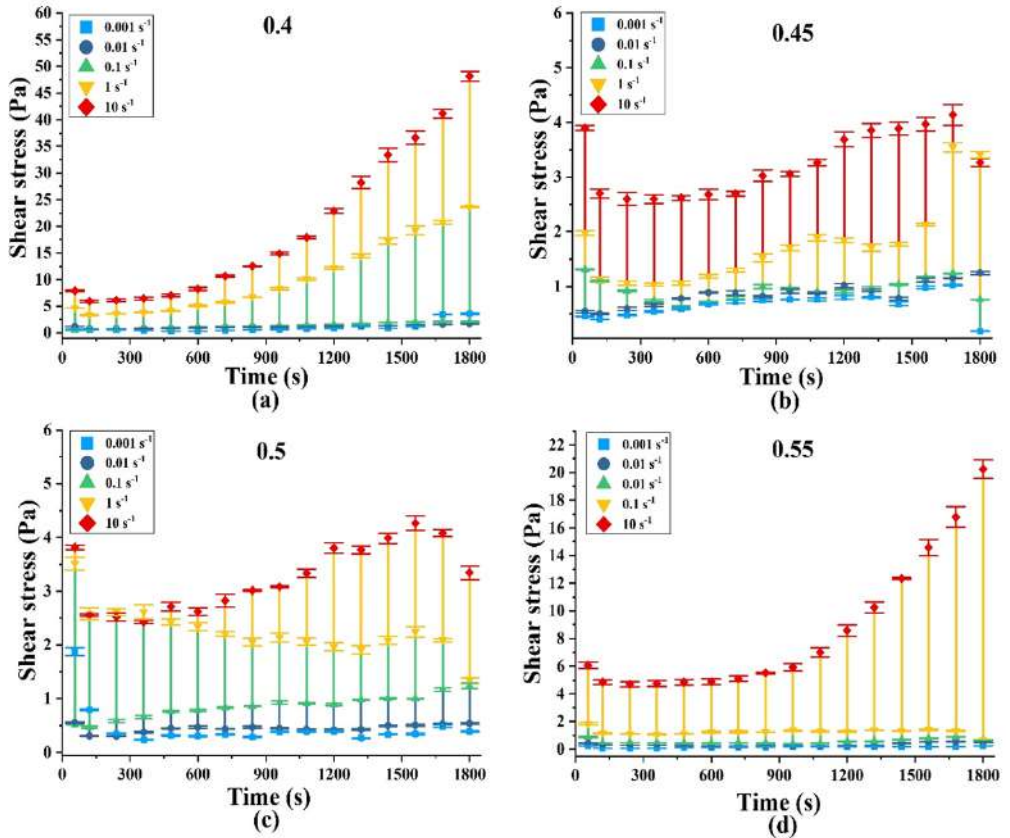


Fig. 1 Shear stress evolution of cement paste at w/c ratios of: (a) 0.40, (b) 0.45, (c) 0.50, (d) 0.55.

Presenter:

Astha Sharma

Indian Institute of Technology Indore, India



Influence of the Parameters of the Topological Optimization Method: Sequential Element Rejection and Admission in the Design of Metamaterials

**Mariela Gómez-Castañeda¹,
Juan Manuel Alvarado-Orozco² and Arturo Gómez-Ortega¹**

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²Universidad Tecnológica del Valle de Toluca, México

Recent advances in topological optimization (TO) techniques have enabled the development of new strategies for designing unit cells from cellular materials, also known as metamaterials. Commonly, the objective function of this type of optimization problem aims to determine the optimal micro-structural topology of the unit cell by maximizing the bulk modulus or the shear modulus, which, together with numerical homogenization theory, allows the design of a unit cell under a limiting volume fraction.

This work uses the discrete structural optimization method of Sequential Element Rejection and Admission (SERA); the SERA's optimization algorithm is bidirectional in nature and operates with two differentiated criteria: one for the elimination of existing solid material (converting it into void) and another for the addition of virtual material (converting it into solid) within the design domain. Now, these criteria are affected by three parameters: 1. The rate of progression (PR) that controls the addition and rejection rate into the design domain; 2. The smoothing ratio (SR) controls the net level of excess material to be admitted or rejected and 3. The material redistribution fraction (β) controls the small constant amount of material that is redistributed until the criterion distribution converges. In this work, the influence of these three SERA parameters on the topological design of unit cells is presented through the possible combinations of the parameters, ranked according to an experimental design.

As a result, we evaluate the influence of the SERA parameters on the resulting topologies and analyse trade-offs between maximizing the bulk and shear moduli using correlation analyses. Besides the results, which reveal several non-trivial topological patterns, the influence of parameter changes on the generation of structures with mechanical characteristics sensitive to these

criteria is shown. Finally, we demonstrate the potential of these methods for designing advanced cellular materials that meet specific requirements.

Presenter:

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Electrical Conductivity of Nanofluids with Carbon Nanotubes

Valery Ya. Rudyak

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Nanofluids are called dispersed fluids with solid nanoparticles or with carbon nanotubes (CNTs). Nanofluids have been actively studied for about thirty years. This is primarily due to their possible and existing applications (thermophysical, biomedical and cosmetic technologies, creation of new materials, tribology, pharmacology, etc.). When studying nanofluids, the main attention was paid to their rheology, thermal conductivity, and heat transfer. However knowledge of the nanofluid electrical conductivity is necessary in the solar energy industry, when cooling processors, to increase the breakdown voltage of transformer oils, and when creating fuel cells with a proton exchange membrane. On the other hand, this knowledge is important for the creation of stable and long-lived nanofluids. Nevertheless, the electrical conductivity of nanofluids with CNTs has been actively studied in the last five to seven years only. It is practically impossible to compare the published data, since they were obtained for different nanofluids, with different CNTs (single-walled, SWCNT, or multi-walled, MWCNT), for different base fluids, etc. This, in particular, explains a certain inconsistency of the literature data. For this reason, there are still a number of questions that need to be answered in order to make the possible applications of CNT nanofluids predictable. There are the following questions. (1) What is the electrical conductivity excess of nanofluids with MWCNTs and SWCNTs? (2) How does the nanofluid electrical conductivity change with increasing CNT concentration? (3) How does the surfactant affect the excess of electrical conductivity of nanofluids? (4) What is the reason for the influence of surfactants? (5) What are the main mechanisms of electrical conductivity of nanofluids? (6) How does the aspect ratio of CNTs affect the electrical conductivity of nanofluids? This report is dedicated to answering these questions. The nanofluids with CNTs based on isopropyl alcohol, ethylene glycol (EG), EG+S (S is a surfactant), and Water+S were considered. The weight concentrations of CNTs varied from 0.05 to 0.25%.

Presenter:

Valery Ya. Rudyak

Novosibirsk State University of Architecture and Civil Engineering, Russia

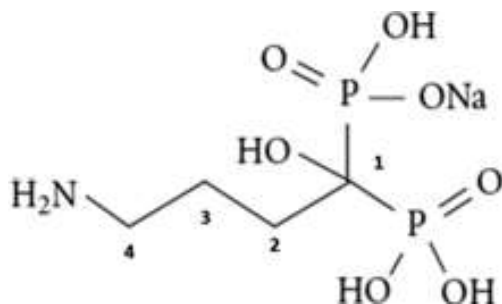


Anticancer Evaluation and Drug Delivery of New Complexes Based on the Chelate of Alendronate onto Hydroxyapatite Nanoparticles

Sahar I Mostafa

Department of Chemistry, Faculty of Science
Mansoura University, Egypt

Bisphosphonates (Bps) is a significant subclass of phosphonates, organophosphorus compounds. Bisphosphonates containing nitrogen (N-Bps) have been used in the treatment of bone-related disease including osteoporosis and cancer therapies. The new alendronate (H_2Ald) complexes were synthesized and characterized using IR, NMR (1H , ^{13}C , ^{31}P), UV-visible, mass spectra, elemental analysis, molar conductivity and thermal measurements. The anticancer activity of the complexes were tested against the human prostate (DU 145) and breast (MDA-MB231) cancer cell lines, which showed promising results compared to the market drug cisplatin. Moreover, the complex $[Pd_2(bpy)_2(Ald-2H)]$ has apparent affinity for hydroxyapatite nanoparticles (HANp), the bone tissue main constituent. Thus, the physicochemical characteristics, *in vitro* release of $[Pd_2(bpy)_2(Ald-2H)]$ from HANp were evaluated using UV-visible spectroscopy. The $[Pd_2(bpy)_2(Ald-2H)]$ encapsulation efficiency was found to be 96.83%, while the released 85.2 up to 10 days at the physiological pH 7.4.



Structure of Alendronate (N-Bps)

Presenter:

Sahar I Mostafa

Mansoura University, Egypt



Development of Neutral Zone-Based Lumbar Support Robotic Device Utilizing an Electroadhesive Clutch

Garam Lee¹, Won Kee Chang² and Nam-Jong Paik^{1,2}

¹Department of Health Science and Technology, Seoul National University, South Korea

²Department of Rehabilitation Medicine, Seoul National University Bundang Hospital, South Korea

Stroke survivors with hand spasticity often struggle to wear and use rehabilitation gloves, limiting therapy participation. Conventional motor-driven hard exoskeletons are bulky and uncomfortable, especially for contracted hands. Soft wearable robots using pneumatic artificial muscles (PAMs) offer lightweight compliance, but require continuous airflow to maintain posture or generate force, raising energy consumption and often failing to overcome the elevated stiffness of post-stroke hands.

We propose a soft-rigid hybrid stiffness control mechanism integrating a thin, flexible electroadhesive clutch (EAC) around the fingers (Fig. 1). The clutch conforms to the finger during free motion and, when activated, increases stiffness *via* electrostatic adhesion, enabling precise control and energy-efficient holding.

Two glove architectures—PAM-only and PAM-EAC—were evaluated. Stiffness and power consumption were measured during posture holding and resistive grasping tasks. The EAC allowed graded resistance matched to patient hand stiffness by adjusting input voltage, reducing the need for continuous pneumatic actuation.

Table 1 summarizes results. The PAM-only glove achieved 0.36 N/mm stiffness, insufficient for the average passive stiffness of post-stroke hands (average 0.44 N/mm). The PAM-EAC hybrid reached 0.45 N/mm, enabling effective posture holding and controlled resistance. For a 1-hour sustained open-hand posture, power consumption dropped from 0.58 Wh (PAM-only) to 0.21 Wh (PAM-EAC), a 63.8% reduction.

Integrating an EAC with PAM actuation offers variable stiffness with lower energy use, combining compliance for safe interaction with rigidity for stable grasping. This dual capability makes the PAM-EAC glove suitable for daily assistance and repetitive rehabilitation in stroke patients with severe spasticity.

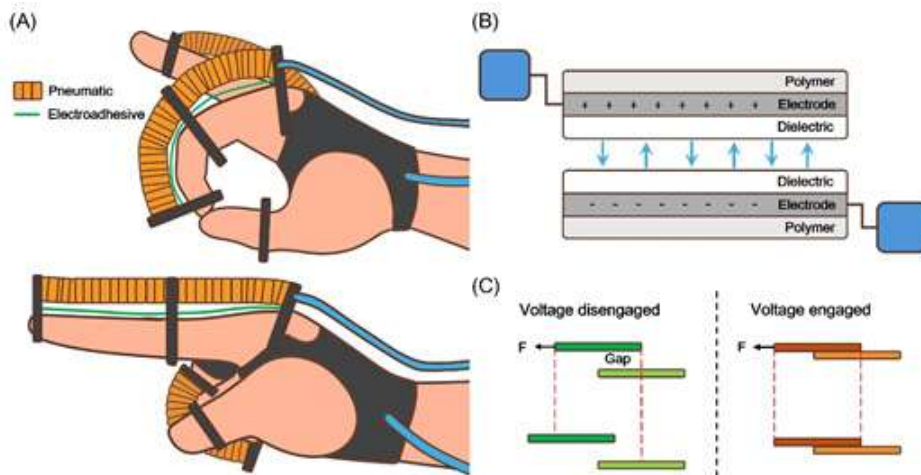


Fig 1. (A) Schematic of the soft-rigid hybrid glove integrating pneumatic artificial muscles (orange) and electroadhesive clutch strips (green) along the finger dorsum. (B) Cross-sectional diagram of the electroadhesive clutch showing polymer–electrode–dielectric layers and electrostatic adhesion mechanism. (C) Conceptual illustration of clutch behavior: with voltage disengaged (left), layers slide freely; with voltage engaged (right), electrostatic adhesion increases stiffness for posture holding or resistive grasping.

Table 1. Measured stiffness and power consumption for PAM-only and PAM-EAC hybrid glove architectures.

Parameter	PAM-only	PAM-EAC
Stiffness (N/mm)	0.36	0.45
Power consumption (Wh)	0.58	0.21

Presenter:

Garam Lee

Seoul National University, South Korea



In-Plane Tensile Effect Induced Ultralow Friction in Suspended Hexagonal Boron Nitride

Kai Chen and **Yunfei Chen**

Jiangsu Key Laboratory for Design & Manufacture of Micro/Nano Biomedical Instruments and School of Mechanical Engineering, Southeast University, China

Achieving ultra-low friction is crucial for advancing micro/nano electromechanical systems (M/NEMS). Suspended two-dimensional materials offer a promising pathway toward this goal, with hexagonal boron nitride (h-BN) standing out due to its excellent lubricity and electrical insulation. In this study, micropore arrays were fabricated on SiO₂/Si substrates, and mechanically exfoliated h-BN flakes were transferred onto both the porous (suspended) and non-porous (supported) regions. Using atomic force microscopy (AFM), we systematically compared the frictional properties of the h-BN flakes in these two configurations. The results reveal that the suspended h-BN exhibits a significantly lower friction coefficient than its supported counterpart, demonstrating superior anti-friction performance. This ultralow friction is attributed to the in-plane tensile effect induced by the suspended geometry, which effectively suppresses flake wrinkling and reduces the real contact area with the AFM tip. This work provides key experimental evidence supporting the application of h-BN as a high-performance lubricating material in M/NEMS.

Presenter:

Kai Chen

Southeast University, China



TiO₂-C₃N₄ Nanocomposites for Visible-Light-Driven Photocatalytic Air Purification

Ângela Lima, Isabel Oliveira and Juliana P. S. Sousa

INL – International Iberian Nanotechnology Laboratory
Portugal

Scope: Most people spend 70–90% of their time indoors, where poor air quality can provoke serious health risks due to the release of volatile organic compounds (VOCs) from different sources. Unlike conventional air purifiers that mainly trap particulate matter, photocatalysis offers a promising solution by converting indoor air pollutants into harmless substances. Titanium dioxide (TiO₂) nanoparticles are widely used as highly effective photocatalysts due to their non-toxicity, low cost, and long-term stability. However, their photocatalytic activity is limited to UV radiation and presents a high recombination rate of electron–hole pairs, reducing efficiency.

Objectives: To enhance visible light activity and decrease recombination rates, TiO₂-C₃N₄ (carbon nitride) composites were developed.

Methods: The composites were synthesized with different proportions of TiO₂ and C₃N₄ through a simple ball-milling method. The prepared materials were characterized by N₂ physisorption, X-ray diffraction analysis (XRD), Fourier-transform infrared spectroscopy (FTIR), Thermogravimetric analysis (TGA), and Scanning Electron Microscope (SEM). To do a screening of the catalytic activity of the materials it was performed photocatalytic experiments under visible light in water using a standard organic dye. The optimized material was further immobilized and tested for photocatalytic activity in a gaseous system.

Results: The TiO₂/C₃N₄ composites exhibited a low surface area and a higher proportion of anatase relative to the rutile phase. These characteristics contribute to the superior photocatalytic performance presented by the compounds. In liquid medium, the 0.9 g TiO₂ + 0.1 g C₃N₄ composites showed the best photocatalytic performance under visible light, 70%. The best material showed that it maintained high photocatalytic activity even when immobilized in a gaseous system, demonstrating its potential for indoor air purification under visible light.

Conclusion: These results highlight $\text{TiO}_2\text{-C}_3\text{N}_4$ composites as a promising and cost-effective solution for improving indoor air quality under visible light.

Presenter:

Ângela Martins Lima

INL – International Iberian Nanotechnology Laboratory, Portugal



Engineering Sustainable Fluorine-Free Hydrophobic Coatings for Painting Equipment Protection

Juliana P. S. Sousa and **Diana Alves**

INL – International Iberian Nanotechnology Laboratory
Portugal

An important challenge faced by the automotive industry is the phenomenon known as overspray, in which excess paint particles disperse and contaminate the surrounding environment. To minimise potential damage, painting robots are commonly protected with polyester covers. However, due to their hydrophilic nature, these covers readily absorb paint, requiring frequent replacement and generating significant waste. A promising strategy to address this issue is to impart the covers with superhydrophobic properties. On superhydrophobic surfaces, liquid droplets adopt an almost spherical shape and roll off easily, reducing surface contact and limiting paint absorption. In this work, several surface modification strategies were investigated to impart polyester fabrics with highly hydrophobic properties. These approaches involved the incorporation of nanomaterials, namely silica and alumina nanoparticles, to introduce hierarchical micro- and nanoscale surface roughness, combined with the application of low surface free energy compounds, specifically stearic acid and hexadecyltrimethoxysilane. The results showed that the immobilisation of polyester fabrics with nanomaterials alone increased the water contact angle; however, water droplets remained pinned to the surface and did not readily roll off. These hydrophobic features were attributed to the increased roughness of the fibres, as confirmed by scanning electron microscopy and surface roughness measurements. When nanomaterials were combined with hydrophobic agents, a synergistic effect was observed, resulting in higher water contact angles and significantly lower sliding angles. All modification strategies improved the resistance of the fabrics to overspray, as evidenced by a substantial reduction in paint absorption. Notably, surfaces exhibiting lower sliding angles showed enhanced resistance to overspray. The durability of the most effective treatment was evaluated after 70 washing cycles, demonstrating that hydrophobic properties could be largely preserved under these harsh conditions and relevant industrial operating environments.

Presenter:

Juliana Patricia da Silva Sousa

INL – International Iberian Nanotechnology Laboratory, Portugal



Functionalisation-Driven Control of ZnO Tetrapod Networks for Enhanced Electronic Performance

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¹Institute of Materials Science, Kaunas University of Technology Lithuania

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Zinc oxide (ZnO) nanoparticles, recognised for their low cost, low toxicity and overall environmental friendliness, have attracted considerable interest due to their strong performance in sensing, catalysis and optoelectronic applications. Among the diverse ZnO nanostructures, ZnO tetrapods (ZnO-Ts) stand out due to their distinctive architecture consisting of four elongated arms joined at a central core. This geometry provides a high surface area, mechanical stability and efficient charge-transport pathways, making ZnO-Ts highly suitable for advanced functional systems. In this work, we examine the growth mechanisms of ZnO-Ts and develop high-yield synthesis routes that enable scalable and reproducible production, with particular attention devoted to their functionalisation to enhance compatibility, interfacial performance and application-specific behaviour. Establishing such feasible growth and functionalisation strategies is essential for integrating ZnO-Ts into practical devices. We also explore their use in sensing platforms and neuromorphic computing, where their structural and electronic properties offer clear advantages. By employing ZnO-T networks as the basis for electronic components and using low-temperature deposition techniques, we demonstrate that virtually any substrate can be coated with controllable ZnO-T morphologies, greatly expanding potential device architectures. Furthermore, we identify correlations between preparation related distributions in various ZnO nanostructures – arising from differences in packing behaviour – and their electrochemical properties. Understanding these relationships supports the optimisation of ZnO-based materials for electrocatalysis, energy storage and related applications. The insights gained from this study provide a solid foundation for further development of functionalised ZnO-Ts in electrochemical, biotechnological and electronic technologies.

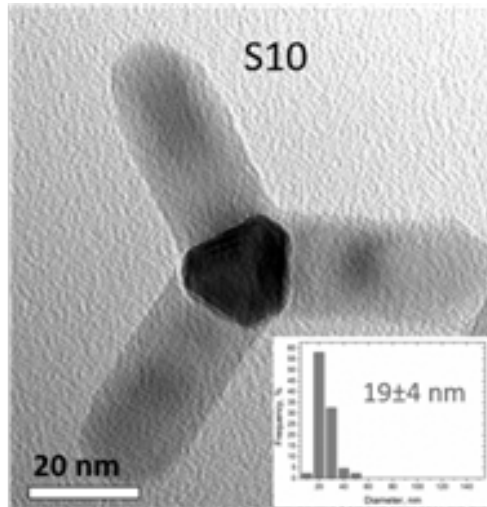


Fig. 1. Morphology and Diameter Distribution of Fractioned ZnO Tetrapods

Acknowledgements

This work was funded from the (Project No. S-ITP-24-4) under a grant agreement with the Research Council of Lithuania (LMTLT).

Presenter:

Mindaugas Ilickas

Institute of Materials Science, Kaunas University of Technology, Lithuania



Nanoemulsions Based on Extracts Obtained from Fruit and Vegetable Biomass

Magdalena Chrobak and **Małgorzata Miastkowska**

Faculty of Chemical Engineering and Technology
Cracow University of Technology, Poland

The aim of the study was to develop and characterize nanoemulsion systems containing lipophilic and hydrophilic extracts derived from vegetable biomass (celery, carrot) and fruit biomass (apple, plum) as the main functional components of the formulation. The nanoemulsions were prepared using a high-energy emulsification method and subsequently characterized in terms of their physicochemical properties. The influence of the type and concentration of the incorporated extracts on the properties of the obtained nanoformulations was systematically evaluated. Key parameters such as particle size, polydispersity index (PDI), and formulation stability were analyzed. The results demonstrated that the composition of the extracts significantly affected the properties of the nanoemulsions. Based on the obtained data, formulations containing selected concentrations of the extracts exhibited favorable characteristics, including small particle size, low PDI values, and good physical stability. These results allowed the identification of the most promising nanoemulsion systems. The developed formulations may represent a potential approach for the utilization of plant-derived biomass extracts in nanoformulation systems.

Presenter:

Magdalena Chrobak

Cracow University of Technology, Poland



Nanostructured Lipid Carriers Based on Extracts Obtained from Fruit and Vegetable Biomass

Zuzanna Orzechowska and **Małgorzata Miastkowska**

Faculty of Chemical Engineering and Technology
Cracow University of Technology, Poland

The aim of this study was to develop lipid nanoparticle formulations containing extracts obtained from fruit and vegetable biomass and to optimize their qualitative and quantitative composition. The investigated systems were designed as potential nanocarriers for bioactive compounds intended for cosmetic applications.

Nanoparticles were prepared using lauryl glucoside as a surfactant, blueberry wax as a solid lipid component, and water as the continuous phase. Hydrophilic and hydrophobic extracts derived from apple, plum, carrot, and celery biomass were incorporated into the lipid systems. The formulations differed in the content of the solid lipid and hydrophobic plant extracts in order to evaluate their influence on nanoparticle formation and stability. Nanoparticles were produced by heating the phases followed by ultrasonication.

The obtained systems were characterized using dynamic light scattering (DLS) to determine the average particle size (Z-Ave) and the polydispersity index (Pdl). The results showed that nanoparticle size strongly depended on the formulation composition, particularly on the concentration of the solid lipid and the type of plant extract used. In general, the smallest particles and the lowest Pdl values were obtained for systems containing plum extract. The optimal formulation contained 1% of the solid lipid component, which allowed the formation of nanoparticles with the most favorable physicochemical parameters. Some formulations showed an increase in particle size during storage, indicating partial aggregation, while other systems demonstrated higher stability.

The obtained results indicate that lipid nanoparticles based on fruit and vegetable biomass extracts may represent promising nanocarriers for bioactive compounds in cosmetic formulations.

Presenter:

Zuzanna Orzechowska

Cracow University of Technology, Poland



Oleogels Based on Extracts Obtained from Fruit and Vegetable Biomass

Lidia Faron and Małgorzata Miastkowska

Faculty of Chemical Engineering and Technology
Cracow University of Technology, Poland

The aim of the study was to obtain and characterize oleogels in which lipophilic extracts derived from plant biomass, a by-product of fruit and vegetable processing, were used as the main components of the formulation. The extracts were obtained from vegetable biomass including tomato, celery and carrot, as well as from fruit biomass such as apple and plum. The oleogels were developed with the intention of their potential use as modern transdermal systems for dermatological applications, enabling effective delivery of bioactive compounds to the skin.

In the study, the influence of the type of plant extract on the properties of the obtained oleogel systems was analyzed, particularly their morphology, rheological properties and physicochemical stability. In addition, the effect of the type of silica used as a structuring agent for the oil phase on the properties of the obtained oleogels was investigated. Three types of silica were used: hydrophilic silica (Aerosil 200), hydrophobic silica (Aerosil R972) and silica with intermediate hydrophilic–hydrophobic properties (Aerosil R816). The influence of the silica type on the formation of a three-dimensional structural network in the oil phase, as well as on the rheological properties and stability of oleogel systems containing plant extracts, was analyzed.

The rheological properties of the prepared systems were measured using a Brookfield R/S Plus rotational rheometer. In addition, the oil binding capacity (OBC) was evaluated using a laboratory centrifuge at 8000 rpm for 15 minutes. The measurements were performed immediately after sample preparation and after one week of storage. The results showed that the OBC values of the samples increased after one week, indicating a higher ability of the gel structure to retain the oil phase.

The results also showed that hydrophilic silica Aerosil 200 provided the best rheological properties, especially the highest viscosity. In general, the oleogels prepared with Aerosil 200 showed the best stability among the tested formulations. The highest viscosities were observed in oleogels containing the hydrophobic tomato, celery and plum extract with Aerosil 200 and the hydrophobic

tomato extract with Aerosil R816. These results highlight that careful selection of plant extracts and silica types allows the design of oleogel systems with enhanced viscosity and stability, which could be advantageous for the development of advanced transdermal delivery systems in dermatological applications.

Presenter:

Lidia Faron

Cracow University of Technology, Poland



Hydrogels Based on Extracts Obtained from Fruit and Vegetable Biomass

Oliwia Kubiczek and **Małgorzata Miastkowska**

Faculty of Chemical Engineering and Technology
Cracow University of Technology, Poland

The objective of this study was to design and characterize hydrogel systems incorporating hydrophilic extracts obtained from fruit and vegetable biomass, which represents a by-product of the food processing industry. The plant extracts were derived from vegetable biomass, including celery and carrot, as well as fruit biomass such as apple and plum. The developed hydrogels were considered as potential carriers of bioactive compounds for dermatological and topical applications.

Hydrogels were prepared using different hydrophilic polymers, including sodium alginate, pectin and hyaluronic acid. To obtain systems with varied structural and rheological properties, both individual polymers and their combinations were applied, with particular focus on mixtures of sodium alginate and pectin. Plant extracts were incorporated into the hydrogel matrices at different concentrations in order to evaluate the influence of extract type and concentration on the physico-chemical properties of the formulations.

The study investigated the effect of polymer type, plant extract type and extract concentration on the properties of the obtained hydrogels, particularly their morphology, rheological behavior and physicochemical stability. Rheological measurements were performed using a Brookfield rotational rheometer to determine viscosity and flow behavior. Analyses were carried out immediately after preparation and after a defined storage period.

The results demonstrated that the properties of the hydrogels strongly depended on the type of polymer matrix used. The most favorable rheological properties and the highest stability were observed for hydrogels based on a mixture of sodium alginate and pectin. Furthermore, formulations containing apple extract showed the most advantageous viscosity and stability parameters, which may be related to the high content of natural polysaccharides and bioactive compounds present in this extract. These findings indicate that the appropriate selection of polymers and plant extracts enables the development of stable hydrogels with desirable rheological properties, which may serve as promising delivery systems for dermatological applications.

Presenter:

Oliwia Kubiczek

Cracow University of Technology, Poland



Hybrid Systems Based on Extracts Obtained from Fruit and Vegetable Biomass

Adrianna Podlewska and **Małgorzata Miastkowska**

Faculty of Chemical Engineering and Technology
Cracow University of Technology, Poland

The aim of the study was to obtain and characterize hybrid systems based on oleogels and hydrogels, in which lipophilic and hydrophilic extracts derived from fruit and vegetable biomass were used as the main formulation components. The extracts were obtained from vegetable biomass including celery and carrot, as well as from fruit biomass such as apple and plum. The developed hybrid systems, in the form of bigels, were designed as potential carriers for bioactive compounds in cosmetic and pharmaceutical applications.

The study analyzed the influence of oleogel-to-hydrogel ratio, silica type, and polymer type on the physicochemical properties and stability of the obtained bigels. Oleogels were prepared using oil containing lipophilic extracts from fruit or vegetable pomace, different types of silica (Aerosil 200, Aerosil R816, and Aerosil R972) as oil-phase structuring agents, and vitamin E as an antioxidant. Hydrogels were prepared using sodium alginate, pectin, or their mixture as gelling agents, together with glycerin, water, hydrophilic extract, and preservative.

The rheological properties of the prepared systems were evaluated using a Brookfield R/S Plus rotational rheometer. Stability was assessed by centrifugation at 6000 rpm for 10 minutes and by a reduced-temperature method involving storage of samples in a refrigerator for 7 days.

The results showed that the most promising bigel systems were obtained using celery biomass extracts. In particular, the formulation composed of hydrogel containing celery extract and pectin combined with oleogel containing celery extract and Aerosil R816 showed the most favorable physicochemical properties. The highest stability was observed for bigels prepared with Aerosil R816 at oleogel-to-hydrogel ratios of 60:40, 50:50, and 40:60. The results indicate that appropriate selection of extract type, polymer composition, silica type, and phase ratio significantly influences the stability and rheological behavior of hybrid systems.

Presenter:

Adrianna Podlewska

Cracow University of Technology, Poland



From Vegetable Biomass to Bio-Patch/Mask: Physicochemical and Structural Characterization of Carrot-Derived Transdermal Hydrogel Systems

Sandra Komaniecka and **Katarzyna Bialik-Wąs**

Faculty of Chemical Engineering and Technology
Cracow University of Technology, Poland

The valorization of vegetable biomass into advanced biomaterials is a highly promising direction in modern biomedicine and cosmetics. *Daucus carota* (carrot) is widely recognized as a rich source of valuable bioactive compounds, including β -carotene, α -carotene, lutein, caffeic acid, protocatechuic acid, anthocyanins, rutin, and falcarinol. Notably, chlorogenic acid, naturally present in this vegetable biomass, stands out for its significant potential to act as a natural cross-linking agent for crosslinking reaction of protein polymers. This study aimed to develop innovative transdermal hydrogel systems by exploiting this unique characteristic. Three different types of carrot preparations were obtained: an aqueous extract, an aqueous-ethanolic extract, and a lyophilized carrot formulation. Each variant was incorporated at various concentrations into a primary polymer matrix comprising gelatin and carboxymethylcellulose (CMC). To ensure the optimal mechanical flexibility required for direct skin application, glycerin was introduced as a plasticizer. The interaction between the biopolymer network and the active extract components yielded successfully cross-linked transdermal hydrogel matrices, suitable for use as wound dressings or cosmetic facial masks. The resulting bio-patches were comprehensively characterized. Structural analysis via Fourier Transform Infrared Spectroscopy (FTIR) verified the successful incorporation of the extracts and the formation of cross-linked matrices. Physicochemical properties were evaluated by measuring the swelling ratio and gel fraction, while morphological features were examined using Scanning Electron Microscopy (SEM). Additionally, studies on the release of active substances were also performed. In conclusion, combining the hydrogel matrix with carrot extracts provides significant dermatological advantages, applying the antioxidant and provitamin A activity of carotenoids to promote skin regeneration. Furthermore, the utilization of vegetable biomass in this manner directly supports the principles of the circular economy, offering a sustainable, zero-waste approach to developing advanced functional biomaterials.

Presenter:

Sandra Komaniecka

Cracow University of Technology, Poland



Optimization of the Chemical Cross-Linking Reaction of Protein Polymers using Plant Biomass Extracts

Kacper Odziomek¹, Mateusz Barczewski² and Katarzyna Bialik-Wąs³

¹Faculty of Chemical Engineering and Technology
Cracow University of Technology, Poland

²Faculty of Mechanical Engineering, Institute of Materials
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Faculty of Chemical Engineering and Technology
Cracow University of Technology, Poland

Protein-based polymers have been widely used in biomedicine for years and often require a cross-linking process to improve their physicochemical properties. Since conventional chemical cross-linking agents frequently exhibit cytotoxic effects, safer and natural alternatives are currently being sought. For instance, celery extract (*Apium graveolens*) is a rich source of polyphenolic compounds with potent health-promoting properties, specifically antioxidant, antibacterial, and anti-inflammatory, which are highly desirable in dermatology, including the support of epidermal regeneration and the treatment of skin inflammation.

The main objective of this research was to optimize the chemical cross-linking reaction of protein polymers using an extract from plant biomass (celery) and to analyze its impact on the morphological and thermal properties of the systems. The scope of the work included the preparation of polymer matrices with varying volume fractions of aqueous and aqueous-ethanolic plant extracts. To characterize the structural properties of the materials, Fourier-transform infrared spectroscopy (FT-IR) was employed, while thermogravimetric analysis (TG/DTG) was used to determine thermal stability, and scanning electron microscopy (SEM) was utilized to visualize the morphology of the cross-sections.

The use of celery extract proved to be an effective and sustainable method for cross-linking protein polymers. The resulting biomaterials are characterized by improved parameters and, due to the presence of phytoconstituents that support skin health, demonstrate high application potential as innovative dressings or scaffolds in modern dermatology.

Presenter:

Kacper Odziomek

Cracow University of Technology, Poland

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Engineering Modifications in Flow Channels for Enhancing Performance of Flow Batteries

Milan Kumar and Aash Mohammad

Department of Chemical and Biochemical Engineering
Rajiv Gandhi Institute of Petroleum Technology, India

A vanadium redox flow battery is an electrochemical device for electrical energy storage which can be efficiently deployed for stationary applications or can be connected with the power grid along with solar energy harvesting equipment. The device consists of membrane electrode assembly – anode and cathode separated by a membrane – and uses liquid electrolyte on both sides. This necessitates properly designed flow channels to guide aqueous electrolyte to pass through the hydrophobic carbon-felt electrodes to efficiently distribute it in the porous spaces of the electrodes and maximize the areas for electrochemical reactions. Conventionally, serpentine, interdigitated, parallel, or no-flow channels are employed which have their own advantages and disadvantages if scaled up for industrial applications. Some other channels have also been proposed in the literature, but they also show their limitations on increasing their dimensions. Our research group is meticulously working on the designing and fabrication of flow channels taking inspiration from nature and modifying the existing ones using first-principle, engineering methods. In this presentation, we will discuss some of the techniques to design the flow channels which are employed in plate-type heat exchanger and microfluidic devices for process intensification through heat and mass transfer enhancements. Splitting the flow channels, changing to sinusoidal-wavy flow path, relocating inlet and outlet ports for electrolyte, and modifying rectangular ribs to trapezoidal shape are some of few important alterations incorporated in the study. Results show that using designed channels ~70% reduction in pressure drop can be achieved with respect to conventional ones. Correlations for pressure drop were also proposed. The iR -free power density of the battery using these channels exceeds 700 mW/cm². These proposed designs are easy to be machined and can also be deployed in other liquid-electrolyte based electrochemical devices such flow batteries and electrolyzers.

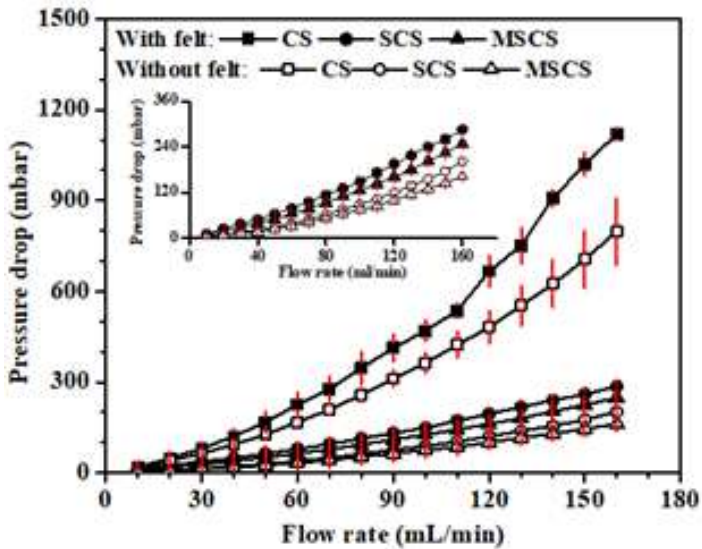


Table 1. *iR*-free power density of designed channels

Channel Type	<i>iR</i> -free Peak Power Density (mW/cm ²)
CS	678.2
SCS	689.8
MSCS	722.8
SS-10	552
SMS-10	363
SWS	~500
CS-10	154.0

Presenter:

Milan Kumar

Rajiv Gandhi Institute of Petroleum Technology, India



Phytochemistry of *Campanula lactiflora*: Quantitative Analysis of Bioactive Compounds, Synthesis and Characterisation of Silver Nanoparticles, Investigation of their Biological Activities

Ramazan Erenler

Department of Chemistry, Faculty of Arts and Sciences
Tokat Gaziosmanpasa University, Turkey

Natural products play a crucial role in drug development owing to their broad spectrum of biological activities. *Campanula lactiflora*, a member of the Campanulaceae family, is a valuable medicinal plant known for its diverse secondary metabolites. In this study, the phytochemical composition of *C. lactiflora* was investigated, and its bioactive compounds were quantitatively analyzed. The major detected compounds included phenolic acids and flavonoids, which are known for their antioxidant and therapeutic potentials. Furthermore, silver nanoparticles (AgNPs) were successfully synthesized using the plant extract as a reducing and stabilizing agent, providing an eco-friendly route for nanoparticle production. The synthesized AgNPs were characterized by UV–Vis spectroscopy, FTIR, XRD, and SEM analyses, confirming their formation and nanoscale structure. TEM image indicated the nanoparticle to be spherical with the particle size of 16.2 nm. XRD analysis showed that the nanoparticle to be face-centered cubic structure. The particle size was also calculated as 14.2 nm by Scherrer equation. The maximum absorption was observed at 437 nm, confirming the nanoparticle formation. AgNPs displayed the good antioxidant activity (Figure). The results demonstrated significant antioxidant capacity. These findings highlight *C. lactiflora* as a promising source of natural compounds and a green reducing agent for nanoparticle synthesis with potential applications in pharmacology and nanobiotechnology.

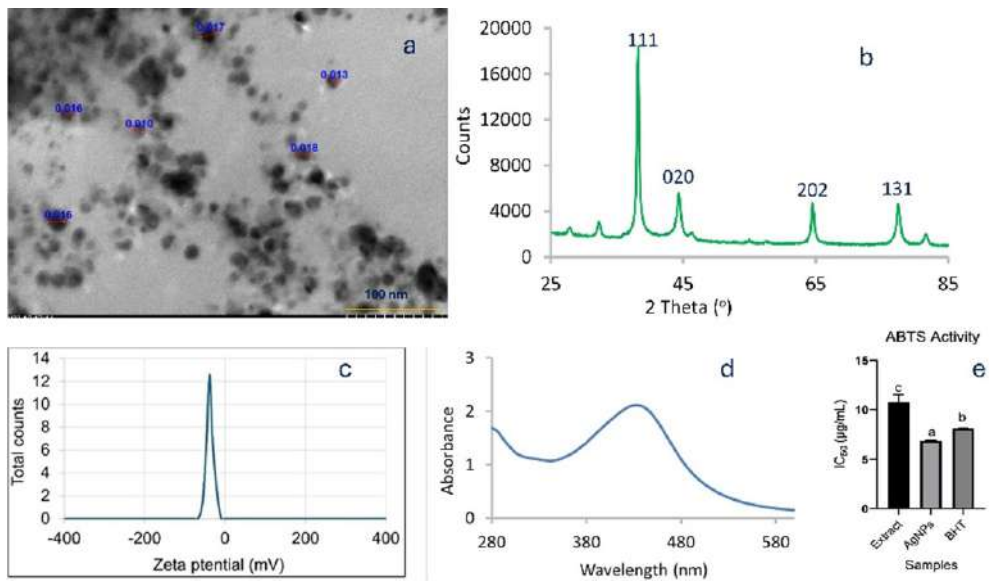


Figure: TEM image (a), XRD (b), Zeta potential (c), UV-Vis (d), antioxidant (e) of nanoparticles.

Presenter:

Ramazan Erenler

Tokat Gaziosmanpasa University, Turkey



Precipitation-Engineered Sulfonated Polystyrene Nanoparticles with Tunable Surface Charge for Efficient Removal of Cationic Dyes and Phenolic Contaminants from Water

Tamer M Tamer¹, Theodora Krasia¹, Mohamed S Mohyeldin² and Ioannis Pashalidis³

¹Department of Mechanical and Manufacturing Engineering
University of Cyprus, Cyprus

²Polymer Materials Research Department, Advanced
Technologies and New Materials Research Institute (ATNMRI)
City of Scientific Research and Technological Applications
(SRTA-City), Egypt

³Department of Chemistry, University of Cyprus, Cyprus

The development of highly efficient and composition-controlled polymeric nanoadsorbents is of central importance for advanced wastewater treatment applications. In this work, a series of sulfonated polystyrene nanoparticles with tunable surface charge and ion-exchange capacity were synthesized *via* a precipitation polymerization strategy in a poor polymer solvent environment. By systematically varying the monomer feed ratio of styrene and styrene sulfonic acid (PSt:PSSt = 100:0, 90:10, 70:30, 50:50, and 0:100), composition controlled copolymeric nanoparticles were obtained without the use of surfactants or stabilizing agents.

Structural and chemical characterization by FT-IR, elemental analysis, and thermogravimetric analysis confirmed quantitative incorporation of sulfonated units and progressive enrichment of surface $-\text{SO}_3^-$ groups with increasing PSSt content. The ion-exchange capacity increased from 0.47 to 2.41 meq g^{-1} for the copolymers, reaching 4.47 meq g^{-1} for pure PSSt, demonstrating precise control over functional group density. SEM analysis revealed uniform spherical nanoparticles, while zeta potential measurements indicated a systematic increase in surface charge with sulfonation degree.

The adsorption performance of the prepared nanoadsorbents was evaluated toward representative cationic dyes (methylene blue and crystal violet) and a phenolic contaminant (caffeic acid) using batch experiments. The sulfonated copolymers exhibited rapid uptake kinetics and markedly enhanced adsorption capacities compared with pristine polystyrene, driven by electrostatic interactions and ion-exchange mechanisms. The highest removal efficiencies were obtained for the PSt:PSSt (50:50) and PSSt systems, correlating directly with their elevated ion-exchange capacity and surface charge density.

The present strategy offers a scalable and additive-free route to engineer composition-programmable polymeric nanoadsorbents with tunable interfacial chemistry. The results demonstrate the strong potential of precipitation-engineered sulfonated nanoparticles as versatile platforms for the efficient removal of dyes and phenolic pollutants from contaminated water streams.

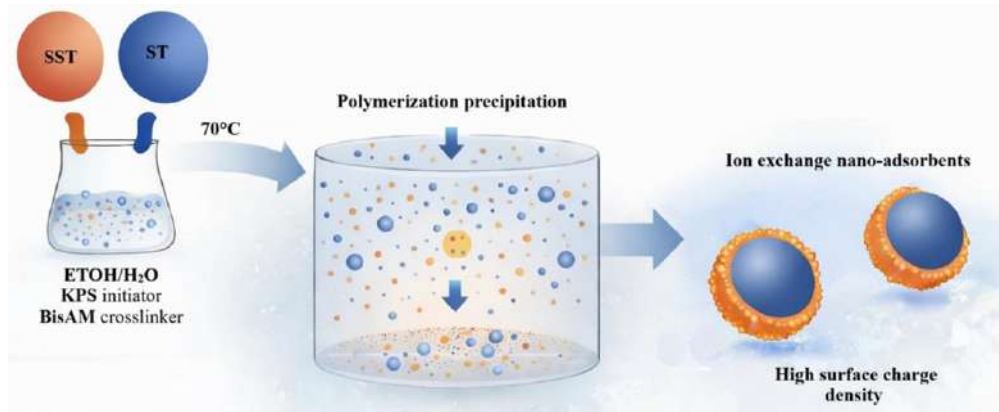


Fig 1. Schematic representation of the precipitation polymerization route employed for the synthesis of sulfonated polystyrene-based nanoparticles.

Presenter:

Tamer Mahmoud Tamer Abdelrazik

University of Cyprus, Cyprus



Phytochemical Profiling and Biological Activity Evaluation of *Centaurea stapfiana*

Esmâ Nur Gecer

Natural Product Laboratory, Department of Chemistry, Faculty of Arts and Sciences, Tokat Gaziosmanpasa University, Turkey

The genus *Centaurea* (Asteraceae) comprises approximately 300–900 species distributed across various regions worldwide. *Centaurea* species have attracted considerable scientific interest due to their rich phytochemical composition and broad spectrum of biological activities. Traditionally, different species have been utilized for their diuretic, antipyretic, and antidiabetic properties, as well as for the treatment of inflammatory, hypoglycaemic, and gastrointestinal disorders. In this study, the quantification of phenolic compounds in the methanol extract of *Centaurea stapfiana* was determined by LC-ESI-MS/MS, and the antioxidant activity was assessed. For quantitative analysis, an Agilent 1260 Infinity II HPLC system coupled to a 6460 Triple Quadrupole mass spectrometer was used to determine the phytochemical compounds. Shikimic acid (4082.6 µg/g extract), salicylic acid (1020.1 µg/g extract), chlorogenic acid (451.8 µg/g extract), syringic acid (336.6 µg/g extract), protocatechuic acid (101.4 µg/g extract), kaempferol-3-glucoside (26.8 µg/g extract), isoquercitrin (12.4 µg/g extract), and fisetin (7.6 µg/g extract) were determined as major compounds. The antioxidant potential of the methanolic extract of *Centaurea stapfiana* was assessed using DPPH, ABTS, and reducing power assays. The extract demonstrated notable antioxidant activity in all tested systems, suggesting a potent free radical scavenging and electron-donating capacity. This activity may be attributed to the presence of major phenolic constituents or the synergistic interactions among multiple bioactive compounds within the extract.

Presenter:

Esmâ Nur Gecer

Tokat Gaziosmanpasa University, Turkey



The Skin as a Reflection of our Lifestyle

J. Lademann¹, M. Darvin¹, W. Köcher² and B. Magnussen²

¹Charité – Universitätsmedizin Berlin, Germany

²Biozoom GmbH, Kassel, Germany

The aim of this lecture is to use non-invasive measurement systems to demonstrate that skin aging can be significantly reduced through a healthy diet and avoiding stressful situations.

A major cause of the aging process is the formation of free radicals in our skin and body due to solar radiation and stressful situations. Our human body has developed a protective system against these processes in the form of antioxidants. We cannot produce most of these antioxidants ourselves; instead, we must consume them through a healthy diet rich in fruits and vegetables.

These substances can neutralize free radicals before they can exert their damaging effects.

A Raman spectrometer was developed at the Charité that allows the first non-invasive, online detection of carotenoids in human skin, meaning without causing damage. Carotenoids are marker substances for the overall antioxidant potential. Since we didn't yet know what to expect from this system, we tested it on our employees for over a year.

It was shown that a healthy diet increases antioxidants in our skin and in our body. On the other hand, all types of stress processes lead to a reduction in these antioxidants in our body. This includes stress in professional and private life, excessive consumption of nicotine and alcohol, and excessive amounts of sun exposure.

The extent to which carotenoids affect skin aging was demonstrated in a study. For this study, participants were examined who were all 50 years old, thus already exhibiting a wrinkle or furrow, and who had not changed their lifestyle for decades. Both the skin surface structure, i.e., wrinkle density and depth, and the antioxidant potential were determined on a light-irradiated skin area—the forehead. It was found that subjects with high antioxidant potential had significantly fewer wrinkles and furrows than those with low values. Age played no role in this study, as all subjects were the same age.

The subjects with many wrinkles and furrows saw the study participants who had younger skin and decided to lead a healthier life in the future. You can protect yourself from skin aging for the coming years through a healthy diet. However, you can't eat yourself young.

That's why we went to the place where nutritional stress behaviour is shaped—to a school in Kassel with vocational training, where the young people could prepare their own meals. This study was conducted using the skin scanner from Biozoom, a miniaturized, portable, inexpensive, and non-invasive measurement system.

For the first month, the students were measured without being informed of their results. In the second month, they were asked to eat a healthy diet, and their measurements were shared with them. What they didn't know was that we would return six months later to check the measurements. We wanted to see if their mental attitude toward life had changed or if the measurements were just a game for the students.

In the first month, the antioxidant concentrations in the students' skin were already very high. They didn't learn their measurements, but they knew they were being measured. They ate healthily to avoid trouble. In the second month, they learned their daily values and saw how their antioxidant concentrations steadily improved through a healthy diet. They felt better and also performed better in school. A real competition ensued to see who had the highest antioxidant concentrations.

After six months, the values improved significantly again.

In another study, the Biozoom measurement system was used to measure carotenoids in pregnant women before delivery and in newborns. It turns out that children are born with a very high antioxidant potential to protect themselves in the new environment.

Presenter:

Juergen Lademann

Charité – Universitätsmedizin Berlin, Germany



Female Computer Teachers Training by the (TAWOCK) Model

Remsh Nasser Alqahtani¹ and **Ahmad Zaid Almassaad²**

¹P.H.D in Curriculum and Instruction, Department of Curriculum and Instruction, College of Education, King Saud University, Saudi Arabia

²Professor of Curriculum and Computer Education Department of Curriculum and Instruction, College of Education, King Saud University, Saudi Arabia

The aim of research is to design the training program based on the TAWOCK model for and reveal their effect on teaching self-efficacy among computer teachers. It used the quasi-experimental approach, with a pre-test and post-test design with a control group. An electronic training program based on the TAWOCK model was designed, and prepared (teaching self-efficacy scale). The research sample included (42) female teachers in the experimental group, and (39) female teachers in the control group. The research reached: There was a statistically significant difference at the level (≤ 0.05) between the mean scores of computer teachers in the experimental and control groups in the post application; In favor of the experimental group, the value of the ETA square for the total scale of teaching self-efficacy was (0.613); Which indicates the size of significant impact on the self-teaching effectiveness of female computer teachers. There was also a statistically significant difference at the level (≤ 0.05) between the mean scores of computer teachers in the experimental group in the pre and post applications; In favor of the post application, the value of Cohen's coefficient for the total scale of teaching self-efficacy was (1.26). This study proposed conceptualization based on the TAWOCK model was presented for training computer science teachers in specialized topics in the field of computing and reviewed by several specialists. This study recommended using this proposed conceptualization for designing and delivering e-training for computer science teachers.

Presenter:

Remsh Nasser Alqahtani

King Saud University, Saudi Arabia



CRISPR-Cas9 Mediated Disruption of Virulence Genes in Uropathogenic *Escherichia coli*: Towards Antibiotic Free Therapeutics

Tajo Abraham

Department of Botany, Sir Syed College, Taliparamba, Kannur University, India

Urinary tract infections (UTIs) represent one of the most prevalent bacterial diseases worldwide, largely caused by uropathogenic *Escherichia coli* (UPEC). The alarming rise of antibiotic resistance in UPEC strains has created an urgent demand for alternative strategies that do not rely on conventional antimicrobials. A promising approach is antivirulence therapy, which targets the pathogenic mechanisms of bacteria rather than their survival.

In the present study, we employed CRISPR-Cas9 genome editing to disrupt two pivotal virulence determinants of UPEC: *iucD*, encoding a lysine N6-hydroxylase essential for aerobactin-mediated iron acquisition, and *papC*, encoding the outer membrane usher protein indispensable for P pilus assembly and adhesion. Using gene-specific single-guide RNAs and homologous repair templates, premature stop codons were introduced, generating truncated, non-functional variants of both proteins. Molecular confirmation through colony PCR and Sanger sequencing validated precise editing events.

In silico functional analyses further underscored the consequences of gene disruption. InterPro and Swiss-Model predictions revealed complete loss of conserved domains in truncated proteins, while docking studies demonstrated significantly reduced binding affinity of *iucD* to NAD(P)H and impaired PapC–PapG interactions, critical for fimbrial biogenesis and host cell adhesion. These findings provide strong evidence that targeting virulence-associated pathways attenuates UPEC pathogenicity without affecting bacterial viability.

This work highlights the potential of CRISPR-Cas9 as a precision tool for antivirulence therapy, opening new avenues for combating multidrug-resistant UPEC infections. By disarming the pathogen rather than killing it, such strategies minimize selective pressure for resistance and offer a safer, sustainable alternative to antibiotics. Our study represents a step forward in the rational design of non-antibiotic therapeutics against recurrent and intractable UTIs.

Presenter:

Tajo Abraham

Sir Syed College, Taliparamba, Kannur University, India



Surface Chemistry-Driven Chlorobenzene Adsorption on Activated Carbons from HCl Streams

Tânia Grainha and **Juliana P. S. Sousa**

INL – International Iberian Nanotechnology Laboratory
Portugal

Inorganic acids are commonly used in the leaching process of end-of-life lithium-ion batteries (LIBs) due to their low cost and high leaching efficiency. Among these, sulfuric acid is the most frequently used. However, in the pursuit of more environmentally friendly approaches, hydrochloric acid (HCl) has emerged as a promising alternative due to its lower environmental impact and potential for recovery and reuse. HCl is also a by-product of polyurethane production, although it is contaminated with chlorobenzene, which makes it unsuitable for direct use in battery recycling. In line with circular economy principles, this project proposes repurposing this waste HCl stream for LIB recycling, provided the chlorobenzene present at approximately 30 ppm can be removed.

Adsorption was selected as the purification method due to its simplicity, low cost, and scalability. This project focuses on developing an adsorption process to remove chlorobenzene from the HCl stream, enabling its reuse in hydrometallurgical treatment of spent LIBs and contributing to sustainability and resource efficiency.

Activated carbon was selected due to its high surface area, chemical resistance and adaptability to functionalization. The materials were modified with nitrogen-containing precursors (dopamine, melamine, polyethylenimine and urea), as well as by acid treatments with HCl and nitric acid, and subjected to thermal treatment to enhance adsorption performance through surface chemistry tuning.

The adsorbents were characterized using N₂ adsorption-desorption isotherms at -196 °C, elemental analysis, thermogravimetric analysis, and point of zero charge measurements.

Fixed-bed column studies were carried out using HCl solutions containing 30 ppm of chlorobenzene under controlled flow and bed height conditions. Adsorption results showed distinct performances depending on carbon type and treatment. The urea-functionalized activated carbon from Sigma exhibited the best performance, achieving 90% removal efficiency and a maximum adsorption capacity of 0.6 mg/g. This study contributes to strategies for chlorobenzene removal from acidic industrial streams.

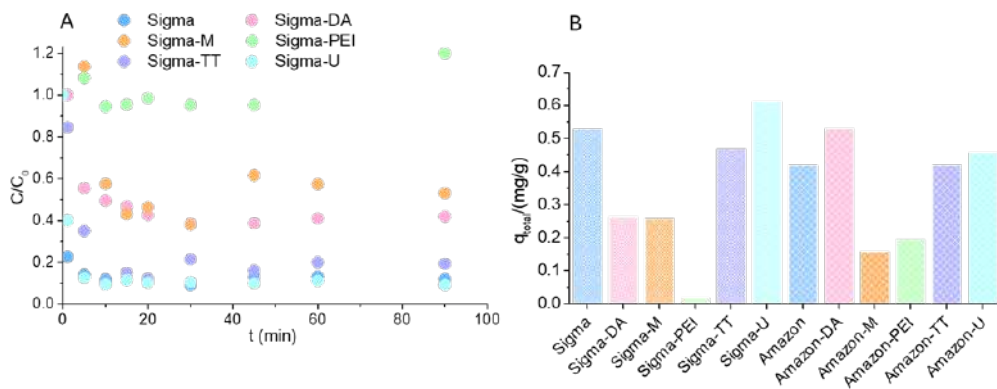


Fig 1. A- Column adsorption study of 30 ppm chlorobenzene onto activated carbon at a flow rate of 4.1 mL/min. B- Total amount of chlorobenzene adsorbed (q_{total}) with the different materials.

Acknowledgements

The authors acknowledge the financial support of the project Agenda NGS - New Generation Storage, with the reference n.º C644936001-00000045, co-funded by Component C5 – Capitalisation and Business Innovation under the Portuguese Resilience and Recovery Plan, through the NextGenerationEU Fund.

Presenter:

Tânia Raquel Rodrigues Grainha

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Sulfur-Doped ZnO as Cathode Interlayer for Efficient Inverted Organic Solar Cells

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Bulk heterojunction (BHJ) organic solar cells (OSCs) represent a promising technology due to their cost-effectiveness, lightweight design and potential for flexible manufacturing. However, achieving a high power conversion efficiency (PCE) and longterm stability necessitates optimizing the interfacial layers. Zinc oxide (ZnO), commonly used as an electron extraction layer (EEL) in inverted OSCs, suffers from surface defects that hinder device performance. Furthermore, the active control of its optoelectronic properties is highly desirable as the interfacial electron transport and extraction, exciton dissociation and non-radiative recombination are crucial for optimum solar cell operation. In this regard, this study investigates the sulfur doping of ZnO as a facile method to effectively increase ZnO conductivity, improve the interfacial electron transfer and, overall, enhance solar cell performance. ZnO films were sulfur-treated under various annealing temperatures, with the optimal condition found at 250 °C. Devices incorporating sulfur-doped ZnO (S-ZnO) exhibited a significant PCE improvement from 2.11% for the device with the pristine ZnO to 3.14% for the OSC based on the S-ZnO annealed at 250 °C, attributed to an enhanced shortcircuit current density (J_{sc}) and fill factor (FF). Optical and structural analyses revealed that the sulfur treatment led to a small enhancement of the ZnO film crystallite size and an increased n-type transport capability. Additionally, the sulfurization of ZnO enhanced its electron extraction efficiency, exciton dissociation at the ZnO/photoactive layer interface and exciton/charge generation rate without altering the film morphology. These findings highlight the potential of sulfur doping as an easily implemented, straightforward approach to improving the performance of inverted OSCs.

Presenter:

Georgios Manginas

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Optimizing Thermoelectric Potential: Low-Temperature Annealed Sb-doped CuInS_2 vs. Cr-doped GaAs: Measurement, Modeling and Materials Comparison

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We report a comparative experimental and modeling study that evaluates thermoelectric (TE) potential in two distinct material systems using complementary, high-precision characterization methods. Objectives were to (i) develop measurement-consistent datasets of thermal and electrical transport on different samples, (ii) assess the influence of low-temperature annealing on Sb-doped CuInS_2 , and (iii) quantify the limitations imposed by the inherently high lattice thermal conductivity in Cr-doped GaAs.

Methods combined PhotoThermal Deflection (PTD) for Sb-doped CuInS_2 , and sequential Front/Inverse Electro-PyroElectric (FEPE/IEPE) configurations for Cr-doped GaAs, supplemented by transport modeling (Boltzmann/Kane frameworks) to project doping-dependent performance. Results show that 4% Sb incorporation with substrate annealing at 473 K reduces lattice thermal conductivity ($k \approx 0.075 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$), raises electrical conductivity ($\sigma \approx 13.9 \text{ S}\cdot\text{cm}^{-1}$) and yields an estimated Seebeck $\approx +52 \mu\text{V}\cdot\text{K}^{-1}$ ($zT \approx 0.015$ at 300 K), demonstrating promising TE improvement *via* low-T processing. In contrast, Cr-doped GaAs presents a high lattice k ($\approx 52 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$) despite a large Seebeck ($\approx -496 \mu\text{V}\cdot\text{K}^{-1}$); measured $\sigma \approx 17.8 \text{ S}\cdot\text{m}^{-1}$ leads to a small zT ($\approx 2.5 \times 10^{-5}$), confirming phonon-dominated heat transport as the critical barrier.

These findings demonstrate that low-temperature annealed Sb-doped CuInS_2 combine low k and enhanced σ to produce meaningful zT gains for flexible TE applications, while Cr doping in GaAs cannot overcome high lattice conductivity without phonon-engineering (alloying/nanostructuring). The studies also validate PTD and FEPE–IEPE as robust tools for coherent thermal–electrical characterization and materials screening.

Table 1: Summary of measured thermoelectric properties of the investigated materials at room temperature

Material	k ($\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$)	σ ($\text{S}\cdot\text{m}^{-1}$)	α ($\mu\text{V}\cdot\text{K}^{-1}$)	zT (300K)
Sb-CuInS ₂ (T _s =473K)	0.075	1.39×10^3	+52	1.5×10^{-2}
Cr-GaAs (meas.)	52.0	17.8	-496	2.5×10^{-5}

Presenter:**Nawel Khaldi**

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Experimental Investigations of Tooth Pitch Variation and Cutting Parameters on Tool Wear and Cutting Forces in Flat End Milling of Fe–Ni Alloy Supra50

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With its low coefficient of thermal expansion, high dimensional stability at elevated temperatures and strong mechanical properties comparable to those of stainless steel, the Supra50 nickel–Fe alloy is widely used in the manufacture of aeronautical components, particularly aircraft solenoid valve parts. However, due to its low thermal conductivity and pronounced work-hardening behavior, several studies have reported the poor machinability of Supra50. Moreover, according to industrial practitioners, the machining of Supra50 components remains challenging, as low cutting speeds generate high cutting forces, leading to accelerated tool wear.

The aim of this research is to analyze the effects of tool geometry and cutting parameters on tool life. An experimental approach was adopted, involving surfacing operations on the SUPRA50 nickel–Fe alloy using flat end mills. Two tool geometries were investigated: a four-tooth flat end mill with constant pitch and a six-tooth flat end mill with offset pitch. Various combinations of cutting parameters were applied by varying the feed rate and axial depth of cut.

The results show that tool wear and cutting forces evolve proportionally. Furthermore, feed rate and axial depth of cut have a significant influence on tool wear and, consequently, on tool life. In contrast, the use of offset-pitch cutters enhances the cutting process and improves tool life. These findings are consistent with previously reported studies on the milling of other materials.

Presenter:

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Comparison of Mechanochemical Synthesis and Co-Precipitation to Obtain Composites of Yellow Clay, Hydroxyapatite and *Clitoria ternatea* L.

Klaudia Kowalska and **Ewa Skwarek**

Department of Radiochemistry and Environmental Chemistry
Maria Curie-Skłodowska University, Poland

Yellow clay and hydroxyapatite are inexpensive and readily available ingredients for the synthesis of new, multifunctional composites. *Clitoria ternatea* L. is a plant known for its diverse bioactive compounds, including anthocyanins, flavonoids and peptides, which demonstrate antioxidant, anti-inflammatory and antibacterial properties. This study compares selected properties of composites based on these materials obtained using two methods: mechanochemical and co-precipitation. The obtained products were characterized using scanning electron microscopy (SEM) and Fourier transform infrared spectroscopy (FTIR). Additionally, particle size, zeta potential and surface charge density were determined using potentiometric titration. Nitrogen adsorption and desorption studies were also conducted to analyze properties of the porous composites. UV-VIS spectrophotometry was used to measure the concentration of bioactive substances.

Both the mechanochemically and co-precipitation composites exhibit differences in their physicochemical properties. Combining yellow clay with hydroxyapatite increases pore volume and accessibility, which can significantly impact their adsorption capacity. As a result, composites can be used as carriers for various bioactive compounds, expanding their potential applications in medicine, pharmacy and materials science.

Presenter:

Klaudia Kowalska

Maria Curie-Skłodowska University, Poland



Study of the Synthesis, Dispersion, and Theoretical-Experimental Analysis of Multiple-Wall Carbon Nanotubes in Portland Cement to Improve the Corrosion Resistance of Embedded Steel

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Objectives and Scope: Steel corrosion in cement structures poses a global challenge. This study addresses this issue by incorporating multi-walled carbon nanotubes (MWCNTs) into Portland cement. The goal is to evaluate their impact on the corrosion resistance of embedded steel by combining sustainable MWCNT synthesis from coconut shell biochar with an analysis of their properties and applications. The scope includes characterizing MWCNTs and their dispersions and evaluating the electrochemical properties of reinforced cement specimens in aggressive environments.

Methods used: Initially, stable dispersions of multi-walled carbon nanotubes (MWCNTs) were achieved for up to three weeks at 440 J/g and 10 mM. These dispersions were characterized using Raman spectroscopy, UV-Vis spectroscopy, and zeta potential analysis. The current phase of the project involves the “green” synthesis of MWCNTs from coconut shell biochar, followed by purification and characterization. We will investigate the dispersion of MWCNTs in surfactants and develop a computational model to correlate experimental data with theoretical simulations. Finally, the stabilized MWCNTs will be incorporated into Portland cement test tubes with steel. The tubes will be characterized by SEM and XRD and subjected to electrochemical testing in a simulated marine environment to quantify corrosion resistance.

Results and Discussions: Preliminary results indicate that adding MWCNTs reduces cement porosity and forms an effective barrier against chloride ion intrusion, thereby protecting the steel. These results suggest significant improvements in mechanical properties and corrosion resistance. Integrating sustainably synthesized and optimally dispersed MWCNTs is expected to further enhance this protection, providing a circular, high-performance solution for infrastructure durability.

Conclusions: The application of MWCNTs in Portland cement is an effective strategy for mitigating the corrosion of embedded steel. The combination of sustainable synthesis, optimized dispersion, and a deep understanding of interactions, together with the demonstrated ability of MWCNTs to reduce porosity and act as a barrier, establishes this research as a significant advancement in developing more durable and eco-friendly construction materials.

Presenter:

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Synthesis and Investigation of Some Conductive Polymers on the Base of Aromatic Diamines

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Yerevan State University, Armenia

Research interest in aromatic diamine polymers is high, driven by their facile synthesis and broad applicability. Key features of these materials include environmental stability and variable conductivity, enabling applications in fields such as: electrocatalysis and electrochromics, sensors and electrode materials, heavy metal complex formation etc.

The characteristics of conductive polymers and copolymers derived from aromatic diamines(p/m-phenylenediamine, benzidine)-prepared through diazotization/azo coupling, oxidative polymerization, or a hybrid of these methods—have been analyzed in terms of their solubility, conductivity, thermostability, and morphology.

Presenter:

Narine Durgaryan

Yerevan State University, Armenia



Boosting Mixed-Matrix Membrane Efficiency with Sulfonated Zn-MOFs for Direct Methanol Fuel Cells

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¹Polymer Institute, Slovak Academy of Sciences, Slovakia

²Polymer Materials Research Department, Advanced Technologies and New Materials Research Institute (ATNMRI) City of Scientific Research and Technological Applications (SRTA-City), Egypt

³Fabrication Technology Department, Advanced Technology and New Materials Research Institute (ATNMRI), City of Scientific Research and Technology Applications, Egypt

Direct methanol fuel cells (DMFCs) represent a promising clean energy technology due to their high energy density and the convenient handling of liquid methanol, making them suitable for portable and auxiliary power systems. However, large-scale commercialization remains constrained by the high cost and methanol crossover of conventional perfluorosulfonic acid membranes such as Nafion, which limit cell efficiency and durability. In this study, a cost-effective proton exchange membrane based on a sulfonated PVDF- HFP/cellulose acetate (CA) blend incorporating sulfonated ZIF-8 was developed using casting technique to overcome these challenges. The composite design introduces additional sulfonic acid sites to enhance proton conductivity, while the ZIF-8 framework creates tortuous pathways that effectively suppress methanol crossover and improve mechanical stability. Comprehensive analyses using FTIR, XRD, EDX, TGA, SEM, and AFM confirmed the structural, thermal, and morphological improvements of the synthesized membranes. The inclusion of CA and sulfonated ZIF-8 increased membrane porosity, amorphicity, and water uptake, as well as enhanced hydrogen bonding interactions, which collectively strengthened the polymer matrix. Additionally, the high glass transition temperature of CA improved dimensional stability, reducing the risk of thermal shrinkage and short-circuiting. The synergistic effects of CA and sulfonated ZIF-8 in the PVDF-HFP blend significantly improved proton transport and mitigated methanol permeation, thereby underscoring the potential of this composite membrane for advanced DMFC applications.

Presenter:

Randa Eslah Khalifa Ghonim

Polymer Institute, Slovak Academy of Sciences, Slovakia



Standards for the use of Sustainable Green Finishing Material and their Impact on Internal Spaces from Economic, Social and Environmental Point of View

Sammer Hendawi Salem

Associate Professor of Architecture, October High Institute For Engineering and Technology, Egypt

Environmentally Sustainable Interior Design (ESID) is a crucial issue in interior design, but many architects and engineers remain unaware of its importance. This is particularly evident when choosing sustainable building and finishing materials. This chapter aims to develop a comprehensive understanding of sustainable options for building materials and finishing, focusing on current green and sustainable products. The study also aims to improve access to information on sustainable residential spaces and provide updated information on sustainable building and finishing materials.

The methodology proposed in this study focuses on evaluating sustainable materials used in residential buildings and their selection criteria to integrate environmental, economic, and social aspects. A descriptive and comparative analytical approach was used to analyze international and Arabic systems for auditing sustainable buildings and evaluating criteria related to standard materials and resources.

The study also analyzes environmental, economic, and social aspects related to choosing suitable building and finishing materials. The proposed model measures the sustainability of building and finishing materials used in projects, leading to an analytical approach specialized in international and local experiments. This helps clarify how to use sustainable finishing materials in different buildings and measure the achievement of sustainability standards in both local and international model buildings.

In conclusion, this chapter proposes strategies and policies for the selection of finishing materials in Egypt.

Presenter:

Sammer Hendawi Salem

October High Institute for Engineering and Technology, Egypt



Optimization of Water Softening by Donnan Dialysis using Fujifilm Cation-Exchange Membranes

Maroua Abbes and **Wided Bouguerra**

University of Gafsa, Tunisia

Donnan Dialysis (DD) is an efficient membrane technique for water softening, allowing selective removal of divalent cations like Ca^{2+} and Mg^{2+} by exploiting the electrochemical potential gradient over cation exchange membranes. This research focuses on the removal efficiency of Ca^{2+} and Mg^{2+} using three Fujifilm cation exchange membranes (Types 1, 2, and 10). Initial experiments were conducted to assess the effect of various significant processing variables like the sodium ion concentration in the receiver side and Ca^{2+} and Mg^{2+} ion concentrations in the feedstock. Among the tested membranes, Fujifilm Type 1 membrane has the highest permeability, thus improving the removal rate of Ca^{2+} and Mg^{2+} .

Full-factorial design analysis showed that the concentrations of calcium and magnesium ions in the feed compartment were the dominant factors that determine the transport of ions. Using Response Surface Methodology (RSM), it is possible to find the interaction between the factors, which is vital for the optimization of a process like Donnan Dialysis. Moreover, the method proposed for modeling the process will not require multiple attempts in the form of experimental analysis for optimizing the process in the future. Under optimized conditions, the Fujifilm-Type 1 membrane showed an ion removal efficiency of 93.78% for the concentrations of $\text{Ca}^{2+} = 120 \text{ mg/L}$, $\text{Mg}^{2+} = 80 \text{ mg/L}$, and $\text{Na}^+ = 0.55 \text{ mol/L}$ (12,644.5 mg/L).

The results clearly show that the combination of Donnan Dialysis with Response Surface Methodology is a very effective and environmentally compatible process for softening water with great industrial applications for ion elimination.

Presenter:

ABBES Maroua

University of Gafsa, Tunisia



Tailoring Processing Techniques to Tune Crystal Phase of Odd-Numbered Nylons for Mechanical Energy Harvesting

Swagata Banerjee and **S.Wazed Ali**

Department of Textile and Fibre Engineering, Indian Institute of Technology Delhi, India

The exponential escalation in technological progress has significantly intensified the search for energy sources to facilitate the uninterrupted functioning of smart gadgets. Mechanical energy harvesting has gained the limelight for its abundance, power generation capability, sustainable and environmental compatibility. Flexible energy harvesters based on piezoelectric polymers are emerging as promising energy materials due to their facile processing conditions and good piezoelectric coefficients. Nylon has attracted significant research interest in its potential as an energy material. Nylon 11 shows piezoelectric characteristics due to the parallel arrangement of amide dipoles in its polymer chain and is influenced largely by its crystal phases. The loose hydrogen bonded pseudohexagonal δ phase is preferred to tightly packed α phase for piezoelectric applications. The loose hydrogen bonding in δ phase of nylon 11 allows free rotation of dipoles in response to applied stress, explaining the higher mechanosensitivity of δ phase than α phase of nylon 11. This work explores these attributes by studying the influence of different fabrication methods in tailoring the piezoelectric property of nylon 11. In this study, nylon 11 has been formed into solution cast film, spin coat films and electrospun film. Each of these processes are based on distinct mechanism that governs the rate of polymer crystallization and solvent removal. Hence, it was observed that each of these films had different crystal phase and crystal phase content. The quick quenching, rapid solvent removal during electrospinning resulted in solely δ phase of nylon 11 in the electrospun film. On the other hand, the spin coated, and solution cast nylon 11 films consists of the α phase, predominantly. This variation in crystal phase, leads to difference in piezoelectric performance of the three films. The electrospun film showed superior performance compared to the other two films due to the desirable δ phase content. Additionally, the *in-situ* poling during electrospinning contributes to higher electrical output from the electrospun film compared to the spin coated and solution cast films. The electrospun film could generate enough power to light up LEDs and charge capacitor, demonstrating its competence in wearable and self-powered applications.

Presenter:

Swagata Banerjee

Indian Institute of Technology Delhi, India



Behaviour of Hinges in a Building with and without Lateral Load Resisting System Provided at Ends – Pushover Analysis

Deepa S¹ and **S.V.Venkatesh²**

¹Senior Scale Lecturer, DACG Government Polytechnic
Chickkamagalore, India

²PES University, India

The principle objective of this paper is to compare regular bare frame with fixed base and regular building with Lateral load resisting system (LLRS) analyzed by Nonlinear analysis. Considering fixed base and performing linear analysis is conventional method. But subjecting the same bare frame to nonlinear analysis and observing the response is very necessary to study the behaviour of the building. Usually the building behaviour changes when subjected to any load which is generally nonlinear. In the present study, a 3D model of ten storey building with fixed base is selected. The building dimension 25m x 25m with base as fixed is analyzed by nonlinear pushover analysis. The 3D building is modelled using SAP2000V.19.2.1 software. The behaviour of hinges in case of bare frame and bare frame with LLRS is studied and compared for nonlinear analysis. The LLRS adopted in this model is shear wall and the shear wall is modelled as shell element layered with nonlinear material behaviour. The nonlinearity is incorporated by applying reinforcement to shear wall. The shear wall is provided at ends and the model is subjected to nonlinear analysis to study the behaviour of the hinges. The results obtained in case of both bare frame and bare frame with LLRS is tabulated. The results in case of displacement, base force, number of hinges and time period are compared and the behaviour is studied. The observation indicates that shear wall provided at ends shows performance.

Presenter:

Deepa S

DACG Government Polytechnic, Chickkamagalore, India



Multimodal Fusion in Machine Learning: A Comprehensive Approach using Linguistics, Visuals and Metadata

Gautam Pal

Indian Institute of Management Ranchi, India

This study introduces a novel approach for integrating linguistics, visuals, and metadata to create a unified view that can provide a more accurate and holistic approach to Machine Learning compared to a single standalone knowledge base. Our methodology includes multimodal classification, clustering, and topic modelling techniques. Key contributions are a hybrid fusion algorithm that combines early and late fusion strategies for multimodal classification, an extended Latent Dirichlet Allocation (LDA) model for joint analysis of textual and visual features, and a novel multimodal clustering algorithm that integrates feature-level and decision-level information. The novelty of our approach lies in combining both early and late fusion strategies, whereas previous studies have focused on each independently; this leads to superior performance in terms of classification accuracy, topic coherence, and clustering quality. Results show significant improvements: a 12.4% increase in classification accuracy, a 54.8% enhancement in topic coherence scores, and a 35.4% higher silhouette score for clustering.

Presenter:

Gautam Pal

Indian Institute of Management Ranchi, India



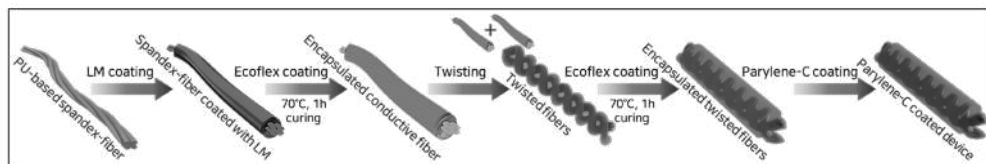
Multimodal Double-Helix Fiber Sensor for Independent Pressure and Strain Detection in Wearable Sensory Applications

Tsogbayer Dashdendeev^{1,2} and Hwa Sung Lee²

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Fiber sensors with engineered architecture offer a compelling platform for next-generation wearable electronics, owing to their inherent mechanical adaptability and compatibility with textile integration. In this study, a multimodal fiber sensor with a one-dimensional double-helix architecture is introduced, enabling the independent detection of pressure and strain stimuli within a single device. Strain sensing is realized *via* piezoresistive changes in a helical conductive fiber, while pressure is detected through piezocapacitive responses between two twisted fiber electrodes separated by a dielectric layer. This structural configuration ensures effective decoupling of signals, yielding reliable dual-mode operation without cross-interference. The strain-sensing component demonstrates a gauge factor of $0.03 \pm 0.001\%$, high linearity (0.996–0.999), negligible hysteresis, and rapid response (~ 300 ms) and recovery (~ 350 ms) times over an extended strain range (0–300 %). The pressure sensor exhibits a gauge factor of $0.001 \pm 2 \times 10^{-5} \text{ kPa}^{-1}$, excellent linearity (0.992), fast response (~ 150 ms), and mechanical durability over 2500 cycles. Practical demonstrations—including joint motion, respiration, tactile force, and airflow detection—validate the sensor's multimodal functionality. By integrating high fidelity, minimal signal interference, and robust structural performance, the proposed double-helix fiber sensor presents a versatile and scalable solution for wearable multimodal sensing applications.



(a)

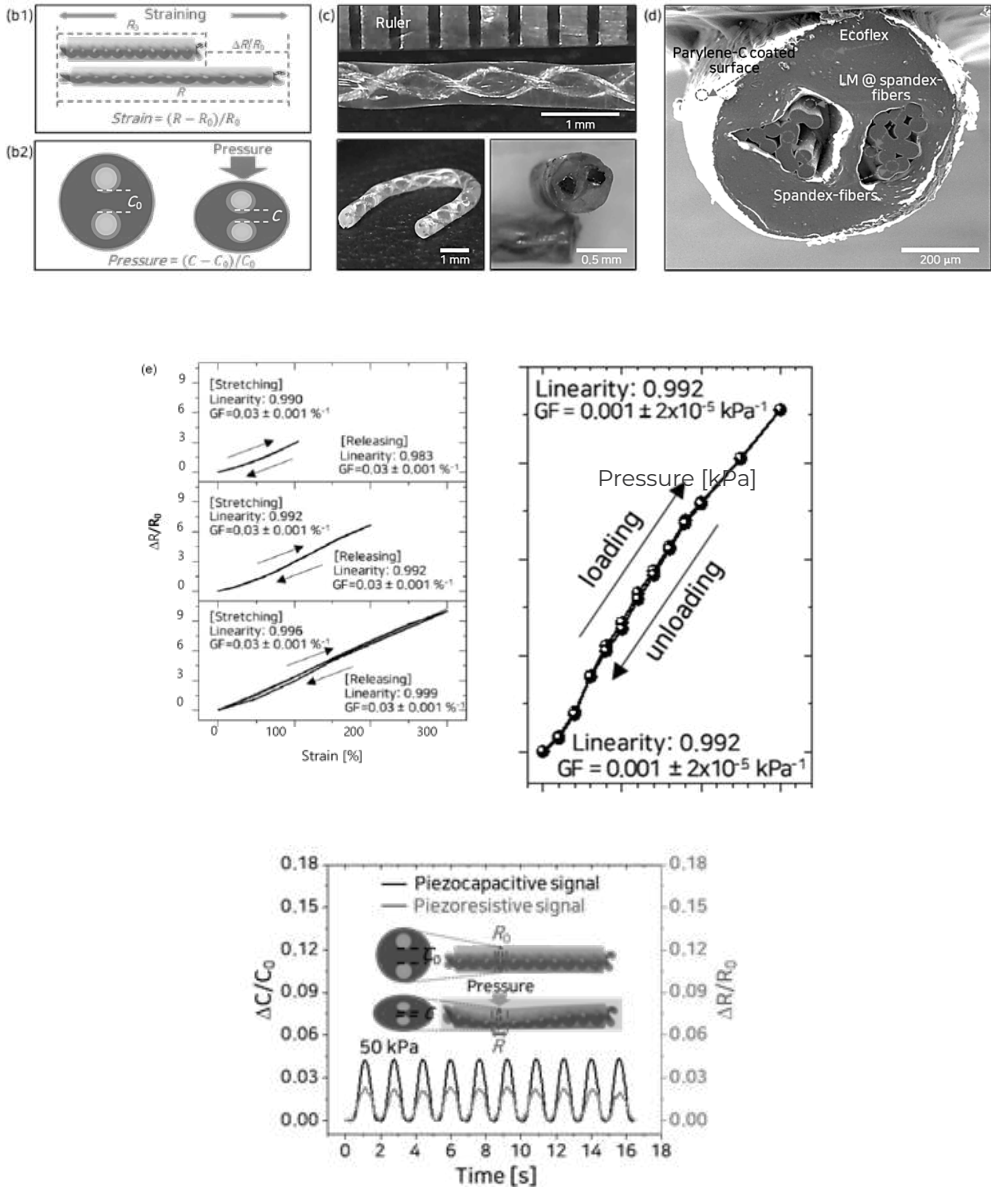


Fig 1. (a) Schematic illustration of the fabrication process for the multimodal double-helix fiber-structured physical sensor, including conductive LM coating, Ecoflex encapsulation, twisting, and Parylene-C surface treatment. (b)

Sensing mechanisms of the sensor: (b1) piezoresistive strain sensing based on resistance change in a single helix, and (b2) piezocapacitive pressure sensing based on capacitance variation between two helices. (c) Optical microscope images showing the fabricated sensor's twisted structure and cross-section. (d) Cross-sectional field-emission scanning electron microscopy (FE-SEM) image revealing the internal structure, including spandex yarns, encapsulated LM, and Parylene-C coating layer. (e) Relative resistance changes in the double-helix structured piezoresistive strain sensor at three different strain ranges: 0–105 %, 0–200 %, and 0–300 %. (f) $\Delta C/C_0$ variation during consecutive loading and unloading cycles. (c) Dynamic response of the sensor under varying pressure levels, ranging from 0 to 150 kPa. (g) Combined piezocapacitive ($\Delta C/C_0$) and piezoresistive ($\Delta R/R_0$) signals of the sensor under pressures of 50 kPa.

Presenter:

Tsogbayar Dashdendev

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Assessment of Pseudo-Random Number Generator Influence on Dosimetric Parameters for Linac Head Simulation in GATE/GEANT4

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Monte Carlo simulations rely on pseudo-random number generators, whose quality can directly influence the accuracy of the results. The GATE platform, widely used in radiotherapy, offers three such generators: Mersenne Twister, Ranlux-64, and James-Random. In this study, we investigated their potential impact by modeling a medical linear accelerator head for 6 MV photons. Simulations were performed for four field sizes using a detailed linear accelerator head model and a voxelized water phantom placed 100 cm from the electron source. Dose distributions obtained with each generator were compared using statistical analyses, including normal probability and Bland-Altman plots. Reference experimental data (dose profiles, percentage depth dose, and other dosimetric parameters) were acquired following a quality assurance protocol for validation. The results revealed notable differences in dosimetric parameters, particularly in the physical penumbra of large fields, with gamma index analysis confirming significant discrepancies between the generators. Performance indicators also varied, with differences in particle generation rates, number of tracks, and computational steps. Among the options tested, the Mersenne Twister generator demonstrated superior performance, offering faster execution, higher particle and trace throughput, and better agreement with experimental measurements. Computationally, simulations with Mersenne Twister were approximately 18% faster than those with James-Random and 27% faster than those with Ranlux-64, making it the most reliable choice for accurate and efficient modeling of 6 MV medical linear accelerator heads.

Presenter:

Meriem Tantaoui

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Theoretical Perspective to the Juggling Sequence Rotation Performance Pattern from System Memory Locality Reference Viewpoint

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²Department of Mathematics, Niger Delta University, Nigeria

Any software/algorithm meant to run on computer systems is desirable to be optimal and efficient, in terms of system resource usage – whether embedded systems that demand minimal memory usage, real-time systems that must meet deadlines or any other computer system without special restrictions. However, some software/algorithms executions fail to exhibit these properties – wholly or partially. Meanwhile, these attributes can be requirements in some systems. Juggling sequence rotation is one of such algorithms that fail to show efficiency. Its average performance is poor within offsets chosen from around the *square root* of the sequence size. Yet, it is optimal in element assignments and performs well with offsets selected from within the first few cycle gaps and some around the middle of the sequence size. This inconsistency has attracted some research attention to unveil the cause of the pattern in order to advance performance of the algorithm and related cache behavior. The attempt has identified hidden *properties* of the algorithm, *by definitions and formulating equations and laying experimental framework* for improving performance of the algorithm. This research is poised to advance the ongoing study to include *validating some of the property concepts, represented in definitions and equations, of the algorithm*. Formal proof methods were adopted for the validation. The results are formulation of 2 lemmas and 5 theorems with proofs. The most important proof is *seqrotcircum* (“*SE*quence *RO*Tation *CIR*CUMference”), defined in a previous study. The *seqrotcircum* concept along with base cycle gap, core in the ongoing study, is key to redesigning the juggling rotation algorithm and to catch up with cache memory behaviour. The results of this study will not only be useful to many computing systems, including embedded and real-time systems, but also for future studies.

Presenter:

Joseph Agarohenefuoma ERHO

Niger Delta University, Nigeria

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