

ABSTRACT BOOK



2nd International Conference & Expo on

Materials Science and Engineering

April 20–22, 2026 | Osaka, Japan



MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Welcome Message:

Dear Colleagues,

We are delighted to invite you to be part of the **2nd International Connect & Expo on Materials Science and Engineering**, taking place from **April 20–22, 2026**, in **Osaka, Japan**.

This prestigious global event will bring together leading scientists, researchers, academicians, industry professionals, and innovators from around the world to foster collaboration and meaningful discussions on the latest advancements in materials science and engineering. The conference will provide a comprehensive platform to explore emerging trends, groundbreaking research, and transformative applications shaping the future of the field.

The event will cover diverse aspects of materials science, including advanced materials, nanotechnology, biomaterials, polymers, energy materials, sustainable materials, and innovative engineering applications. It offers an exceptional opportunity for participants to present their research, exchange ideas, and gain valuable insights into cutting-edge developments. Attendees will benefit from inspiring keynote presentations, interactive panel discussions, technical sessions, poster presentations, and an engaging exhibition showcasing the latest scientific and technological innovations. The conference will also provide outstanding networking opportunities to connect with global experts, establish collaborations, and expand professional horizons.

Beyond scientific exchange, this conference is a platform for building lasting partnerships, inspiring innovation, and collectively shaping the future of materials science and engineering. It is a gathering of passionate minds committed to driving progress and creating impactful solutions for global challenges.

Join us in Osaka, Japan, for an enriching and memorable experience at the **2nd International Connect & Expo on Materials Science and Engineering**. Let us connect, collaborate, and innovate together for a brighter scientific future.

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PLENARY ABSTRACTS



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Cornelia G. Palivan

University of Basel, Switzerland

Clusters of Nanocompartments Mimicking Natural Organelles for Medical Applications

Abstract:

Compartmentalization is fundamental in nature, where the spatial segregation of biochemical reactions within and between cells ensures optimal conditions for the regulation of cascade reactions. One of the most promising strategies to mimic nature compartmentalization is to combine synthetic nano/micro-compartments with biomolecules in order to develop artificial organelles and to generate a more complex architecture and functionality, as protocells. Here, we present a strategy to program the organization of nanocompartments into clusters that support cascade reactions or theragnostic applications. First, we generate individual catalytic nanocompartments (CNCs) by encapsulating within polymersomes specific enzymes and equipping them with biopores for molecular transport through their membrane. Then, we zip the CNCs together into clusters by using DNA hybridization between single DNA strands and complementary DNA strands exposed on different CNCs. DNA hybridization controls the distance between the respective CNCs such to support efficient cascade reactions between them: the product of the reaction inside the first CNC is released and serves as substrate for the second reaction inside the nearby CNC. Multicompartments allow precise localization and sequential reactions mimicking communications between natural organelles with high potential for medical applications.

Biography:

Cornelia G. Palivan, Prof. Dr. Prof. Dr. Cornelia Palivan is currently Professor of Physical Chemistry in the Chemistry Department at the University of Basel, Switzerland. She is member of the Swiss Nanoscience Institute and the management of the National Center of Competence in Research (NCCR) Molecular Systems Engineering Switzerland. Her research team develops functional bio-artificial systems that interface biomolecules with supramolecular synthetic assemblies for complex reactions and communication at the nanoscale (artificial organelles, protocells, smart surfaces, antimicrobial systems). Such bio-artificial systems support applications in domains such medicine, catalysis, food- or environmental-sciences (more than 220 publications). She received during her career several fellowships and awards.

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Igor Reshetov

Sechenov University, Russia

Modulation Phototherapy for Cancer by Metallbased Medication

Abstract:

Introduction. Number of cancer cases with non typical behavior are growing.

Popular surgical, chemo- and radio therapy of the cancer limited by individual biology of tumor. Because to investigate in new approach in anti-cancer treatment actually.

Our team performed research in modification PDT by synchronic chemotherapy based on metal Pt. Theory is in synergy destroying tumor's cells from other sides.

Material and methods. Clinical protocol included 2 groups pts. oral cancer. they are divided by p16+ and p16- types. Last cohort input in perioperative treatment chemotherapy DPF scheme and PDT chlorin-e6 in 640 nm wave. PDT addressed in primary tumor site in oral cavity in 200 Dg energy. Time of procedure performed till online-control utilization of medication in the tumor.

Results. In both group to met objective answer tumors . in scale of pathomorphology high level destroy of tumor's cells were in 1 and 2 group the same.

Conversation. p16+ oral cancer have more best prognosis then p16-. It's directly connected with answer of the tumor on to treatment. p16- oral cancer traditionally to show low level of the answer. Because to input in scheme of treatment new factors to make better results.

Summary. Combine synchronic treatment oral cancer by chemo- and PDT showed more effectiveness then separately.

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Biography:

Prof. Igor V. Reshetov is a renowned Russian surgeon and academic specializing in plastic and reconstructive microsurgery in oncology. He currently serves as the Director of the Institute for Cluster Oncology named after Prof. L.L. Levshin and Head of the Department of Plastic Surgery at I.M. Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia. He began his career at the Herzen Moscow Oncology Research Institute, where he advanced from researcher to deputy director and head of the microsurgery department. Prof. Reshetov earned his Ph.D. in 1992, Doctor of Medicine degree in 1998, and became a full professor in 2002. A full member of the Russian Academy of Sciences since 2016, he has authored over 500 scientific publications and holds 65 patents. His recent research focuses on plastic and reconstructive microsurgery in oncology, tissue and organ prototyping, and combined oncological treatments.

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Sanboh Lee

National Tsing Hua, Taiwa

Surface Properties and Solvent Transport in Ion-Irradiated Polydimethylsiloxane

Abstract:

Polydimethylsiloxane (PDMS) is widely employed in microfluidics, biomedical engineering, and flexible electronics, yet its intrinsic hydrophobicity limits applications requiring controlled solvent transport. In this study, we systematically investigated the effects of ion irradiation on PDMS surface properties and their influence on solvent diffusion dynamics. Ion treatment induced a transition from hydrophobic to hydrophilic behavior, with surface energy, roughness, and wettability increasing linearly with ion dose. These modifications, however, were metastable and gradually reverted during aging, strongly dependent on environmental exposure to air, vacuum, or water.

To probe transport phenomena, diffusion of nonpolar toluene and polar butanone was measured in untreated PDMS, ion irradiated PDMS, and PDMS aged in air. Untreated PDMS favored nonpolar solvents, exhibiting higher diffusion coefficients and swelling ratios due to smaller Hansen solubility parameter distances. Conversely, ion irradiation enhanced surface polarity, leading to increased diffusion coefficients and reduced activation energy for polar butanone, while suppressing toluene transport and raising its activation energy. A linear correlation was observed between activation energy and surface energy across all irradiation and aging conditions, highlighting the role of surface energetics in governing diffusion kinetics. Importantly, swelling ratios and mixing enthalpy remained unchanged, indicating that ion irradiation introduced a chemical energy barrier affecting surface diffusion without altering bulk thermodynamics.

These findings establish a mechanistic framework for tailoring PDMS surface characteristics through ion irradiation, enabling precise modulation of solvent transport while preserving bulk material integrity. The insights gained provide a foundation for optimizing PDMS in next generation applications spanning lab on chip devices, implantable biomedical systems, and advanced soft materials.

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Biography:

Professor Sanboh Lee received his Ph.D. in Materials Science from the University of Rochester, Rochester, New York, in 1980. He has served as Emeritus Professor in the Department of Materials Science and Engineering at National Tsing Hua University since 2018. Professor Lee's professional career began at the Webster Research Center of Xerox Corporation. He subsequently held visiting professorships at Lehigh University (1987–1988) and at the National Institute of Standards and Technology (from 1996 onward). Over the course of his academic and research career, he has authored or coauthored more than 280 technical publications, contributing extensively to the advancement of materials science and engineering. His scholarly achievements have been recognized through numerous honors and awards, including the Outstanding Research Award, National Science Council, Taiwan; Roon Foundation Award (1998), Federation of Societies for Coatings Technology; Tsing Hua Chair Professor of Engineering (2003–2006); Tsing Hua Chair Professor (2006–2018); Fellow of ASM International (2004); Committee Member, Honors & Professional Recognition (H&PR), The Minerals, Metals & Materials Society (2018); Lifetime Achievement Award (2022), VDGGOOD® Professional Association, India. Professor Lee's distinguished career reflects a sustained commitment to research excellence, academic leadership, and professional service. His contributions have earned him international recognition as a leading figure in materials science and engineering.

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Takashi Matsuoka

Tohoku University, Japan

The World of Nitride Semiconductors from the Dawn to the Future

Abstract

Since blue light-emitting diodes (LEDs) based on nitride semiconductors InGaAlN became commercially available in 1993, nitride semiconductors have enabled a wide range of applications, including white LEDs for solid-state lighting and power amplifiers for cellular base stations. Nitride semiconductors exhibit unique characteristics such as high electron-mobility, high breakdown-voltage, high-temperature operation, and tunable emission and absorption wavelengths ranging from the ultraviolet to the infrared through compositional control. These properties allow nitride semiconductors to overcome the limitations of conventional semiconductor devices, including the maximum operating temperature of approximately 150 °C for silicon devices, the breakdown voltage and switching speed limitations of other wide band-gap semiconductors, and the restricted wavelength range of conventional compound semiconductors. Consequently, nitride semiconductors offer device performance and functionality beyond those of traditional semiconductor materials.

Although wide-bandgap semiconductors such as diamond and SiC surpass nitride semiconductors in some physical properties, they face significant challenges in crystal growth compared with nitride materials. Among the distinctive features of nitride semiconductors, this paper focuses on crystallographic polarity, which is not found in other semiconductor systems. Nitride semiconductors exhibit “spontaneous polarization” originating from their wurtzite crystal structure. Furthermore, when strain is present in heterostructures with different lattice constants, such as AlGa_N/Ga_N, “piezoelectric polarization” is induced. These polarization effects play a crucial role in the formation of a two-dimensional electron gas (2DEG) in high-electron-mobility transistors (HEMTs) and in the efficient extraction of photocarriers in solar cells. Conversely, polarization effects can degrade the performance of LEDs.

For crystal growth, nitrogen polarity enhances the incorporation of nitrogen atoms into the lattice, leading to indium-rich InGaAlN alloys, because InN has the highest equilibrium vapor pressure among the three binary compounds AlN, GaN, and InN. In this presentation, epitaxial growth techniques and device applications of nitride semiconductors are discussed in detail.

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Biography:

Takashi Matsuoka started his career at NTT in 1978. He moved to Institute for Materials Research, Tohoku University as a Professor in February 2005. He has been an Emeritus Professor, and a Specially Appointed Professor, New Industry Creation Hatchery Center since April 2019. His research covers optoelectronic materials and devices. It is worthy of special mention that in 1981 he succeeded in the first CW operation of InGaAsP DFB lasers used worldwide for optical communications systems. He also proposed the InGaAlN system in 1986 and successfully grew InGaN for blue light in 1988. Based on his results, blue LEDs have become commercially available. In 2002, he corrected the band-gap energy of InN from 2 eV to 0.8 eV. This result has expanded the application of nitride semiconductors from infrared to ultraviolet. He also noted the crystalline polarity and developed N-polar HEMT for 5G.

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Tomas Zalabsky

University of Pardubice, 532 10 Pardubice, Czech Republic

Advanced Material Innovations for Electromagnetic Shielding and Radar Signature Reduction of Drones and UAVs

Abstract:

The rapid proliferation of unmanned aerial vehicles (UAVs) in civil, industrial, and defense sectors has intensified the demand for enhanced electromagnetic robustness and reduced radar observability. Although miniature UAVs generally exhibit a low radar cross section (RCS), the increasing density of C/X-band radar systems and advanced signal-processing methods calls for novel, lightweight composites with strong and tunable dielectric losses.

This work presents an experimental and simulation study of polymer- and carbon-based radar-absorbing composites, namely nanotubular polypyrrole and nanostructured carbons as conductive fillers. The composites were characterized over the frequency range from 2.6 to 18 GHz using waveguide measurements, from which the complex permittivity was extracted via the Nicolson–Ross–Weir method. The shielding effectiveness (SE) and its absorptive components were determined and implemented into validated, frequency-dispersive material models in CST Studio Suite.

3D electromagnetic simulations were conducted on canonical geometries and simplified UAV structures to assess the influence of layer thickness, stacking, and filler concentration on RCS reduction. The study establishes a direct link between laboratory characterization and physically consistent simulations, providing validated models of conducting-polymer and carbon composites for the rapid design and optimization of lightweight radar-absorbing layers for aerospace applications.

Keywords:

Electromagnetic Shielding; Radar Cross Section (RCS) Reduction; Polypyrrole-Based Composites; Unmanned Aerial Vehicles (UAVs)

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Biography:

Dr. Tomáš Zálabský is Vice Dean for Science and Head of the Research Centre at the Faculty of Electrical Engineering and Informatics, University of Pardubice, Czech Republic. His research bridges advanced electromagnetic sensing with materials science, focusing on radar-based evaluation of functional materials for electromagnetic shielding. He has extensive expertise in the design of antenna systems and high-frequency components for radar and detection systems, and in the development of measurement techniques for electromagnetic shielding effectiveness and radar cross section. A significant part of his current research involves the characterization of materials with enhanced electromagnetic attenuation properties, including nanocomposite materials. Dr. Zálabský is actively involved in international and national collaborative projects. He is a key academic partner in Horizon Europe projects focused on hybrid testbeds for high-integrity EGNSS-based systems, and in the CIDET Project, which fosters cross-sectoral innovation in detection and electromagnetic technologies. He has led or co-led several research and development initiatives in cooperation with industrial partners such as ELDIS Pardubice and RETIA, targeting real-world applications of radar and material diagnostics. He regularly publishes in peer-reviewed journals, serves on international conference committees, and is a member of the IEEE Czechoslovakia Section. His work contributes to the deeper integration of materials research with electromagnetic diagnostics and applied sensing technologies.

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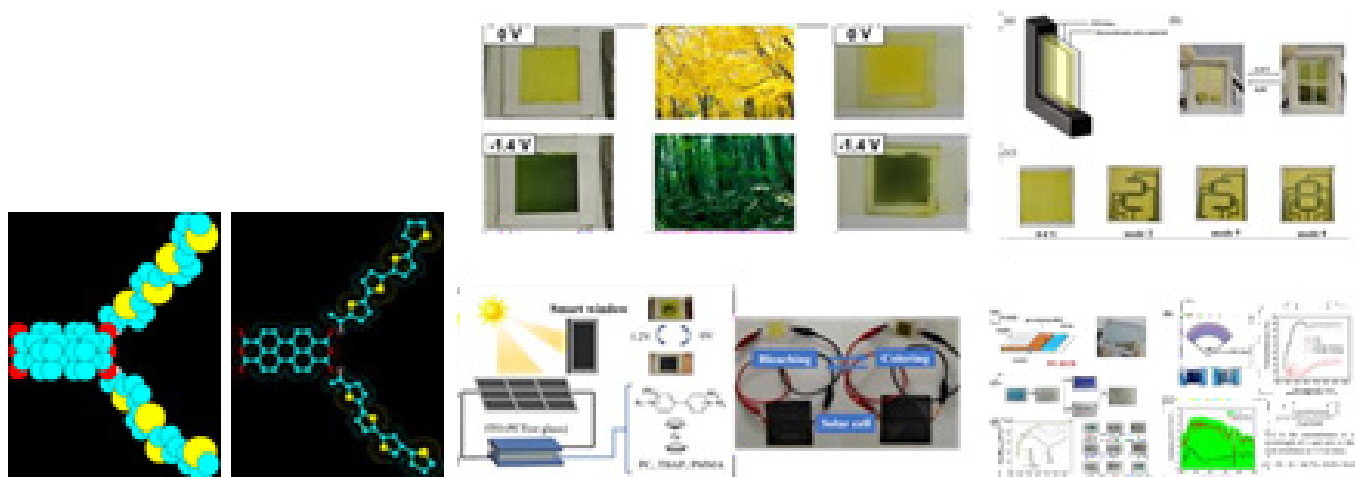
Liu Ping

South China University of Technology, China

Flexible Organic Electrochromic Devices Having Multicolored, Low Voltage-Driven and High Contrast, and Organic Photovoltaic Properties Based on Oligomers and Viologen Derivatives

Abstract:

A series of organic conjugated oligomers and viologen derivatives are synthesized, their photovoltaic (OPV), electrochromic (OEC) properties and corresponding flexible electrochromic devices (FOECD) were investigated.. The research results of OPV showed that the hydrogen bond interaction between electron donor and electron acceptor, and photovoltaic materials with liquid crystal and crystal properties, can improve the photoelectric conversion efficiency (PCE) of organic photovoltaic devices. The research results of OEC showed that these oligomers and viologen derivatives exhibit reversible color changes upon electrochemical doping and dedoping. The FOECD has high optical contrast is 75.2% at 700 nm. Furthermore, FOECD driven by solar cells demonstrated good stability.



Keywords:

Oligomer; viologen derivatives; Liquid crystal; crystal; vacuum-evaporated thin film; molecular orientation; organic photovoltaic device; organic photovoltaic performance; flexible electrochromic device; electrochromic performance; optical contrast.

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Biography:

Ping Liu is a professor in the School of Materials Science and Engineering and the Institute of Materials Science in South China University of Technology (SCUT). He received his B.S. and M.S. degrees from Sun Yat-sen University in 1986 and 1991, respectively, and his Ph.D. degree in Materials chemistry from Osaka University in Japan in 2000. He joined the Institute of Materials Science, South China University of Technology (SCUT) in 1991, and became a full professor in 2005. His research focuses on organic/polymer functional materials, including: organic/polymer optoelectronic materials and devices, organic/polymer flame retardants and flame retardant material, adhesives for automotive, pressure sensitive adhesives for power batteries, etc.



KEYNOTE ABSTRACTS



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April 20–22, 2026 | Osaka, Japan

Akira SAITO

The Univ. of Osaka, Japan

Optical Devices for Reflection and/or Transmission Inspired by the Morpho-Butterfly's Coloration

Abstract:

Although the Morpho butterfly's brilliant blue relies on optical interference, it exhibits an extraordinary blue that remains consistent across a broad angular range. This phenomenon can be attributed to complex 3D nanostructures on their wing; specifically, inherent structural nano-disorder eliminates the typical "rainbow effect," while the narrowness of these structures ensures a wide diffraction of light. This principle serves to realize brilliant color materials that are free from fading for long time, environmental-friendly, and single color for wide angular range with high reflectivity. Furthermore, by applying this principle of reflection to transmission, we have recently developed a new daylight window satisfying high transmittance, wide angular spread, and low color dispersion at the same time, which have long been a hard challenge. Moreover, this Morpho-type transmission device has ability to control the shape of the transmitted light, and advantage of the anti-fouling properties based on the "lotus-effect" on surface. Although it was difficult to find a processing method to produce the Disorder with a nanoscale width and high aspect ratio in a large area, by utilizing the concept of metasurface to expand 3D-disorder into 2D, we have made it possible to easily fabricate the Morpho-type diffuser. This result leads to realizing not only the Morpho-type daylight window, but also general nanostructure-based devices, i.e. "optical diffusers" to make a uniformly distributed light in different applications, such as LEDs, projectors, and illumination.

Biography:

Akira Saito is an Associate Professor at Osaka University. He studied surface physics at the Univ. of Tokyo using Synchrotron Radiation (SR) and received Ph.D. in 1994. He worked at the European Synchrotron Radiation Facility (Grenoble, France) with French Government Scholarship and at KEK (Japan) to study surface structures with atomic resolution using X-rays. His research interests span the interaction of photons with the surface nanostructures, including the analysis and control of the nanostructures on surface of materials, elemental analysis, SPM, SR. □ One of the recent developed fields is the bio-mimetic applications of the optical nanostructures. Also, he is a member of the ISO TC266, committee for biomimetics (representative of the Japanese committee for WG1.)

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Sanja Ercegović Ražić

University of Zagreb, Croatia

Plasma as an Environmentally Friendly Technique for Modifying the Surface Properties of Polymer Materials

Abstract:

The paper presents mechanisms of low-pressure interaction with material surfaces, focusing on the nature of gases and pretreatment processes that modify materials through cleaning, activation, and functionalization of surfaces without damaging their bulk properties. Argon, a naturally occurring, non-toxic gas, is environmentally friendly and safe for use in plasma cleaning, as it does not introduce harmful by-products into the process. Due to its properties, argon gas generates a so-called “physical plasma”, which interacts with the target solely through physical interactions. In contrast, oxygen plasma interacts with the material's surface, breaking C–C and C–H bonds and effectively decomposing organic contaminants into CO₂, H₂O, and hydrocarbons. After contaminant removal, species in the oxygen plasma react with the free radicals created on the surface, leading to the grafting of oxygen-containing functionalities such as carbonyl (C=O), carboxyl (–COOH), and hydroxyl (–OH) groups onto the surface. As a result, the surface becomes polar and hydrophilic [1]. The phenomenon of plasma action on the textile substrate is manifested by a change in its surface, enabling the achievement and improvement of properties such as hydrophilicity and surface roughness, which enhance the durability of coloring and printing, confer antimicrobial properties to the treated materials, and enable the formation of a stable polyester/chitosan structure that reduces the release of fiber particles during washing without affecting mechanical and functional properties [2, 3]. The presented results were obtained through research conducted on extruded chemically recycled polymers and textile materials made of man-made, cellulose, and wool fibers. The results demonstrate that plasma pretreatment improves hydrophilicity, roughness, and inkjet printing on cotton-based materials, increases color strength and fastness of wool-based materials, and enhances the antimicrobial efficacy of textile polymers [4].

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Biography:

Sanja Ercegović Ražić, PhD, is a full professor, researcher and manager with 25 years of experience in teaching polymer fiber modification, plasma technology, sustainable development, environmental management and quality testing at the University of Zagreb Faculty of Textile Technology (Croatia). She has participated in about 20 scientific and professional projects, published more than 100 scientific and professional papers in journals and proceedings, and supervised over 30 student theses. She founded the Laboratory for Plasma Treatment in 2008. She was elected Vice Dean for Business Management for the period 2020 – 2023 and has been a member of numerous scientific and professional associations, working groups and advisory boards. From 2024, she is President of the doctoral study in Textile Science and Technology.

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Uchida Keitaro

Software Engineer, Japan

Abstract on Introduction to Hyper-Exponential Functions

Abstract:

Purpose: To Promote awareness and use of hyper-exponential functions worldwide. To clarify the definition, characteristics, and applications of hyper-exponential functions (exph), to highlight its essence and significance, and to construct a new frame to solve differential equations.

Methods:

Hyper-exponential functions are defined as a family of special functions whose n -th derivatives equal a specific function times the original function itself. They are constructed through repeated integration and infinite series expansion. The Weierstrass M-test is used to determine convergence. Furthermore, it is shown that second-order hyper-exponential functions are inherent in second-order linear homogeneous equations with variable coefficients.

Results:

Hyper-exponential functions generalize the exponential function e^x and yield multiple linearly independent special functions for each order greater than two. Uniform convergence in a generalized sense is proved. In the second-order case, any second-order linear homogeneous equations have two independent solutions. Furthermore, second-order hyper-exponential functions are harmonic functions in the complex domain. Applications include the wave equation and the Schrödinger equation.

Conclusion:

Hyper-exponential functions form a new family of special functions for solving ordinary and partial differential equations, with applications in mathematics and physics. In higher-order cases, hyper-exponential functions are not tied to Napier's constant e , offering new possibilities and broader significance.

Biography:

Uchida Keitaroh, aged 71, graduated from the Tokyo University of Science and later completed the Master's Program at the School of Graduate Studies, The Open University of Japan. He had been working at a software house as a software engineer for 30 years since 1981. He is an active member of the Mathematical Society of Japan, contributing to the field through his academic interests and professional engagements.



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Victor Posligua

National University of Singapore, Singapore

AI-guided design of functional materials: From thermoelectrics to data-driven spectroscopy

Abstract:

Machine learning (ML) and data-driven workflows are becoming central tools in materials research, but turning them into reliable guidance for experiments remains a practical challenge. In this keynote, I will discuss how combining electronic-structure methods, interpretable descriptors and modern ML models can accelerate the discovery and understanding of complex functional materials.

I will first show how descriptor-based and deep learning approaches can be used to screen and optimise thermoelectric materials, with a focus on skutterudites and related compounds, linking model predictions back to bonding, phonon transport and entropy. I will then highlight how similar ideas can be extended beyond standard property prediction, for example to model fragmentation patterns in mass spectrometry and to analyse structure-property relations in complex solids.

Throughout the talk, I will emphasise practical aspects: how to build robust datasets, incorporate DFT-derived quantities into ML models, quantify uncertainty and extract chemically meaningful insight rather than purely black-box predictions. The aim is to outline workflows that are broadly applicable across materials classes and to discuss where AI methods already provide reliable value and where significant gaps remain.

Biography:

Victor Posligua, Senior Research Fellow – National University of Singapore (NUS)

Dr Victor Posligua is a Senior Research Fellow at the Institute for Functional Intelligent Materials (I-FIM) at NUS. He obtained his PhD in Chemistry from the University of Reading (UK) and subsequently held postdoctoral positions at Imperial College London (UK) and University of Seville (Spain), working on first-principles modelling of functional and energy materials. His current research focuses on combining electronic-structure theory, high-throughput workflows and machine learning to design and understand advanced materials, with an emphasis on thermo electrics and other complex solids. He also leads collaboration with DSO National Laboratories (Singapore) on data-driven approaches for interpreting mass-spectrometric fragmentation, developing physically grounded AI tools that can guide experiments



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Albin Kälin

CEO, epeaswitzerland gmbh, Switzerland

Cradle to Cradle Design Innovations

Abstract:

Cradle to Cradle® Design implies a paradigm shift in industrial production. The design and innovation process move from the present linear thinking towards thinking in closed cycles. Materials and processes are chosen and used in a way that the resulting products become “nutrient” at the end of their life. The materials are either reintegrated into biological cycles or remain in technical cycles. Cradle to Cradle® Design does not allow waste and strives to keep resources in endless cycles.

Sample products and projects will demonstrate the concrete application and results of the design process. Design for disassembly and avoidance of problematic substances allows for a new level of quality and safety during production and use and opens new opportunities for material reuse. This can be combined with system and business models that leave the ownership with the producer. This guarantees take back and maximal reuse of resources. The radical rethinking of design and production can go even beyond towards regenerative design.

Production processes are designed according to the model of nature. No waste, no surrender, no restrictions. The right materials at the right place at the right time, in endless cycles is the key. Case studies will cover:

- Innovations drive change, e.g biodegradable polymers, flexible packaging
- Changes from passive to active business approach
- Business management systems + certification integration
- Dissemination, scaling up - Creating demand, the pull effect - Redesign from downcycling to upcycling
- Circular Accounting by epeaswitzerland™
- EU Taxonomy, Digital Product Passport Compass Cradle to Cradle™

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As a partner of industry in the role as knowledge and innovation trustee, epeaswitzerland has been able to implement and celebrate numerous breakthroughs of concrete innovations with industry in recent years: solutions to global problems of "microfibers", "bottles in the ocean", "toxic and non-recyclable packaging" have been created, such as biodegradable elastomers and polymers, reactive dyes or printing inks for packaging. These have been applied in areas such as flexible packaging, beverage bottles, parquet floors, luxury products, mattresses, workwear and outdoor textiles.

References:

THE EUROPEAN Climate Change: "A book for the businesses of tomorrow" From Rebel to Radical Innovator; Leading the Transformation through Ciruclarity" Albin Kaelin.

Biography:

Albin Kaelin, CEO epeaswitzerland gmbh, Author Albin Kaelin is the founder, owner and CEO of epeaswitzerland gmbh since its foundation in 2009 and has driven the development and implementation of the Cradle to Cradle® design concept in various areas of the company. As early as 1993, he initiated the development of the Climatex® product line, which produced the world's first Cradle to Cradle® products. wards: Honored with over 30 awards since 2022, including IE 100 Award- 2024 Albin Kaelin - Most Innovative CEO of The Year testify to his leadership and innovative spirit.



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Saida Benhmida

Tunis El Manar University, Tunisia

Mechanical Compatibility of Polymeric Orthopedic Implant Materials: A Comparative Analysis Based on Young's Modulus, Stress–Strain Response, and Energy Absorption

Abstract:

Mechanical compatibility between orthopedic implant materials and native articular cartilage plays a crucial role in ensuring physiological load transfer and long-term implant stability.

Excessive stiffness mismatch may alter stress distribution, reduce deformation capacity, and affect energy absorption mechanisms at the joint interface.

In this study, experimentally determined mechanical properties of human articular cartilage—including Young's modulus, stress–strain behavior, and strain energy density under compression—were used as a physiological reference to evaluate commonly used polymeric biomaterials for orthopedic implants. A comparative mechanical analysis was conducted using literature-reported properties of polyethylene-based and high-performance polymer materials.

The results reveal substantial differences in elastic modulus and deformation capacity between cartilage (MPa range) and implant polymers (hundreds of MPa to GPa range). This stiffness mismatch leads to reduced strain accommodation and significant variations in stored mechanical energy under equivalent loading conditions. The limited capacity of stiff implant materials to mimic cartilage's natural shock-absorbing properties is further highlighted by an energy-based comparison.

In order to improve material selection for next-generation orthopedic implants, this work suggests a mechanical compatibility assessment framework based on stiffness, stress distribution, strain capacity, and energy absorption metrics.

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Biography:

Saida Benhmida is a researcher specializing in biomechanics. She obtained her Ph.D. in Biophysics, Medical Physics and Medical Imaging from Tunis EL Manar University in 2021. She worked as a post doc researcher at the Laboratory of Biophysics and Medical Technologies at the Higher Institute of Medical Technologies in Tunis. Where she worked on the numerical modeling of the viscoelastic behavior of human trabecular bone. Her work focuses mainly on multiphysics simulation, the rheology of biological fluids, and the mechanical analysis of musculoskeletal tissues. She has published several articles in indexed scientific journals, presented her work at international conferences, and supervises master's students. His research interests include tissue viscoelasticity, advanced numerical simulation (Python, Abaqus, and SolidWorks), biomaterial mechanics, and the application of constitutive models to osteoarticular pathologies.

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Hubert Kolcz

CEO of WaverQ, Poland

Modeling Computational Fluid Dynamics with Quantum Physics Informed Neural Networks" of "Computational Modelling and Simulation in Material Science

Background and Motivation:

Computational fluid dynamics in reactor subcomponents, coupled to neutronic and thermal-hydraulic state evolution, defines a high-dimensional simulation space whose Wilks-based statistical characterization requires 200 trajectories at 97/94 two-sided third-order tolerance — roughly 3,300 CPU-minutes for an ATHLET LBLOCA campaign and substantially more when full CFD is included. Physics-informed neural networks (PINN) and their quantum extensions (QPINN) are proposed as accelerators, but the deployment-relevant validation evidence has not yet been established.

Methods:

We organize PINN-based surrogates around a master-controller architecture in which the surrogate generates a forward trajectory bundle and a configured out-of-distribution (OOD) score governs whether the controller acts directly or invokes the high-fidelity solver as fallback. The validation foundation comprises six surrogate architectures (M0–M6) evaluated on PARCS reactivity-insertion transients, three ATHLET load-following transients with held-out pump-trip generalization, and Zircaloy-4 cladding-degradation trajectories. The CFD/QPINN component is the third roadmap phase: five Quasar geometries with fully specified boundary conditions are prepared for flow solution, with QPINN circuit design following recent Maxwell-equation results in the literature. Comparisons enforce six parity conditions covering scenarios, identical observables, total compute, held-out test sets, prediction intervals, and 500-scenario population statistics.

Results:

Internal Case A power MAPE (0.0129%) is worse than persistence baseline (0.0042%); external Case B MAPE reaches 0.341%, with conformal coverage collapsing from 0.907 to 0.0869. Cross-code transfer yields 461.7% MAPE. The 500-scenario benchmark shows 33.2% global pass rate, rising to 75.1% under the configured $\text{OOD} \leq 0.4$ gate, with 83% of failures concentrated above that threshold.

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Conclusions:

Distribution shift, not architecture, is the central limiting factor. OOD-aware deployment with high-fidelity fallback is mandatory. Hundred-fold acceleration is an engineering projection conditional on validation gates, not yet a measured benchmark result. The QPINN-based CFD trajectory generator is a research target; the present contribution is the validation framework that determines when such a generator can be trusted in coupled reactor analyses. A parity comparison against DeepXDE and NVIDIA Modulus is planned.

Keywords:

quantum physics-informed neural networks; CFD; reactor surrogates; BEPU; Wilks order statistics; conformal prediction; out-of-distribution detection; nuclear digital twin

Biography:

Hubert Kołcz, M.Sc. Eng., is an experienced technical leader, computer scientist, and quantum researcher with over 16 years of industry experience, including 8 years in professional roles. He has a proven track record of earning more than 20 competitive accolades in IT competitions and is currently specializing in Quantum Artificial Intelligence applications in the Physical Sciences. Drawing on expertise gained while working at Intel and Cisco, as well as through scientific internships at KAIST and TU Delft, Hubert Kołcz, M.Sc., successfully provides technology consulting and mentoring services to a diverse clientele, ranging from established companies to startups.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Gary J. Dickelman

EPSScentral LLC, USA

Reversing the Paradigm: Intensifying Advanced Materials Science Domain Expertise in the Age of Generative AI

Background and Motivation:

Integrating generative AI into advanced materials science is reshaping experimental discovery toward probabilistic, computational materials design. Systems such as AI-generated crystal structure prediction, graph neural network property estimation, and autonomous laboratories are rapidly expanding the scale of materials exploration. Paradoxically, these successes have produced what this paper terms a Competence Halo: the systematic assumption that AI advances reduce rather than intensify the importance of domain expertise.

Drawing on the cognitive offloading fallacy and a three-zone performance taxonomy, the paper argues that the human competencies most at risk of institutional neglect are precisely those required to evaluate, interrogate, and correct AI-generated predictions—especially at regime boundaries where physical models fail or change validity. The Hall–Petch grain boundary relationship and its inverse nanoscale breakdown provide a concrete demonstration of this problem: AI systems can correctly apply the model while failing to recognize the conditions under which it ceases to describe physical reality.

The analysis then examines five emerging institutional practices—uncertainty quantification, symbolic–subsymbolic hybrid architectures, provenance tracking, red-teaming protocols, and modular sandboxed deployment—as evidence that research organizations are already encoding safeguards for precisely the competencies that the cognitive offloading fallacy treats as obsolete. Extending the framework to workforce dynamics, the paper shows how the task-equivalence assumption is producing a shortage of hybrid practitioners capable of operating at the AI materials interface.

The paper concludes with governance and educational design principles for the advanced materials science community, arguing that effective integration of generative AI requires intensifying, rather than diminishing, domain expertise in the evaluation of AI-mediated scientific work.

MATERIALS SCIENCE AND ENGINEERING

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Biography:

Gary J. Dickelman is a thought leader, researcher, strategist, and solution provider for the knowledge ecosystem: technology-based learning, performance support, predictive analytics, knowledge management, and artificial intelligence. He has developed global knowledge solutions while directing cross-functional teams in the learning and knowledge spaces. Solutions include global eLearning, software simulations, predictive analytics, just-in-time reference, emergency management, business continuity, pandemic response, customer support, digital transformation, and AI integration. Dickelman has authored scores of peer-reviewed articles, contributed to industry books, publishes the p-literate.com blog, and has served as author/editor of industry journals. He has served as adjunct faculty for university graduate programs in the learning technologies and human performance engineering. Dickelman works across a plethora of industries, including nuclear power, career development, finance, insurance, publishing, travel, hospitality, education, sales/marketing, defence, security, performing arts, and historical preservation.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Dou Zhang

Harbin Institute of Technology, China

Mechanics of Shape Memory Polymer Composites and their Application in Aerospace

Abstract:

Shape memory polymer composites (SMPCs) are thermally activated materials capable of fixing a temporary shape and recovering their original configuration through temperature-induced modulus transition of the polymer matrix. In such systems, the thermomechanical stability of the reinforcing fibers plays a critical role in determining structural integrity, recovery efficiency, and long-term reliability. Among the possible instability modes, fiber microbuckling is particularly important because it is strongly coupled with matrix softening, thermal loading history, and stress redistribution during programming and recovery.

This study investigates the thermomechanical microbuckling behavior of fiber-reinforced SMPCs with emphasis on the role of temperature-dependent matrix properties and thermal activation. As the temperature approaches the glass transition region, the matrix undergoes a pronounced reduction in stiffness, which weakens lateral support to the fibers and increases susceptibility to local compressive instability. The initiation and evolution of fiber microbuckling are therefore governed by the competition between thermal softening of the matrix, elastic constraint of the fiber phase, and internal stress redistribution during thermomechanical cycling. Particular attention is given to how temperature affects the critical stability condition, local deformation morphology, and the resulting recovery response of the composite.

The results indicate that fiber microbuckling is not only a mechanical instability phenomenon but also a thermally controlled microstructural response closely related to matrix viscoelasticity and energy storage-release behavior. The study highlights the importance of thermomechanical design in suppressing local fiber instability and improving the structural reliability of SMPCs under thermal actuation. These findings provide useful insight for the design of high-performance smart composites in deployable structures and other thermally responsive engineering systems.



INVITED ABSTRACTS

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Ashok Rao

Manipal Institute of Technology, India

Study of Low Temperature Thermoelectric Performance of Samarium Doped Cu_2SnSe_3 System

Abstract:

Cu_2SnSe_3 system has garnered significant attention as a possible thermoelectric material due to the distinct electrical and thermal characteristics. We present the impact of samarium doping on the Cu_2SnSe_3 system's Sn site. Solid-state reaction followed by traditional sintering was used to make the polycrystalline $\text{Cu}_2\text{Sn}_{1-x}\text{Sm}_x\text{Se}_3$ ($0 \leq x \leq 0.08$) samples. XRD was used to characterise the crystal structure, and the results showed that the samples had a diamond cubic structure with a space group of $F4\bar{3}m$. Analysis using scanning electron microscopy shows that the sample's surface is uniform. The temperature range of 10-350K was used to study the electrical transport properties. All the samples' Seebeck coefficients were found to be positive within the investigated temperature range, indicating that holes make up most of the charge carriers. With increasing Sm concentration, the resistivity and Seebeck coefficient gradually decreased showing degenerate semi-conducting behaviour. The thermal conductivity also decreased with increasing doping concentration due to the induced point defect which enhances the phonon scattering in the Cu_2SnSe_3 system. Overall, a maximum ZT of 0.017 was achieved for $x = 0.08$ at 350 K.

Biography:

Dr. Ashok Rao is working as Professor in the Department of Physics at Manipal Institute of Technology, Manipal, Karnataka, India. He obtained MS and PhD in Physics from University of Delhi, India. His areas of interest include Condensed Matter Physics and Material science.

He has over 30 years of research and teaching experience. He has guided 12 students for PhD and has over 150 Scopus indexed journal papers with an h-index of 24.



MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Dhanya Sunil

Manipal Institute of Technology, India

Fluorene-Bithiophene Based Fluorophore for High-Resolution Latent Finger Print Detection

Abstract:

Latent fingerprints are invaluable forms of physical evidence in forensic science owing to their uniqueness, permanence, and ease of deposition. However, the effective visualization of these prints on various surface types, particularly on complex substrates, remains limited by current development techniques. In this study, we report the design and synthesis of a novel multifunctional fluorophore featuring a conjugated fluorene-bithiophene (BTAF) framework for latent finger print visualization. This π -extended molecule integrates the rigidity and photostability of fluorene with the electron-rich nature of bithiophene, yielding strong, red-shifted solid-state fluorescence with a high quantum yield. BTAF exhibited excellent capability in visualizing latent fingerprints on porous, semi-porous, non-porous, and complex surfaces. Optical and microscopic imaging further enabled both qualitative and quantitative analysis of fine print details. To elucidate the mechanism of interaction, the binding of BTAF with glycine and myristic acid which are the key constituents of fingerprint residue on glass substrates was investigated through computational modeling and molecular dynamics simulations and validated through ATR-FTIR spectroscopy. The facile synthesis, low toxicity, dual functionality, and stable performance of BTAF highlights its promise as a promising candidate for advanced forensic applications.

Biography:

Dhanya Sunil is a Professor in Department of Chemistry, Manipal Institute of Technology, Manipal India. Her research interests are in the field of functional materials, especially fluorescent materials for various applications. She has more than hundred journal publications and three patents in materials chemistry domain.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Ichiro Imae

Hiroshima University, Japan

Additive Engineering Strategies for Thermoelectric Performance Control in Carbon Nanotube Networks

Abstract:

Carbon nanotube (CNT) networks have attracted attention as lightweight, flexible thermoelectric materials; however, precise control of charge transport and thermopower remains challenging. In this presentation, we introduce an additive engineering strategy to tailor the thermoelectric properties of single-walled carbon nanotube (SWCNT) networks through interfacial modification and molecular doping. Two complementary routes are examined. Composite formation with a conductive polymer modulates inter-tube junctions and carrier transport pathways, while molecular charge-transfer doping directly controls carrier concentration and electronic structure. By comparing these approaches, we demonstrate how polymeric and molecular additives provide distinct yet complementary mechanisms for tuning electrical conductivity and the Seebeck coefficient. These findings highlight the importance of chemical and interfacial design in optimizing thermoelectric performance of carbon-based materials and offer a versatile framework for engineering flexible, scalable energy-harvesting systems.

Biography:

Ichiro Imae, Associate Professor.

He received his B.E., M.E., and Ph.D. degrees from Osaka University. His research centers on the design and synthesis of π -conjugated polymers and oligomers for sustainable materials aligned with the Sustainable Development Goals (SDGs). He investigates π -conjugated compounds with well-defined molecular structures, along with composite systems incorporating carbon-based materials such as carbon nanotubes and graphene, as well as silicon-based materials including silica. His work further encompasses environmentally friendly fabrication approaches for energy-related applications, including thermoelectric and photovoltaic energy conversion, energy storage systems, and display technologies. His research achievements have been recognized with awards including the CSJ Presentation Award and the Award for Encouragement of Research in Polymer Science, Japan.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Kamil Rusztyn

University of Warsaw, Poland

Polymeric Particles as a Platform for Localized Drug Delivery

Abstract:

With the rapid development of biomedical engineering, polymeric systems are gaining prominence as versatile platforms for localized and targeted delivery of therapeutics. In this work, we introduce a novel fabrication strategy that enables the controlled formation of polymeric particles through the melting of a thin film deposited on a solid substrate. The process involves spin-coating a flat surface with a polymer film, immersing the substrate in a polar solvent, and heating it above the polymer's melting point. This induces dewetting, leading to the formation of molten droplets that solidify into firmly attached particles upon cooling. The morphology and size of the particles depend strictly on processing parameters, enabling the tuning of material properties relevant for biomedical applications.

The obtained particles can serve as matrices for active agents, including anthracycline chemotherapeutics such as doxorubicin, which is widely used in the treatment of breast cancer. Local incorporation of doxorubicin within these polymeric carriers enables controlled release directly at the target site, potentially reducing systemic toxicity and minimizing adverse side effects often associated with conventional chemotherapy.

The structure and physicochemical properties of the materials were characterized using complementary analytical methods, including optical microscopy, scanning electron microscopy (SEM), and Raman spectroscopy. To assess their therapeutic potential, in vitro studies were performed using the triple-negative breast cancer cell line (MDA-MB-231), a clinically aggressive subtype associated with poor diagnosis and limited treatment options. Doxorubicin-loaded substrates significantly decreased cancer cell viability, demonstrating localized cytotoxicity.

This study aimed to combine clinical insights with material engineering, which offers a new perspective for designing multifunctional platforms for biomedical applications.



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Biography:

Kamil Rusztyn conducts interdisciplinary research at the Medical University of Warsaw and the University of Warsaw, focusing on the intersection of chemistry and medicine. His work focuses on polymer-based drug delivery systems designed to enhance therapeutic precision while minimizing side effects. He investigates polymeric carriers from the perspective of directly transporting anticancer and antimicrobial agents to target tissues. His long-term goal is to develop multifunctional drug delivery platforms that bridge laboratory research and clinical application. Combining insights from both medical and chemical sciences opens new possibilities for innovative treatments. Kamil Rusztyn is the author of peer-reviewed scientific papers and has presented his findings at several scientific conferences.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

N. Podrojškova

Pavol Jozef Šafárik University in Košice, Slovakia

Heavy p-Block Doping of Graphite in Vanadium RFBs

Abstract:

The large-scale deployment of renewable energy systems requires efficient and durable energy storage technologies. All-vanadium redox flow batteries (VRFBs) are well suited for grid-scale applications; however, their performance is limited by slow electrode kinetics and parasitic hydrogen evolution at conventional graphite electrodes. This study investigates heavy p-block element doping of graphite as a strategy to enhance vanadium redox activity while suppressing hydrogen evolution. Density functional theory calculations were performed using the PBE functional with Grimme D3 dispersion corrections, as implemented in Quantum ESPRESSO. A fully relaxed graphite (0001) slab containing a single-vacancy defect was used to model Bi-, In-, Sn-, and Pb-doped surfaces. Adsorption energies, electronic structure modifications, and surface interactions relevant to vanadium redox reactions were analyzed. The results show that incorporation of Bi, In, Sn, and Pb significantly alters the electronic properties of graphite, strengthening interactions with vanadium species while increasing the overpotential for the hydrogen evolution reaction. This selective modification promotes vanadium redox processes over parasitic reactions, leading to improved catalytic selectivity and reaction kinetics. The findings demonstrate that heavy p-block dopants are promising for the rational design of advanced VRFB electrodes and provide fundamental insight into improving efficiency and operational stability in redox flow battery systems. This work was supported by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V04-00086.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Biography:

Natália Podrojková, academic researcher

Natália Podrojková is a researcher at the Department of Physical Chemistry, Faculty of Science, Pavol Jozef Šafárik University in Košice. She earned her BSc (2016), MSc (2018), and PhD (2022) degrees in Physical Chemistry at UPJŠ. Her research focuses on quantum chemistry simulations of materials for sustainable energy technologies, including batteries and electrolyzers, and within Slovakia's Recovery Plan project she conducts large-scale studies using the national Devana high-performance computing system. She gained international research experience in Germany, Finland, and Spain, and regularly presents and publishes in leading journals, including Sustainable Energy & Fuels.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Nur Nadhirah Mohamad Zain

Universiti Sains Malaysia, Malaysia

Green Magnetic Solid Phase Extraction with hydrophobic Deep Eutectic Solvents for Simultaneous Analysis of NSAIDs, Sulfonamides, and Estrogens in Farm-Area Effluents by HPLC-DAD

Abstract:

Pharmaceutical residues in veterinary wastewater pose significant environmental risks due to their persistence, biological activity, and potential ecological impact. Common contaminants such as non-steroidal anti-inflammatory drugs (NSAIDs), sulfonamides, and estrogens are widely used in livestock farming and often bypass complete removal in wastewater treatment systems. The simultaneous detection of these compounds in complex environmental matrices remains challenging, highlighting the need for rapid, selective, and environmentally sustainable monitoring strategies. In this study, a novel magnetic solid phase extraction (MSPE) method was developed using magnetic hydrophobic deep eutectic solvents ($\text{Fe}_3\text{O}_4@$ HDES) for the simultaneous extraction of NSAIDs, sulfonamides, and estrogens from veterinary wastewater. Fe_3O_4 nanoparticles functionalized with a hydrophobic deep eutectic solvent exhibited enhanced affinity toward analytes with diverse polarities. When coupled with high-performance liquid chromatography equipped with diode-array detection (HPLC-DAD), the optimized MSPE method achieved recoveries ranging from 90.2% to 112.7% and low limits of detection between 0.02 and 0.50 $\mu\text{g L}^{-1}$. The method is simple, rapid, and requires minimal organic solvent, making it suitable for routine monitoring. Sustainability evaluation using the ComplexGAPI and AGREEp tools demonstrated strong compliance with green chemistry principles, while the BAGI index validated the method's analytical robustness for real environmental samples. Overall, this work presents an efficient, selective, and green analytical platform for monitoring pharmaceutical contaminants in environmental waters.



MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Biography:

Nur Nadhirah Mohamad Zain is an Associate Professor in Analytical Chemistry at the Pusat Kanser Tun Abdullah Ahmad Badawi, Universiti Sains Malaysia. She obtained her PhD and MSc in Analytical Chemistry from the University of Malaya. Her academic training and research experience focus on separation science, green analytical chemistry, and the development of sustainable extraction and sample preparation techniques. Her research interests include magnetic solid-phase extraction, deep eutectic solvent-based materials, and the detection of emerging pharmaceutical and environmental contaminants in complex matrices.



MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Poornima Bhagavath

Manipal Institute of Technology, India

Exploring Mesophase Behavior in Pyridine based H-bonded Liquid Crystals

Abstract:

A new series of H-bonded liquid crystals (HBLCs) is synthesized through a non-mesogenic Schiff base as proton acceptor and mesogenic 4-n-alkyloxybenzoic acids as proton donors in the ratio 1:2. The mesogenic behavior of the synthesized HBLCs is studied using polarizing optical microscopy and differential scanning calorimetric techniques. The structures have been optimized using density functional theory, employing B3LYP-D3 theory and a 6-31G** basis set to study the reactivities of isomeric forms of pyridinecarboxaldehyde contributing to mesomorphic behavior. A huge decrease in the crystallization temperatures is achieved with the formation of HBLCs.

Biography:

Poornima Bhagavath is an Associate Professor in the Department of Chemistry, Manipal Institute of Technology, Manipal, India. Her research interests lie in the field of materials science, particularly soft matter for electro-optic applications. She has published research articles in different journals of repute.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Nantapat Soontornnon

Tokyo University of Agriculture and Technology, Japan

Salt-Concentrated Crosslinked Poly(Ethylene Carbonate/Ethylene Oxide) Solid Polymer Electrolyte for Lithium-Ion Batteries

Abstract:

In contrast to poly(ether)-based solid electrolytes like poly(ethylene oxide, PEO), aliphatic polycarbonate-based solid polymer electrolytes (SPEs) with elevated lithium salt concentrations offer significant electrochemical and ionic conductivity advantages for all-solid-state batteries (ASSBs). We have also reported on the synthesis of a poly(ethylene carbonate-co-ethylene oxide) (P(EC/EO)) to combine the beneficial properties of salt dissolution from the carbonyl group and polymer flexibility from the ether group. The synergistic of both structures exhibited superior ionic conductivity compared to those of PEO and PEC. However, the trade-off between salt concentration and mechanical characteristics is a significant obstacle in establishing polycarbonate-based solid polymer electrolytes as a conventional material for practical all-solid-state batteries. Here, we report the CO₂-derived crosslinked random poly(ethylene carbonate-co-ethylene oxide)-based copolymer electrolyte to improve the mechanical properties of P(EC/EO). The structural design and precise balance of copolymer ratio and salt content can simultaneously achieve optimal mechanical and ionic conductivity properties. This research may facilitate the practical application of poly(carbonate)-based solid polymer electrolytes in practical all-solid-state batteries.

Biography:

Nantapat Soontornnon received a Ph.D. from Tokyo University of Agriculture and Technology in 2024 under the supervision of the Tominaga Research Group and is currently serving as an Assistant Professor in the same group. Her research specializes in polymer chemistry and energy storage materials. Her work focuses on the development of next-generation solid polymer electrolytes (SPEs) derived from CO₂-based polycarbonate copolymers and crosslinked architectures. By integrating carbonate and ether functionalities, her research aims to overcome the limitations of conventional poly(ethylene oxide)-based systems and achieve enhanced ionic conductivity, interfacial stability, and mechanical robustness.

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Her background includes the synthesis of carbonate/ether copolymers via epoxide–CO₂ copolymerization, structural characterization using NMR and XPS, and electrochemical evaluation with Li metal, graphite, and silicon anode systems. She has also investigated the use of nanoinorganic fillers and in situ crosslinking strategies to suppress electrode expansion and improve long-term cycling stability in solid-state lithium-ion batteries. Through collaborations with academic groups and industrial partners, her work has led to preliminary demonstrations of coin-cell prototypes employing LFP cathodes and Li metal anodes, achieving stable cycling performance for over 400 cycles. These achievements highlight her commitment to translating fundamental polymer design into practical solid-state battery technologies.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Hasan Saygılı

Batman University, Turkey

Mesoporous Activated Carbon from Lentil (*Lens culinaris*) Biowaste by K_2CO_3 Assisted Microwave: Cobalt Ions Removal through Adsorption Isotherm

Abstract:

In contrast to poly(ether)-based solid electrolytes like poly(ethylene oxide, PEO), This study reported a facile method to synthesize lentil (*Lens culinaris*) biowaste activated carbon (LBAC) via microwave-assisted K_2CO_3 activation. The process resulted in high carbon content and mesoporous structure with a high surface area ($1875 \text{ m}^2/\text{g}$). LBAC was applied as an adsorbent for cobalt ions (Co^{2+}) removal from aqueous solutions. The LBAC was analyzed by different techniques, including N_2 adsorption and SEM. Equilibrium adsorption isotherms were determined by experiment and evaluated using two isotherm correlations. Furthermore, the Langmuir model well represented the adsorption isotherms, with a R^2 value greater than 0.9995, suggesting the presence of monolayer adsorption. The optimum fitting correlation for the LBAC was the Langmuir isotherm, with a maximum adsorption capacity of 145.25 mg/g at 333 K . The results of this work show that quite rapidly manufactured LBAC is an excellent environmentally friendly adsorbent for removal of heavy metal ions (Co^{2+}) from polluted water.

Biography:

Dr. Hasan Saygılı is currently working as a Professor in the Chemistry and Chemical Process Technology Department, Vocational School of Technical Sciences, Batman University, Turkey. He has an experience in the field of functional carbon nanomaterials for environmental and energy applications. He holds a PhD in activated carbon production from biowastes from Dicle University, Turkey. His primary research interests include carbon nanomaterials, biomass conversion, environmental pollution, hydrothermal carbonization, cleaner production technology, electrochemical supercapacitor and energy storage device. He has published 36 SCI papers.



POSTER ABSTRACTS

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Dagmara Brzezińska

University of Silesia in Katowice, Poland

Technology and Dielectric Properties of Multicomponent PZT-Type Ceramics Modified with Rare Earth Elements

Abstract:

The work presents the technology and electrophysical properties of multicomponent material based on $\text{PbZr}_{1-x}\text{Ti}_x\text{O}_3$ (PZT) doped with earth elements (i.e., neodymium, europium, samarium, or gadolinium) obtained by the classical sintering method (pressureless sintering). The general chemical formula of the tested material is $\text{Pb}_{0.99}(\text{Zr}_{0.49}\text{Ti}_{0.51})_{0.94}\text{Mn}_{0.021}\text{Sb}_{0.016}\text{X}_{0.012}\text{W}_{0.012}\text{O}_3$, where a rare earth element dopant was introduced into position X. Four compositions of multicomponent material were received, i.e., PZT-Nd (with neodymium Nd^{3+}), PZT-Eu (with europium Eu^{3+}), PZT-Sm (with samarium Sm^{3+}), and PZT-Gd (with gadolinium Gd^{3+}). The crystal structure, microstructure, dielectric properties and DC electrical conductivity were tested. SEM microstructural analysis confirmed the homogeneous microstructure of the ceramic samples, which positively affects the electrophysical properties of PZT-type ceramic materials. Dielectric studies showed high permittivity values and low dielectric loss of the multicomponent PZT materials. The PZT composition doped with samarium (PZT-Sm) shows the most homogeneous microstructure with properly crystallized grains, translating into the highest electrical permittivity values and the lowest electrical conductivity and dielectric loss values. In the case of composition with a gadolinium dopant (PZT-Gd), the permittivity values are lower, but at the same time, the dielectric loss values are low, too. In contrast, PZT compositions doped with neodymium Nd^{3+} (PZT-Nd) and europium Eu^{3+} (PZT-Eu) show intermediate permittivity values but with significantly higher dielectric loss values. Research confirmed that the multicomponent materials based on PZT material modified appropriately with manganese Mn, antimony Sb, tungsten W, and additionally doped with rare earth elements (neodymium, europium, samarium, or gadolinium) show favourable properties for use in microelectronic applications. Using an appropriate admixture of rare earths in the multicomponent composition of PZT allows obtaining material properties for specific applications.



MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Biography:

Dagmara Brzezińska, Assistant Professor

Dr Dagmara Brzezińska is currently employed as an assistant professor at the University of Silesia in Katowice (Poland) in a research group at the Institute of Materials Science and Engineering dealing with the production and research of ceramic materials and multiferroic composite materials with functional properties for microelectronic and micromechatronic applications. She has published 27 scientific articles in the research area listed in the SCOPUS database.



MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Dariusz Bochenek

University of Silesia in Katowice, Poland

Three-component Multiferroic Ceramic Composites; Technology and Electrophysical Properties

Abstract:

The work presents the technology and functional properties of two ternary multiferroic ceramic composites obtained by the pressureless sintering method. The multiferroic composites contain a double ferroelectric phase in the amount of 90% and a magnetic phase in the amount of 10%. In the first composite (BF-BT-F), the ferroelectric components were BiFeO₄ (BF) material and BaTiO₃ (BT) material (in a 50/50 ratio), and the magnetic component was zinc-nickel ferrite (F). In the second composite (PZT-BT-F), the ferroelectric components were doped PZT-type (PZT) and BaTiO₃ (BT) materials (in a 50/50 ratio), while the magnetic component was zinc-nickel ferrite (F). The starting powders were mixed in a high-energy planetary ball mill for 20 h and next were calcined at 900°C for 3 h. The multiferroic composite samples BT-BF-F and BT-PZT-F were sintered by the pressureless sintering method at 1250°C for 2 h. Studies of the crystal structure, microstructure, and DC electrical conductivity were performed, and, ferroelectric, and magnetic measurements. Tests have shown that the use of two ferroelectric materials in the multiferroic ceramic composites has a beneficial effect on the functional composite parameters, maintaining high dielectric, and magnetic properties of multiferroic composites. Comparing two multiferroic composite compositions, the BF-BT-F exhibits better magnetic properties, i.e., higher magnetization values but weaker ferroelectric properties. In contrast, the PZT-BT-F exhibits high ferroelectric properties with good saturation of the P-E hysteresis loop (i.e., P_m maximum polarization is 11.2 μC/cm², P_r residual polarization is 2.95 μC/cm², and E_c coercive field is 0.57 kV/mm) but lower values of magnetic parameters. Obtaining the intended final properties of composite materials depends on selecting individual composite components, the appropriate proportions between them, and the sintering method used in the technological process. Multiferroic composites built based on magnetic and ferroelectric materials show interesting functional properties that are adequate for applications in modern microelectronics.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Biography:

Dariusz Bochenek, Professor

Prof. dr hab. Dariusz Bochenek is currently employed as a Professor at the University of Silesia in Katowice (Poland) and is the head of a research group at the Institute of Materials Engineering dealing with the production and testing of ceramic materials and multiferroic composite materials with functional properties for microelectronic and micromechatronic applications. He is a member of the Polish Ceramic Society PTCr's board. He is also a member of the Polish Society of Microscopy PTMi, the European Microscopy Society (EMS), and the International Federation of Societies for Electron Microscopy (IFSM). He has published more than 135 research articles placed in the SCOPUS database.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Iva Dimitrievska

Ss. Cyril and Methodius University in Skopje, North Macedonia

Enhancing Smart Building Infrastructure with Graphene-Reinforced EMI Shielding Composites

Abstract:

The increasing integration of wireless technologies and sensitive electronics in smart buildings has intensified electromagnetic interference (EMI) pollution, creating a strong demand for lightweight, durable shielding materials. Graphene based polymer nanocomposites are particularly attractive due to graphene's exceptional electrical conductivity, high aspect ratio, and mechanical robustness, which enable the formation of efficient conductive networks at low filler loadings. This work reports the design and characterization of thin polymethyl methacrylate (PMMA) and polyvinyl chloride (PVC) composite films incorporating electrochemically produced graphene as the conductive phase. Graphene samples were synthesized by molten salt electrolysis under non stationary current conditions over a range of temperatures (330 – 390 °C) and voltages (10 – 15 V), and then dispersed into the polymer matrices by solution casting. The resulting nanocomposites were characterized using SEM and TEM to evaluate filler morphology and dispersion, Raman and XRD to probe structural organization, and TGA/DSC to assess thermal stability, together with dielectric and electrical measurements to quantify EMI relevant properties. PMMA/graphene films exhibited pronounced dependence of structural parameters and electrical response on graphene type and synthesis voltage, demonstrating the sensitivity of microstructure to electrochemical growth conditions. Incorporation of only 1 wt. % graphene in PMMA reduced the electrical resistivity by seven orders of magnitude, from $2.1 \times 10^{16} \Omega \text{ cm}$ for neat PMMA to $2.29 \times 10^9 \Omega \text{ cm}$ for the PMMA/graphene nanocomposite, indicating the formation of an efficient percolated network capable of EMI shielding. These results highlight tuning of electrochemical synthesis parameters and polymer matrix selection as an effective strategy for engineering scalable graphene/polymer nanocomposites with tailored structural, thermal, and electrical properties for EMI shielding in smart building applications.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Biography:

Iva Dimitrievska, PhD, Teaching Assistant

Dr. Iva Dimitrievska is a teaching assistant at the Faculty of Technology and Metallurgy, Ss. Cyril and Methodius University in Skopje, where she earned her bachelor's, master's, and doctoral degrees. Her research focuses on electrochemical sensors based on screen printed electrodes for biological and environmental analysis, polymers, composites, and nanomaterials. Combining her academic expertise with her hands-on experience in the pharmaceutical industry, Dr. Dimitrievska applies a unique, interdisciplinary perspective to her work. She is currently developing graphene based EMI shielding materials for smart buildings. Dr. Dimitrievska publishes in peer reviewed journals, serves on conference organizing committees, and is an active member of the Society of Chemists and Technologists of Macedonia and the Association of South East Electrochemists.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Jakub Leščinský

Pavol Jozef Šafárik University in Košice, Slovakia

Understanding the Impact of Polysulfide–Additive Interactions on the Performance of Li–S Batteries

Abstract:

The global transition toward renewable energy sources has intensified the need for efficient, sustainable, and high-energy storage technologies. Among the promising candidates, lithium–sulfur (Li–S) batteries attract significant attention due to their exceptionally high theoretical capacity (1675 mAh g^{-1}), low cost, and the natural abundance of sulfur. However, their commercialization remains limited by short cycle life and low energy efficiency, mainly caused by the dissolution and migration of lithium polysulfides (Li_2S_n , $4 \leq n \leq 8$), which result in active material loss and gradual cell degradation.

This research investigates the influence of polysulfides and functional electrolyte additives on the lifetime and stability of Li–S batteries. The studied systems include carbonate- and ether-based electrolytes modified with boron- and fluorine-containing additives to stabilize electrode interfaces, as well as bio-based, halogen-free flame-retardant additives derived from 9,10-dihydro-9-oxa-10-phosphaphenanthrene-10-oxide (DOPO) and chitosan polyelectrolyte complexes (PEC) to improve safety and environmental compatibility.

Electrochemical characterization involves cyclic voltammetry, galvanostatic cycling, and impedance spectroscopy to assess redox reversibility, reaction kinetics, and overall cell behavior. The obtained data provide insights into how electrolyte composition and additive chemistry affect the electrochemical response and long-term stability of the Li–S system. The findings emphasize that appropriate selection and optimization of functional additives can significantly influence the balance between stability, efficiency, and safety in Li–S batteries. This work contributes to a better understanding of electrolyte design strategies and offers guidance for the development of next-generation Li–S systems with improved operational reliability and sustainability.

This work was funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project SUNFLOWERS No. 09I02-03-V01-00022.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Biography:

Jakub Leščinský is a doctoral student at the Department of Physical Chemistry, Faculty of Science, Pavol Jozef Šafárik University in Košice, Slovakia. His research focuses on lithium–sulfur batteries, with particular emphasis on the influence of polysulfides and additives on battery lifetime and stability. He has actively participated in national and international conferences and has received several awards recognizing his scientific achievements. His broader research interests include electrochemical energy storage, interfacial phenomena in battery systems, and the development of advanced materials for sustainable energy technologies.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Nathanael Chun-Him Lai

The Hong Kong Polytechnic University, China

Preparation and Characterization of Esterified *Artemisia sphaerocephala* Krasch. Gum-based Superabsorbent Polymers: Effect of Crosslinking and Their Potential Applications in Biomedical Engineering and Sustainable Agriculture

Abstract:

In light of the ongoing interest in sustainable development and green manufacturing, it is highly significant to develop new bio-based sustainable materials to replace synthetic materials. Synthetic polymer-based superabsorbent polymers (SAP) such as polyacrylates, polyacrylamides, and maleic anhydride copolymers have been extensively used in various applications, including disposable hygiene products, spill control, food packaging, and agricultural use. However, synthetic superabsorbent polymers are generally non-biodegradable and toxic, which poses an environmental and safety concern. Therefore, it is of high importance to develop a sustainable, food-based superabsorbent polymer.

Herein, we report the preparation of *Artemisia sphaerocephala* Krasch Gum (ASKG)-based superabsorbent polymers via esterification of ASKG with green crosslinkers and subsequent polymerization with minimal acrylic acid (AA). Fourier transform infrared spectroscopy (FTIR) confirmed the successful synthesis of ASKG-SAP. By fine-tuning the esterification degree of ASK and esterified ASK:AA ratio, the as-prepared ASK-SAP exhibited excellent water absorbency (over 1200 g absorbed water/g SAP), and elicited better swelling properties and absorption of saline when compared with synthetic SAP poly(acrylic acid) (PAA). Scanning electron microscopy (SEM) analysis revealed the porous structure of esterified ASKG-SAP, which indicates that the ASKG esterification is crucial to create well-defined three-dimensional polysaccharide networks for enhanced water absorption. Such esterified ASKG-SAP have been demonstrated for 3D cell culture and as a soil conditioner. We envision this novel series of food-based SAP is instrumental in various applications and promoting the use of food-based materials for sustainable development.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Biography:

Chun Him Nathanael LAI, Research Assistant Professor, Department of Food Science and Nutrition, The Hong Kong Polytechnic University.

Dr. Lai's research group focuses on developing food-based materials for biomedical and agricultural applications and on developing new methods for sustainable and green manufacturing. He has published 18 peer-reviewed top journals and 3 patents, including ACS Nano, Advanced Materials, and Carbohydrate Polymers. He has also been a registered European Commission expert since 2023.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Marija Prosheva

Ss. Cyril and Methodius University in Skopje, North Macedonia

Effect of Acrylic Acid and (Hydroxyethyl)methacrylate Monomers on the Properties of G/CNT Hybrid Composites

Abstract:

This study compares the effects of acrylic acid (AA) and (hydroxyethyl)methacrylate (HEMA) functional monomers on the properties of hybrid graphene (G) and carbon nanotube (CNT) polymer composites. G/CNT hybrid fillers were prepared via sonication at different weight ratios. The hybrid fillers were incorporated at 1 wt% into a methyl methacrylate/butyl acrylate matrix via emulsion mixing. The polymer matrix was previously synthesized via semicontinuous emulsion polymerization. To evaluate the functional monomers' influence, mechanical, electrical, and surface properties were investigated. Results showed that AA-functionalized composites achieved superior mechanical performance, specifically higher Young's modulus and stress at break, due to enhanced interfacial bonding. While HEMA-based systems generally exhibited higher baseline conductivity, the 1:1 G/CNT ratio with AA reached a peak conductivity of 0.22 S/m, demonstrating an optimal synergistic bridging effect. Conversely, the HEMA series showed lower surface energy and higher contact angles, attributed to the monomer's lower polarity and hydrocarbon shielding. These findings indicate that while AA optimizes mechanical reinforcement and filler networking at specific ratios, HEMA is preferable for applications requiring lower surface energy and stable electrical baseline performance.

Biography:

Marija Prosheva, teaching assistant

Marija Prosheva is a Teaching Assistant at the Faculty of Technology and Metallurgy, Ss. Cyril and Methodius University in Skopje, and a PhD candidate in materials engineering. Her research focuses on graphene-polymer nanocomposites, sustainable materials, and smart sensors. She has participated in several NATO and Erasmus+ projects, as well as national projects, and has completed research stays in Serbia, Spain, Germany, Sweden, and Poland. Marija has co-authored publications in Nanotechnology, Polymer Composites, and Progress in Organic Coatings. Her work contributes to advancing green materials and innovative sensor technologies for environmental and industrial applications.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Moon Hyun Chung

Interjo INC, South Korea

Effect of Poly(acrylic acid) Ionization on Surface Interaction of Silicone Hydrogel Contact Lenses

Abstract:

Poly(acrylic acid) (PAA) is widely employed as a hydrophilic surface coating for soft contact lenses due to its strong water affinity and tunable surface chemistry. The ionization of carboxyl groups ($-\text{COOH} \rightarrow -\text{COO}^-$) in PAA significantly alters surface charge and hydration behavior, which are expected to influence comfort-related surface properties. However, the direct relationship between PAA ionization degree and lens comfort remains unclear, particularly under industrial post-treatment conditions.

In this study, we investigate how controlled surface ionization of a PAA coating affects surface interaction and wettability of silicone hydrogel contact lenses. A post-treatment process (“P-treatment”) employing alkaline conditions with or without a nonionic surfactant was used as a model approach to modulate PAA ionization and surface accessibility. Changes in the chemical state of the PAA coating were analyzed by FT-IR spectroscopy, while surface charge accessibility was evaluated using methylene blue adsorption monitored by UV-Vis spectroscopy. Macroscopic wettability was assessed through static contact angle measurements.

FT-IR results confirmed variations in the relative contributions of $-\text{COOH}$ and $-\text{COO}^-$ groups depending on post-treatment conditions. Methylene blue adsorption experiments indicated that alkaline treatment increased the accessibility of negatively charged sites, whereas the presence of a surfactant reduced probe accessibility due to surface adsorption and shielding effects. Despite increased ionization, contact angle measurements revealed that enhanced surface ionization did not result in a proportional improvement in wettability.

These findings demonstrate that surface ionization alone is not sufficient to improve comfort-related surface properties. Instead, an optimal balance between PAA ionization degree and surface accessibility must be achieved. This study highlights the importance of controlled surface ionization and adsorption environment in the design of PAA-based contact lens coatings for improved wearing comfort.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Biography:

Moon Hyun. Chung, Industry Professional (Senior Researcher, Ph.D).

Moon Hyun Chung received his Ph.D. degree in Physics from Yonsei University, Seoul, Republic of Korea, in 2023. He is currently a Senior Researcher at the R&D Center of Interjojo Inc., where he focuses on the development of hydrogel and silicone hydrogel contact lenses. His work includes surface coating materials, post-treatment processes, and the optimization of surface interactions for improved wearing comfort. His research interests include polymer surface engineering, coating materials, interfacial phenomena, tribology and the relationship between surface chemistry and functional performance in polymer films.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Wai-Yin Cheng

The Hong Kong Polytechnic University, China

Intranasal Delivery of Melatonin-loaded Lipidic Nanocapsules Ameliorates Systemic Inflammation-Triggered Circadian desynchrony and Neuroinflammation

Abstract:

Circadian rhythms play a critical role in regulating immune function and behavior, and disruptions to these rhythms are increasingly linked to systemic inflammation and neuroinflammation. This study aimed to investigate the effects of melatonin-loaded lipidic nanocapsules on systemic inflammation induced neuroinflammation and disruptions in circadian rhythms, in comparison with melatonin. Here, we induced systemic inflammation in C57BL/6J mice using intraperitoneal (i.p.) injections of lipopolysaccharide (LPS). The i.p. injection of LPS disrupted diurnal expressions of circadian clock genes and proinflammatory cytokines, inducing inflammatory responses in liver and brain tissues. Intranasal delivery of MEL-LNC treatment modulated diurnal rhythmicity of circadian clock genes and proinflammatory cytokines, and reduced neuroinflammation. These modulatory effects outweighed those observed following the conventional melatonin treatment. These findings underscore the therapeutic potential role of melatonin-loaded lipidic nanocapsules for ameliorating circadian disruption and neuroinflammation under challenge.

Biography:

Dr. Nano Wai-Yin Cheng, Research Assistant Professor.

Dr. Nano Wai-Yin Cheng is a research assistant professor of the Department of Food Science and Nutrition of The Hong Kong Polytechnic University. She received her Ph.D. in Neurosciences from the University of Hong Kong and postdoctoral training at KU Leuven. Dr. Cheng's main research interests are in the areas of chrononutrition, neuroscience and nanomaterials. She aspires to develop novel strategies for treating chronodisruption (e.g. shift-work/ jet lag) and its related diseases.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Veronika Niščáková

Pavol Jozef Šafárik University in Košice, Slovakia

Organic Electrolytes as a Pathway to Sustainable Redox Flow Batteries

Abstract:

The transition to renewable energy systems requires scalable and cost-effective energy storage technologies. This growing demand for efficient and sustainable energy storage technologies highlights the potential of redox flow batteries (RFBs) for this type of application. While conventional RFB systems rely primarily on vanadium electrolytes, their high cost and dependence on strong supporting acids limit broader implementation. Organic redox-active molecules offer a promising alternative due to their tunable electrochemical properties, high reversibility, and compatibility with neutral electrolytes.

In this study, two structurally similar viologens, Bu_2VBr_2 and Bu_2VCl_2 , were investigated as potential active species for RFB electrolytes. Electrochemical characterization by cyclic voltammetry demonstrated a reversible two-step reduction process with fast electrokinetics and diffusion coefficients comparable to previously reported viologens. The results suggest that these compounds could provide stable and efficient redox behavior in neutral aqueous media, making them promising candidates for next-generation, cost-effective RFB systems.

Biography:

Veronika Niščáková is a researcher in chemical sciences at the Department of Physical Chemistry, Faculty of Science, Pavol Jozef Šafárik University in Košice. She earned her Bachelor's (2018), Master's (2020), and PhD (2024) in Physical Chemistry at the same university. Her early research focused on developing a nonenzymatic glucose sensor using gold nanoparticles. Currently, she studies composite cathode materials based on sulfur with conductive additives for post-lithium-ion batteries. She also works on redox flow batteries, focusing on advanced electrode materials and optimized electrolytes to improve efficiency, durability, and scalability of large-scale energy storage systems.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Zizhuo Nie

Aimer Co., Ltd, China

Emerging Functional and Smart Materials for Next-Generation Textiles: Structure, Properties, and Applications

Abstract:

The rapid convergence of materials science and textile engineering has enabled the creation of next-generation functional and smart textiles that go beyond traditional passive roles to deliver active, responsive performance. Recent advances in nanomaterials, conductive polymers, and bio-based functional coatings have introduced unprecedented opportunities for multifunctional textiles with integrated capabilities such as sensing, thermal regulation, energy harvesting, and antimicrobial protection. This paper reviews key emerging material classes, including conductive fibers and inks, phase-change materials (PCM), nanocomposites, responsive polymers, and bio-based coatings, emphasizing their structure–property relationships and relevance to textile integration.

Scalable processing strategies such as electrospinning, layer-by-layer deposition, and composite fiber spinning are analyzed for their impact on material stability, washability, and long-term performance. Application-driven case studies are presented in sectors such as wearable electronics, healthcare monitoring, protective apparel, and sustainable product development, highlighting recent progress and persistent challenges. In particular, the paper addresses critical barriers including recyclability, integration into circular economy frameworks, and the durability of functionality under repeated mechanical and laundering stresses.

By synthesizing cross-disciplinary advances in nanotechnology, polymer engineering, and textile manufacturing, this work establishes a roadmap for the design and implementation of advanced material systems in next-generation textiles. These insights aim to guide both academic researchers and industrial practitioners in bridging laboratory innovation with scalable, commercially viable smart textile solutions.

Keywords:

Smart textiles, functional fibers, nanocomposites, wearable electronics, sustainable materials, advanced material processing

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Chang-Yull Lee

Inha University, South Korea

Grid-Type Temperature Sensors for Temperature Mapping

Abstract:

This study proposes a grid-type thin-film temperature sensor for satellite thermal monitoring using electrohydrodynamic (EHD) inkjet printing, which enables high-resolution sensor fabrication. Because EHD printing is highly sensitive to ink properties and process conditions, suitable inks were formulated and experimentally evaluated to determine optimal printing parameters. Based on these conditions, grid-type thin-film temperature sensors were successfully fabricated. To verify their performance, a heating element was placed at an arbitrary location, and the fabricated sensor was used to detect the heat-source position and monitor the transient heat-transfer process. The results confirmed that the printed sensor could track the heat source and visualize time-dependent heat distribution. These findings demonstrate the feasibility of fabricating grid-type thin-film temperature sensors through EHD inkjet printing and suggest their potential for satellite thermal control and other temperature-monitoring applications.

Biography:

Chang-Yull Lee. Professor.

He is currently a professor in the Department of Aerospace Engineering at Inha University, where he conducts research in various fields, including thermal sensors for satellites and structural health monitoring.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Gye Seok An

Kyong University, South Korea

Optimization of Dispersion and Sodium Ion Removal in Water Glass-Based Silica Coating of Maghemite Nanoparticles

Abstract:

Superparamagnetic nanoparticles are highly sought after in various applications due to their ability to maintain high dispersibility in the absence of an external magnetic field. While magnetite (Fe_3O_4) is a representative material for such applications, its industrial utility is limited by a narrow phase equilibrium region and the challenges associated with mass production and reaction control in hydrothermal synthesis. Furthermore, conventional silica coating processes utilizing tetraethyl orthosilicate (TEOS) often require significant amounts of organic solvents, leading to difficulties in process optimization and wastewater treatment.

To overcome these limitations, this study proposes the use of maghemite ($\gamma\text{-Fe}_2\text{O}_3$) as a core material. $\gamma\text{-Fe}_2\text{O}_3$ is widely utilized in industries such as toner and memory devices due to its chemical stability and superior superparamagnetic properties at the nanoscale. However, as the strong magnetic nature of $\gamma\text{-Fe}_2\text{O}_3$ can lead to particle aggregation, we investigated effective dispersion methods to ensure colloidal stability. Additionally, we present a silica shell synthesis method using sodium silicate (water glass) as a solvent-minimized alternative to TEOS. To address the issue of residual sodium ions from the water glass precursor—which can compromise stability through salt bridging—we also optimized a purification process to effectively remove these residual ions.

Biography:

Gye Seok An, Assistant Professor. He received the Ph.D. degree from Hanyang University, Seoul, Republic of Korea, in 2018. He is currently an Assistant Professor in the Department of Materials Science and Engineering at Kyonggi University, Suwon, Republic of Korea. His research interests focus on the synthesis of superparamagnetic core-shell particles and functional nanomaterials. He is particularly interested in developing eco-friendly synthesis processes and optimizing the colloidal stability of magnetic nanoparticles for industrial applications.

MATERIALS SCIENCE AND ENGINEERING

April 20–22, 2026 | Osaka, Japan

Woo Jin Kim

Hongik University, Republic of Korea

Prelithiation-Activated Li_2O -Rich Interphase and CNT-Reinforced Ultrafine Microstructure for Durable Al Foil Anodes in Lithium-Ion Batteries

Abstract:

To overcome the recurring trade-off between mechanical robustness and interfacial instability in aluminum (Al) foil anodes in lithium-ion batteries, we integrate microstructure engineering with interphase engineering in a scalable Al-carbon nanotube (CNT) composite foil anode. The composite foils are fabricated via powder metallurgy using spark plasma sintering of milled powders followed by rolling, offering a manufacturing-relevant route for Al anode production. With an optimized CNT fraction of 1 vol%, the Al matrix is refined to an ultrafine grain size of $\sim 0.83 \mu\text{m}$ and incorporates a CNT network. This microstructure yields a pronounced hardness increase while maintaining a favorable strength-ductility balance. Furthermore, prelithiation converts the mechano-chemically fragmented Al_2O_3 into a Li_2O -rich inorganic passivation layer that stabilizes the interface. This interphase promotes redistribution of ionic and electronic fluxes through the embedded CNT network, thereby homogenizing electrochemical activity and suppressing localized reaction. It also guides lithiation toward a partitioned pathway. In turn, a conductive α -Al filament network is preserved within the β -LiAl matrix, sustaining electronic continuity and mitigating strain localization during repeated alloying and dealloying. As a result, the prelithiated Al-CNT composite foil enables stable LFP full-cell cycling approaching ~ 630 cycles, together with the lowest interfacial resistance and improved rate capability among the anodes evaluated. These findings establish a scalable design guideline in which mechano-chemical oxide activation combined with prelithiation transforms native oxide into a robust inorganic interphase, enabling durable CNT-reinforced Al foil anodes.

Biography:

Woo Jin Kim is a Professor in the Department of Materials Science and Engineering at Hongik University. He received his Ph.D. in Materials Science and Engineering from Stanford University. His research focuses on the mechanical, corrosion, and electrochemical properties of metals and composites. He has authored over 265 SCI(E) papers.



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