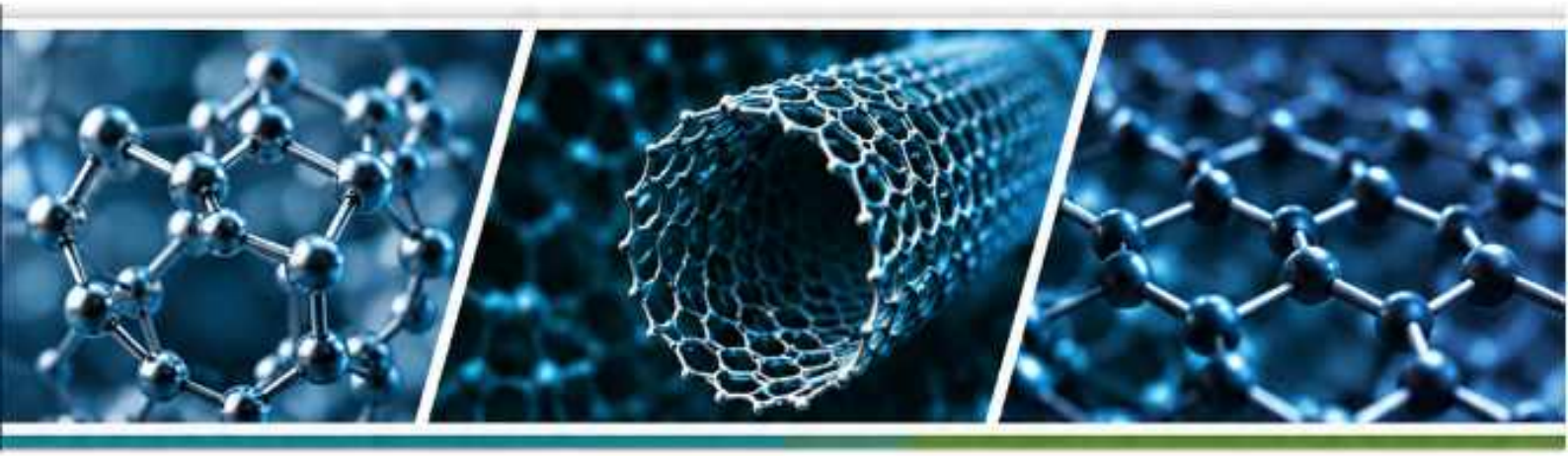
RESEARCH CONNECTS

ABSTRACT BOOK
MATERIALS2026

2nd Global Summit on

MATERIALS SCIENCE AND NANOSCIENCE



PRAGUE, CZECH REPUBLIC

JULY 20-21, 2026

https://materials2026.researchconnects.org/

FOREWAORD

Dear Colleagues,

It is our great pleasure to welcome researchers, academicians, scientists, industry professionals, young researchers, and students from around the world to the 2nd Global Summit on Materials Science and Nanoscience (MATERIALS2026), held on July 20–21, 2026 in Prague, Czech Republic.

MATERIALS2026 provides an international forum for the exchange of knowledge, ideas, and scientific perspectives across the broad and rapidly evolving fields of materials science and nanoscience. The summit brings together researchers and professionals from academia, industry, and related scientific disciplines to present recent advances, discuss emerging challenges, and explore new opportunities for collaboration.

The scientific program encompasses a wide range of topics, including advanced materials, nanomaterials, energy materials, biomaterials, functional materials, sustainable materials, computational materials science, ceramics, polymers, catalysis, nanophotonics, optoelectronic materials, quantum materials, and emerging applications of nanotechnology.

The Book of Abstracts brings together the contributions presented at MATERIALS2026 and reflects the breadth and diversity of research being carried out across these fields. We are grateful to all contributing speakers, presenters, researchers, and participants whose scientific contributions have enriched the program and helped make this summit a platform for meaningful scientific exchange.

We sincerely hope that the discussions, presentations, and interactions at MATERIALS2026 will encourage new ideas, interdisciplinary collaborations, and lasting scientific partnerships, while contributing to continued progress and innovation in materials science and nanoscience.

We would like to express our sincere appreciation to all speakers, presenters, delegates, organizing committee members, and contributors for their valuable participation and support.

We hope that this Book of Abstracts serves as a valuable record of the scientific contributions presented at MATERIALS2026 and inspires further research, collaboration, and innovation in the years ahead.

ORGANIZING COMMITTEE MEMBER

Maria Manuela Silva

Department of Chemistry Centre of the University of Minho (CQ-UM), Campus de Gualtar, 4710-057 Braga, Portugal

Energy Materials: Performance and Sustainable Innovation

ABSTRACT:

Today's world faces a global energy crisis linked to world population growth, accelerated industrialization and increasing energy demand. In the last years, aligned to the Industrial Revolution 4.0, Internet of Things paradigm and the introduction of Artificial Intelligence, has driven the need to develop compact and high-performance electronic devices, requiring efficient and sustainable energy. With the growing demand for energy solutions, researchers and companies are continuously exploring new materials and technologies to enhance devices performance, durability, and safety. Nowadays, it is the pursuit of the materials science community to implement sustainable materials in all fields of applications. It is expected that materials encompass properties like high abundance in nature; low cost; eco-friendliness; recyclability and suitable properties for the envisaged application. In this sense, we propose herein the development of novel electrolytes for electrochemical devices, based on a natural polymer [1], doped with green ionic liquids (ILs) or/and different salts.These electrolytes may assume a multifunctional role as separator, adhesive and cell sealant in electrochemical devices. The results emphasize the huge potential of the developed green electrolytes in technological applications, as diverse as batteries and electrochromic windows.

The UN introduced 17 Goals for 2030 that intend to be a foundation for a better and more sustainable future. Out of these, Goals 7, 11, and 13, it will hopefully help to achieve a more sustainable energy future in the cities, the storage systems, the construction of more beautiful architectural face of the building, and a better lifestyle.

ACKNOWLEDGEMENTS

The authors thank the Fundação para a Ciência e Tecnologia (FCT) for financial support under the framework of Strategic Funding UID/QUI/00686:Centro de Química da Universidade do Minho (CQ-UM/UM) and Multi-sensing SMART battery electrodes concept for in-situ operation monitoring, 2022.04012.PTDC and SOLPOWINS-Solar-Powered Smart Windows for Sustainable Buildings (PTDC/CTM/4304/2020). NGS-New Generation Storage, C644936001-00000045, supported by IAPMEI (Portugal) with funding from the European Union Next Generation EU (PRR).

BIOGRAPHY:

Maria Manuela Silva obtained a Research Assistant position in the Department of Chemistry of the University of Minho (1991). She received her PhD in Chemistry in 1999 and was promoted to Assistant Professor at the same University, where she is now Full Professor. Her research activities focus on the synthesis and characterisation of solid polymer electrolytes and their application in the domains of solid-state electrochemistry (batteries and electrochromic devices). She is also interested in the chemistry of organic-inorganic hybrid materials. She is co-author of more 220 papers in SCI journals, 35 papers in Proceedings and 7 book chapters.

Haixue Yan

Queen Mary University of London, United Kingdom

Characterization of Ferroelectric Polarization Switching at Different Frequencies

ABSTRACT:

Understanding polarization switching under varying electric fields and frequencies is essential for advancing a wide range of ferroelectric applications, including dielectric capacitors, piezoelectric sensors, ferroelectric memory devices and transparent electro-optic components. Polarization switching behaviour is typically characterised using ferroelectric hysteresis loops. However, both electric displacement–electric field (D–E) loops and strain–electric field (S–E) loops comprise multiple overlapping contributions, making accurate interpretation of these signals critical. Rigorous characterization enables the separation of different components associated with polarization switching and allows the extraction of physically meaningful polarization values.It is important to emphasise that improper measurement of D–E and S–E loops can lead to artificially high polarization and strain values, in some cases even exceeding theoretical limits, which is physically impossible. Such artefacts often arise from unaccounted electrode–sample interface effects, electrode geometry, leakage currents and mechanical deformation during measurement.Furthermore, ferroelectric responses are governed by a hierarchy of polar entities, including domains and domain walls with distinct relaxation dynamics. Their frequency-dependent behaviour, spanning from radio-frequency to terahertz and optical regimes, reflects the interplay between domain switching kinetics, local dipolar fluctuations and lattice dynamics. Recent advances highlighting these multi-scale mechanisms will be discussed to provide a more physically grounded framework for interpreting ferroelectric switching behaviour.

BIOGRAPHY:

Dr Haixue Yan is a Reader in Materials Science and Engineering at Queen Mary University of London. He received his bachelor degree at University of Science and Technology Beijing (USTB) in 1994 and PhD degree at Shanghai Institute of Ceramics, Chinese Academy of Sciences (SICCAS) in 2001. His research spans dielectric, piezoelectric and ferroelectric materials, with contributions ranging from new materials discovery and advanced characterisation to fundamental mechanisms and emerging applications.He has published over 260 SCI papers, holds nine patents, and authored two teaching books, Phase Transitions and Functional Materials.He received Award for Excellence in Reviewing for ActaMaterialia in 2021 and the IOM3 Pfeil Awardin 2023. He is aFellow of the Institute of Materials, Minerals and Mining (FIMMM) and the Royal Society of Chemistry (FRSC). He has delivered numerous keynote and invited talks. He is also a Member of the Editorial Board of Advances inApplied Ceramics, Journal of Advanced Dielectrics, Materials Research Bulletin, Scientific Reports and Journalof Advanced Ceramics.

Sharmila M. Mukhopadhyay

Frontier Institute for Research in Sensor Technologies (FIRST), University of Maine, Orono, Maine, USA

Hierarchical Hybrid Superstructures for Precisely Tailored Multifunctional Materials

ABSTRACT:

Precisely tailored multifunctional materials are needed for the development of versatile, lightweight, compact, and smarter (more interactive) devices. They could reduce the number of separate solid parts to create smaller, lighter, more interactive, and cost-effective devices. In living biological systems, multifunctionality is often found in interactive vital organs (related to sensing, digestion and ion-exchange) through their surfaces, which contain progressively smaller units such as cilia and microvilli that are further functionalized with specific receptors (e.g. catalytic enzymes or proteins). This design enables full integration where precisely tailored nanomaterials are strongly bonded with the larger device, resulting in seamless convergence of different functionalities.

Our team has been focused on incorporating this design principle to create multifunctional hierarchical hybrid materials that synergize 0D nanoparticles, 1D nanotubes, and 2D nanosheets with larger solid materials. Several materials have beendesigned, fabricated, and evaluatedfor a variety of applications ranging for tissue engineering, thermal management, catalytic, and electrochemical properties. The emphasis for this talk will be on an architecture where carpet-like arrays of electrically and thermally conducting carbon nanotubes (CNT) are covalently bonded to selected solid substrates. The nanotube carpet creates orders of magnitude increase in specific surface area of the solid, which can be subsequently functionalized with nanoparticles or organic entities for tailoring their fluid permeation, catalytic, thermal, electrical, and bio-interaction properties. Some specific examples presented are as follows: (i) These materials, used as electrodes, can significantly impact the rates and ease of hydrogen evolution reaction (HER) and the oxygen evolution reaction (OER) in water electrolyzers; (ii) They can increase the electrochemical sensing capability of challenging pollutants such as per- and polyfluoroalkyl substances (PFAS); (iii) These structures can serve as ultra-high activity nanocatalysts for chemical conversion and room-temperature degradation of persistent halogenated pollutants such as PFAS and pesticides; and (iv) They can serve as highly effective nano-radiators and radiation shielding for energy generation devices such as electric vehicle batteries and nuclear reactors. In addition to sharing these results, this talk will provide important insights into the structure-property relationships of these materials, and their future applicability to chemical, environmental and energy-related devices.

***Keywords:** Nanostructured Surfaces, Chemical Detection, Hydrogen Evolution, Thermal and Radiation Management.*

BIOGRAPHY:

Dr Sharmila M. Mukhopadhyay is Director of the Frontier Institute of Research in Sensor Technologies (FIRST) and Professor of Mechanical Engineering at University of Maine. She is also leading the interdisciplinary educational programs in Materials Science and Engineering in the State of Maine. This includes Graduate Programs and a Professional Certificates encompassing four colleges and nine academic departments. Her own research focuses on fundamental surface and interface phenomena; design, and development of novel nanomaterials for energy, environment and health; and multidisciplinary convergence. She received her Ph.D. from Cornell University and BS and MS degrees from the Indian Institute of Technology. Prior to joining University of Maine, she was Professor at Wright State University (WSU) and founding Director of their Centre for Nanoscale Multifunctional Materials. Mukhopadhyay.Dr. Mukhopadhyay has served as Jefferson Science Fellow in the National Academies of Science, Engineering and Medicine, where she was assigned as Senior Scientific Advisor to the US Department of State to create linkages between scientific innovations and governmental entities focused on economic development. She is an elected Fellow of the American Ceramic Society.

Prof. Rufan Zhang

Tsinghua University, China

High-Performance Photothermal Regulation Materials

ABSTRACT:

Against the backdrop of global warming and increasingly frequent extreme heat events, the demand for cooling in the construction, industrial and transportation sectors, along with its corresponding energy consumption and carbon emissions, has been rising continuously. Meanwhile, human body cooling in hot outdoor environments has long been confronted with technical challenges. Therefore, developing low-carbon, energy-efficient and highly scalable high-efficiency thermal management technologies has become the key to advancing energy conservation and emission reduction as well as safeguarding human health in outdoor scenarios. Photothermal regulation materials refer to a category of materials whose optical and thermal radiation properties are specially designed to realize effective regulation of light and heat under low or even zero energy consumption conditions, and they hold enormous potential for the development of new low-carbon and energy-efficient thermal management technologies. Research on photothermal regulation materials has long been faced with three major challenges: precise regulation of the spectral properties of materials, cross-scale structural design and functional coupling of materials, and mass production and application of materials. In recent years, our research team has focused on the research direction of precise structural design and controllable preparation of high-performance photothermal regulation materials, and carried out research targeting two key scientific issues: first, the mechanisms and strategies for realizing precise regulation of the photothermal properties of materials; second, the theories and methods for realizing cross-scale structural design and large-scale preparation of photothermal regulating materials. Three representative academic achievements have been mainly obtained. First, we proposed the idea of inverse spectral decoupling and band-selective regulation of materials, revealed the intrinsic structure-activity relationship of the photothermal properties of materials, and invented the method for spectral design and precise regulation of photothermal regulation materials. Second, we developed the on-demand customized material design concept, put forward the strategy of ordered assembly of material functional primitives, and established the technology for structural design and functional integration of photothermal regulation materials. Finally, we solved the difficulty of mass transfer control in the large-scale preparation of photothermal regulation materials was solved, and realized the large-scale preparation and application of a variety of photothermal regulation materials.

BIOGRAPHY:

Rufan Zhang is a tenured associate professor, Principal Investigator and doctoral supervisor at the Department of Chemical Engineering, Tsinghua University. He is an awardee of the National High-Level Young Talents Program, and also serves as Youth Council Member of the Chinese Society of Particuology, Member of the Award Recommendation Committee of the Chinese Chemical Society, Guest Editor of Smart Materials and Devices, Editorial Board Member of Coating and Processes, and Youth Editorial Board Member of SusMat, Carbon Future, Carbon Energy, Carbon Neutralization, Carbon and Hydrogen, Particuology, Clean Energy and Exploration. His research mainly focuses on the controllable preparation, performance characterization and application of nanocarbon materials and photothermal regulating nanomaterials. He has published 150 papers in total, among which more than 100 papers were published in internationally renowned journals as the first/corresponding author, including Science, Nature Nanotechnology, Nature Sustainability, Science Advances, Nature Communications, Journal of the American Chemical Society, Angewandte Chemie International Edition, Advanced Materials, Nano Letters, ACS Nano, etc. He has presided over more than 10 projects, including key projects of the Science and Technology Commission of the Central Military Commission, general projects of the National Natural Science Foundation of China, and key projects of Sinopec. He has filed more than 20 invention patents and authored 7 academic monographs. He has won numerous honors and awards, including the 5th Qingshan Science and Technology Award (2026), First Prize of Natural Science of the Chinese Society of Particuology (2024), Second Prize of Scientific and Technological Progress of the China Petroleum and Chemical Industry Federation (2025), Youth Innovation Award of the China Petroleum and Chemical Industry Federation (2024), the first "Red Avenue Youth R&D Fund" of the China Petroleum and Chemical Industry Federation (2023), Second Prize of Natural Science of the China National Textile and Apparel Council (2024), "Hou Debang Chemical Science and Technology Youth Award" of the Chemical Industry and Engineering Society of China (2019), Youth Chemistry Award of the Chinese Chemical Society (2018), being selected into MIT Technology Review "35 Innovators Under 35" (China Region, 2018), China Emerging Sci-Tech Figure (2018), "National Excellent Young Scholar in Metamaterials" of the Chinese Materials Research Society (2024), "Future Chemical Engineering Scholar" of the Global Chinese Chemical Engineering Scholars Association (2024), "Outstanding Innovation Award" of the Engineering Science Society of USA (2025), being selected to the "Periodic Table of Chinese Young Chemists" for the 2019 International Year of the Periodic Table of Chemical Elements (2019), First Prize of Natural Science of the Ministry of Education of China (2016), and the Swiss Chorafas Young Researcher Award (2015).

Tamar Bzhalava

Engineering Physics department, Georgian Technical University, 77 Kostava Str., Tbilisi, Georgia

Nanoscale Materials: Optical Properties, Computational Modelling, Application in Biomedicine

ABSTRACT:

Development of modern approaches and tools for studying the optical, scattering, and absorption properties of composite, hybrid materials, and nanoscale particles is an important issue in materials science, nanomedicine and nanotechnology. Knowledge of spectral signatures is essential for identifying molecules, chemicals, and harmful biological or non-biological agents. Scattering and absorption spectra are among the principal tools for the operation of advanced detection systems and biomedical devices. Modern experimental (Raman, UV, IR) spectroscopy, along with theoretical and simulation research, is the key to studying the optical properties of hybrid nanoparticles such as virions. We examined a virion, the extracellular infectious form of a virus, as a physical particle. Virion consists of a capsid (protein molecules) and a core containing nucleic acids (DNA/RNA). Capsids are mostly helical, icosahedral or near-spherical with icosahedral symmetry. Optical characteristics of virus-like particles (VLPs) are determined by considering the interaction between the electromagnetic (EM) wave and VLPs, using Maxwell's EM theory, solutions of Helmholtz's wave equations in cylindrical or spherical coordinate systems, relevant to the symmetry and morphology of VLPs. A deterministic solution of the problem has been obtained and used to execute mathematical modelling and simulation. Optical properties of virions are proposed to be studied using VLP models defined by a set of geometrical, electrical, and magnetic parameters specific to each virion. An elaborated methodology allows for the analysis of EM field characteristics in both the near and far fields of VLPs. This research focuses on the resonance interaction of EM waves and VLPs. The ranges of resonance scattering wavelengths are estimated using both theoretical and empirical formulas. Computer simulation and outcome analyses revealed a significant correlation between the scattering capabilities of VL particles and the geometric shape, the values and ratio of the outer and inner diameters of the particle's shell, as well as electromagnetic parameters of the core, shell, and environment within resonance ranges. This study presents a graphical analysis of the scattering properties associated with the bacteriophages T7, MS2, and M13, as well as the Tobacco mosaic virus (TMV). The resonance scattering wavelength is observed mostly in the UV region. Computing and simulation executed in the MATLAB environment. Analysis of simulation outcomes indicates a strong dependence of scattering characteristics on the wavelength of the incident EM wave. Mathematical and computational modelling, together with theoretical solutions, enables the determination of resonance-scattering wavelength ranges and the scattering spectra of VLPs of different origins. Research outcomes may be extended and applied to biomedical, healthcare, and environmental protection purposes. Work is supported by Shota Rustaveli National Science Foundation of Georgia [grant №FR-23-4069].

Keywords: Scattering spectra; modelling; Nanobiomaterial; Virus-like particles

BIOGRAPHY:

Tamar N. Bzhalava, Professor at the Department of Engineering Physics at the Faculty of Informatics and Control Systems of Georgian Technical University (GTU), has been a faculty member at GTU since 1983. She received her master's degree in physics (1980) and a doctor's (PhD) degree in phys.&math. sciences (1990) from Ivane Javakhishvili Tbilisi State University, the title of Docent in Radio Physics from the Board of Academic Experts of Georgia (1994). She has over 40 years of teaching and scientific experience and is currently the Principal Manager of the master's program in "Engineering Physics" at GTU. The area of her research interests encompasses EM wave theory, applied electrodynamics, modelling and computer simulation of physical processes, with a primary focus on the spectral/vibration properties of nano/micro particles and biomaterials. T. Bzhalava is an author of up to 90 scientific publications and textbooks, and has participated in 40 national and international scientific conferences/workshops. She has served as the Scientific Manager for grant projects funded by Shota Rustaveli National Science Foundation (SRNSF) in (2014-2017) and (2023-2026), and has been a member of scientific teams involved in EU and ISTC projects (SENS-ERA, FP7-INCO-2011-6, №G-1376 (2006-2009), №G-717 (2003-2004)), and GNSF (2006-2008), SRNSF projects (2020-2021).

Oleksandr Tkach

Department of Materials and Ceramic Engineering, CICECO – Aveiro Institute of Materials, University of Aveiro, Aveiro, Portugal

Elevated Dielectric Breakdown Strength and Electrical Homogeneity in Alternatively Sintered Barium Strontium Titanate Ceramics for High-Power Capacitor Applications

ABSTRACT:

By increasing breakdown strength (Ebd) and hence power density, ceramic capacitors can be used to drive a variety of loads such as high-power microwave and ultra-wideband sources for electronics, lasers for sensors, and electric vehicle starters [1]. The growing demand for advanced dielectric materials in these power electronic and energy storage applications has intensified efforts to optimize their electrical performance by means of microstructural engineering. Moreover, if the capacitor is tunable, it can be used in lightweight communication systems.

Here, we investigate the impact of Spark Plasma Sintering (SPS) and Spark Plasma Texturing (SPT) [2] on the structural and electrical properties of BST ceramics, comparing them with conventional sintered (CS) counterparts [3]. SPT is defined as an edge-free SPS approach in which a pre-sintered body with sufficient mechanical resistance to be handled is placed in a larger diameter matrix, allowing the sample to deform perpendicularly to the applied pressure.

SPT BST ceramics, characterized by the smallest grain size of 0.44 μm, exhibit a dielectric breakdown strength of 515 kV cm⁻², exceeding that of CS ceramics with 2 μm-large grains by more than twice that is important for energy storage applications [4]. On the other hand, SPS BST ceramics demonstrate the highest quality factor for tunable component of 1465 under 11.5 kV cm⁻², achieving an optimal balance between dielectric tunability and loss, that underscores their potential for tunable electronic applications. The dielectric tunability and quality factor are also shown to be enhanced by tailoring SPT conditions like pre-sintering method and pressure-temperature profile [5].

These findings provide insights into the role of sintering techniques in tailoring dielectric properties for next-generation energy storage and functional materials.

1. A.R. Jayakrishnan, J.P.B. Silva, K. Kamakshi, D. Dastan, V. Annapureddy, M. Pereira, K.C. Sekhar, Are lead-free relaxor ferroelectric materials the most promising candidates for energy storage capacitors? Prog. Mater. Sci. 132 (2023) 101046.
2. R. Pinho, A. Tkach, S. Zlotnik, M.E. Costa, J. Noudem, I.M. Reaney, P.M. Vilarinho, Spark Plasma Texturing: a strategy to enhance the electro-mechanical properties of lead-free potassium sodium niobate ceramics, Appl. Mater. Today 19 (2020) 100566.

3. T. Ostapchuk, J. Petzelt, J. Hlinka, V. Bovtun, P. Kužel, L. Bellaiche, A. Tkach, P. Vilarinho, Broad-band dielectric spectroscopy and ferroelectric soft-mode response in the Ba0.6Sr0.4TiO3 solid solution, J. Phys.: Condens. Matter 21 (2009) 474215.
4. C. Ribeiro, A. Tkach, J. Noudem, C. Randall, M.E. Costa, P.M. Vilarinho, Grain-boundary engineering by spark plasma texturing to enhance dielectric breakdown strength in barium strontium titanate ceramics, Chem. Eng. J. 535 (2026) 175499.
5. C. Ribeiro, A. Tkach, J. Noudem, M.E. Costa, P.M. Vilarinho, Radial Deformation–Driven Sintering: Effects on the Microstructure and Dielectric Tunability of Ba0.6Sr0.4TiO3, Open Ceram. 26 (2026) 100952.

Keywords: Alternative sintering; Microstructure development; Tunable dielectrics; Dielectric breakdown; High-power capacitors

BIOGRAPHY:

Dr. Oleksandr Tkach is a Principal Researcher of the University of Aveiro and CICECO – Aveiro Institute of Materials, Portugal. He graduated in Microelectronics and Semiconductor Devices by the National Technical University of Ukraine "Kyiv Polytechnic Institute" in 1999. In 2005 he got Ph.D. in Materials Science and Engineering from the University of Aveiro, Portugal. His post-doc activity was performed in the University of Porto (2007-2012) and Johannes Gutenberg University of Mainz (2012-2014) with further return to the University of Aveiro as Auxiliary Researcher.

Since then, Dr. Tkach has (co-)supervised 11 Master and 1 PhD students, and oriented 3 post-docs; given 19 invited or keynote talks; was an organizing or scientific committee member of 11 events; joined Editorial boards of 5 scientific journals, also reviewing manuscripts for >70 journals. His publication profile contains 1 edited book, 8 book chapters and 123 articles. Dr. Tkach has participated in 3 European, 10 Portuguese R&D and 2 projects with industry as well as 2 bilateral projects.

Present research interests of Dr. Tkach include the development of giant permittivity dielectric oxides for energy storage; thermoelectric and piezoelectric oxide materials and composites for energy harvesting technologies; nanostructured magnetoelectrics for sensor and electronic applications; and alternative, energy-efficient concepts for electrically assisted ceramic sintering.

Ia Chitrekashvili

Petre Melikishvili Institute of Physical and Organic Chemistry of Ivane Javakhishvili Tbilisi State University, Tbilisi, 0186, Georgia

Biodegradable Polymeric Controlled-Release Nitrogen Fertilizers: Synthesis, Structure Regulation And Environmental Compatibility

ABSTRACT:

The development of environmentally safe and efficient nitrogen fertilizers represents an a significant challenge in modern agriculture. Conventional mineral fertilizers often exhibit low utilization efficiency and significant nutrient losses due to leaching and volatilization, which may lead to environmental pollution and reduced agronomic effectiveness. In this context, polymeric controlled-release fertilizers have attracted increasing attention as promising alternatives capable of providing gradual nutrient supply while minimizing ecological impact. The present study is devoted to the synthesis and investigation of biodegradable polymeric nitrogen fertilizers containing functional groups that are capable of controlled nutrient release.

The polymeric fertilizers were obtained through the interaction of nitrogen-containing monomers with reactive chemical components in the presence of condensation agents. Particular attention was paid to amide–formal dehyde polycondensation systems, including urea–formal dehyde and melamine–formal dehyde reactions. Since the degree of crosslinking in such polymers significantly influences their solubility, degradation behavior, and nutrient release characteristics, the regulation of polymer structure represents one of the key approaches to controlling fertilizer performance. The polycondensation process was investigated by varying synthesis parameters such as molar ratios of the initial components, temperature conditions within the range of 50–95°C, reaction times ranging from several minutes to several hours, and the pH of the reaction medium.

Kinetic studies of the melamine–formaldehyde interaction demonstrated that the formation of methylol derivatives plays a key role in oligomer formation. The stability and reactivity of methylol groups depend strongly on the pH of the reaction medium. Under weakly alkaline conditions (pH 7.5–8.0), methylol derivatives are formed, while acidic conditions promote condensation reactions leading to the formation of methylene bridges (–NH–CH_2–NH–). The results showed that optimal conditions for controlled oligomer formation correspond to reaction durations of approximately 80–90 minutes, which allows for the formation of higher molecular weight oligomers suitable for controlled polymer structuring.

In addition to physicochemical studies, the environmental compatibility of the synthesized polymeric fertilizers was investigated through microbiological experiments. Soil microorganisms play a crucial role in nitrogen transformation processes and therefore represent an important indicator of ecological safety. Different strains of Urobacterium were isolated from soil samples and tested for their ability to degrade

the synthesized polymeric fertilizers. Experiments conducted under both laboratory and field conditions demonstrated that the obtained polymers do not exert negative effects on soil microbial communities. On the contrary, an increase in the biomass of certain microorganisms, particularly Urobacterium species and free-living nitrogen-fixing bacteria, was observed in comparison with untreated soils.

The obtained results indicate that the synthesized polymeric fertilizers are biodegradable and compatible with soil microbial ecosystems. It was established that polymers with predominantly linear or moderately crosslinked structures undergo microbial degradation more readily than highly crosslinked three-dimensional networks. Regulation of synthesis conditions therefore allows the design of fertilizer systems with optimized degradation rates and improved nitrogen availability for plants. The study demonstrates that amide–aldehyde oligomers can also function as effective fixing agents and encapsulating materials in fertilizer compositions, providing additional technological advantages. Overall, the developed polymeric systems represent promising environmentally compatible controlled-release nitrogen fertilizers suitable for sustainable agricultural applications.

Keywords: Fertilizer; Polycondensation; Biodegradable; Amido–aldehyde;

Acknowledgement

The abstract was prepared within the framework of the project № FR-23-29704 - "A method for obtaining polymer nitrogen fertilizers of prolonged action containing a functional group", funded by the Shota Rustaveli National Science Foundation of Georgia.

BIOGRAPHY:

Ia Chitrekashvili graduated from the Faculty of Chemistry at Ivane Javakhishvili Tbilisi State University (TSU) in 1989. Between 1990 and 1992, she completed her postgraduate studies at the PetreMelikishvili Institute of Physical and Organic Chemistry. In 2003, she defended her doctoral dissertation and was awarded the degree of Academic Doctor of Chemical Sciences. Currently, she serves as a Chief Scientific Researcher in the Laboratory of High-Molecular Compounds at the Petre Melikishvili Institute of Physical and Organic Chemistry of TSU. Her research interests focus on the synthesis and investigation of various classes of polymers, environmental protection, polymeric fertilizers, and polymer compositions. Dr. Chitrekashvili has authored 131 scientific publications, including journal articles and conference papers, and holds 11 patents and 7 monographs. She has participated in 11 local and international grant projects, serving as the Principal Investigator (Scientific Supervisor) for two of them. Her academic productivity metrics are as follows: Google Scholar — Citations: 41, h-index: 3; Scopus — Citations: 33, h-index: 3.

Nathalia Hammes

Centre of Physics of Minho and Porto Universities (CF-UM-UP), Campus of Azurém, University of Minho, Guimarães, Portugal

Enhanced Structural and Thermal Stability of Carbon Nanofibre-Reinforced Wet-Spun Coaxial Phase Change Fibres with Fatty Acids

ABSTRACT:

The increasing instability of the energy sector and the rising pressure to reduce carbon emissions have intensified the search for passive solutions that can lower energy use in buildings. Since the thermal properties of construction materials directly influence heating and cooling demands, thermal energy storage has become an important strategy for managing temperature fluctuations and advancing energy efficiency. In this context, phase change materials (PCMs) are particularly appealing because they can store and release thermal energy as latent heat. However, directly integrating PCMs into construction materials may cause leakage, physicochemical incompatibilities, and a decrease in mechanical performance during phase changes. Encapsulation is therefore an effective method for containing the PCM within a protective shell, maintaining its thermal performance, and minimising negative impacts on the host material's structural integrity. In this study, coaxial polymeric phase change fibres (PCFs) were successfully fabricated via wet-spinning, a technique that controls polymer precipitation in a coagulation bath to form continuous core-sheath structures. Linoleic acid (LA) and oleic acid (OA), both fatty acids and PCMs, were used as core materials, while cellulose acetate (CA) reinforced with carbon nanofibres (CNF, 0.05 and 0.10 wt.%) was used as the protective sheath. Bright-field microscopy confirmed the formation of well-defined coaxial structures and showed good dispersion of CNF within the sheath. Attenuated Total Reflectance Fourier Transform Infrared spectroscopy (ATR-FTIR) verified the preservation of chemical structures after processing and confirmed the presence of characteristic fatty acid functional groups in the encapsulated fibres. Thermogravimetric analysis (TGA) revealed a two-stage degradation profile, with fatty acid volatilisation occurring at 230–310□ °C and CA decomposition at 310–400□ °C. Differential scanning calorimetry (DSC) demonstrated consistent phase change behaviour, with higher melting enthalpy observed in CNF-reinforced PCFs, indicating improved thermal energy storage capacity. Dynamic mechanical analysis (DMA) showed that adding CNF enhanced the stress-strain response and increased the time to failure, suggesting improved structural reinforcement and mechanical stability. Overall, these findings demonstrated that wet-spinning is an effective method for encapsulating fatty acids into coaxial PCFs, while CNF reinforcement offered a promising approach to simultaneously improve thermal energy storage and mechanical strength. The developed composite material is a promising solution for sustainable, energy-efficient use in the built environment.

Keywords: Carbon nanofibres; Fatty acids; Polymeric coaxial fibres; Thermal comfort.

BIOGRAPHY:

Nathalia Hammes holds a Master's degree in Materials Engineering from the University of Minho (Portugal) and is currently a PhD candidate in the Doctoral Programme in Materials Engineering at the same institution. In 2024, she ranked first in the FCT doctoral scholarship call in the Materials Engineering panel. She is a member of the (RE)NERGY-BUILD project, where her research focuses on the development of wet-spun coaxial phase-change fibres for civil engineering applications, with particular emphasis on passive thermal regulation and energy-efficient materials for the built environment. Her work is centred on the design of functional polymeric fibres incorporating phase change materials to enhance thermal energy storage and contribute to more sustainable construction solutions. Alongside her research activities, she has published in peer-reviewed journals, mentored undergraduate and Master's students, and contributed to the organisation of international scientific conferences. She has also been recognised with an academic award for her achievements.

Riva Liparteliani

Petre Melikishvili Institute of Physical and Organic Chemistry of Ivane Javakhishvili Tbilisi State University, Tbilisi, 0186, Georgia

Seed Pelleting And Encapsulation Using Biodegradable Amide-Aldehyde Oligomers For Improved Wheat Germination

ABSTRACT:

The development of biodegradable polymeric materials for agricultural applications represents an important direction in modern sustainable agriculture. Controlled-release polymeric nitrogen fertilizers based on amide-aldehyde oligomers have attracted particular attention due to their ability to regulate nutrient release while remaining environmentally compatible. Such polymers gradually degrade under the influence of soil microorganisms, releasing nitrogen in forms accessible to plants. Owing to their functional structure and controlled biodegradability, these materials can be applied not only as fertilizers but also as technological components in seed treatment processes.

One promising application of these materials is their use as fixing agents in seed pelleting and encapsulation technologies. In multicomponent pelleted fertilizer compositions, the fixing agent plays a crucial role by ensuring the adhesion and stabilization of active ingredients on the seed surface. The results of the present study demonstrated that amide-aldehyde oligomers, particularly melamine-formaldehyde derivatives, can effectively serve as both fixing agents and encapsulating materials. This approach is technologically advantageous because the polymer coating simultaneously performs two functions: it stabilizes the seed coating composition and acts as a biodegradable controlled-release nitrogen source.

High-quality seed material is one of the key prerequisites for achieving stable crop yields. However, seed performance is strongly influenced by numerous environmental and biological factors, which may lead to significant yield losses in cereal crops. In some cases, crop losses may exceed 30%, and under unfavorable conditions complete crop failure may occur. Therefore, the development of effective technologies for protecting seeds and improving germination characteristics represents an important agronomic challenge.

To address this problem, a novel pelleting and encapsulation method for cereal crop seeds was developed. Four types of pelleting compositions were investigated. In the first composition, traditional fixing agents such as starch or molasses were used. The other compositions contained mixtures of aqueous melamine-formaldehyde oligomer solutions with starch solutions of different concentrations. The adhesive properties of the oligomer were optimized by adjusting its molecular weight in order to ensure effective fixation of the active components while maintaining biodegradability.

Laboratory and field experiments were conducted using winter wheat seeds of the cultivar "Bezostaya-1" cultivar. The obtained results demonstrated that pelleted and encapsulated seeds exhibited slightly lower laboratory germination rates compared with untreated seeds, which can be explained by minor mechanical damage during the pelleting process. However, under field conditions, a significant improvement in germination was observed. Field germination rates ranged from 90.6% to 93.0%, exceeding the control by 14-16%.

An important factor influencing germination efficiency was the thickness of the coating layer formed on the seed surface. Excessive fertilizer application resulted in thicker coatings that slowed water penetration and germination. Conversely, reduced fertilizer application rates produced thinner coatings that facilitated water absorption, oxygen exchange, and seedling emergence.

Overall, the pelleting-encapsulation method significantly improved field germination and provided effective protection of seeds against microorganisms, pests, and environmental stress factors. The developed polymer-based technology, therefore, represents a promising approach for improving crop productivity while simultaneously reducing fertilizer losses and ensuring environmentally safe agricultural practices.

Keywords: Encapsulation; Biodegradable; Amide-aldehyde; Fertilizer;

ACKNOWLEDGEMENT

The abstract was prepared within the framework of the project № FR-23-29704 - "A method for obtaining polymer nitrogen fertilizers of prolonged action containing a functional group", funded by the Shota Rustaveli National Science Foundation of Georgia

BIOGRAPHY:

Riva Liparteliani completed her postgraduate studies at the Agricultural University of Georgia between 1996 and 2000. Over the years, she has held various positions, including Associate Professor in the Department of Agroecology, Head of the Agrochemistry division, and Scientific Researcher at the Mikhail Sabashvili Institute of Soil Science, Agrochemistry, and Melioration of the Agricultural University of Georgia. Since 2006, she has held the degree of Academic Doctor of Agricultural Sciences. Currently, Dr. Liparteliani serves as a Senior Researcher in the Laboratory of High-Molecular Compounds at the Petre Melikishvili Institute of Physical and Organic Chemistry of IvaneJavakhishvili Tbilisi State University. Her research interests include agrochemistry, the synthesis and investigation of polymeric fertilizers, environmental protection, ecological safety, and polymer compositions. She has authored 81 scientific publications, including journal articles and conference papers, and is a co-author of 6 patents and 14 textbooks and methodological manuals. Additionally, she has participated in 10 local and international research grant projects.

Ilia Chachava

Petre Melikishvili Institute of Physical and Organic Chemistry of Ivane Javakhishvili Tbilisi State University, Tbilisi, 0186, Georgia

Kinetic Regularities Of Oligomer Formation In Melamine-Formaldehyde And Carbamide-Melamine-Formaldehyde Systems

ABSTRACT:

Melamine-formaldehyde polymer systems occupy an important position among nitrogen-containing polymeric materials due to their wide range of industrial and agricultural applications. In particular, melamine-based oligomers and their copolymers with urea represent promising precursors for the development of functional polymeric materials and controlled-release nitrogen fertilizers. Despite the long history of research on amide–aldehyde polycondensation systems, further investigation of the kinetic regularities governing oligomer formation remains important for improving control over polymer structure and functional properties.

The present study investigates the formation of melamine–formaldehyde homooligomers and carbamide–melamine–formaldehyde copolymers obtained through polycondensation reactions in aqueous media. Particular attention was paid to the influence of key physicochemical parameters on the reaction kinetics and the degree of conversion, as well as to the comparative reactivity of melamine and urea toward formaldehyde during joint condensation processes.

The mechanism of oligomer formation in the melamine–formaldehyde system was found to be analogous to that observed in the urea-formaldehyde system and proceeds through the formation of methylol derivatives at the initial stage. Under weakly alkaline conditions (pH 7.5-8), melamine first reacts with formaldehyde to form monomethylolmelamine, followed by the formation of dimethylolmelamine through the addition of a second formaldehyde molecule. These intermediate products subsequently undergo condensation reactions leading to the formation of oligomeric structures.

The influence of several factors-including temperature, reaction duration, initial reactant concentration, and the molar ratio of melamine to formaldehyde-was systematically investigated. Experimental studies performed in the temperature range of 50–70°C demonstrated that increasing temperature significantly accelerates both the reaction rate and the degree of conversion. The most intensive reaction stage occurs during the initial period of polycondensation, and the reaction approaches completion within approximately one hour. Kinetic analysis showed that, prior to deep conversion of formaldehyde, the process follows second-order reaction kinetics, with rate constants remaining relatively constant within the studied temperature interval.

Comparative analysis revealed that melamine exhibits lower reactivity toward formaldehyde than urea under identical experimental conditions. During the joint condensation of amide components with different reactivities, the formation of mixed oligomers occurs through a sequential reaction pathway. At the early stages of the process, formaldehyde preferentially reacts with the more reactive amide component, leading to the formation of methylol derivatives that subsequently participate in oligomer growth. At later stages, molecules of the less reactive amide component become involved in the condensation reactions, resulting in the formation of structurally heterogeneous mixed oligomer chains.

The optimal conditions for controlled oligomer synthesis were determined to be a reaction temperature of approximately 60°C, a melamine-to-formaldehyde molar ratio of 1:1, a reaction duration of about one hour, and an initial melamine concentration of 0.1 mol L^{-1}. The obtained results provide important insights into the kinetic regularities and structural features of amide–aldehyde oligomer systems and may serve as a scientific basis for the design of functional polymeric materials and environmentally compatible controlled-release nitrogen fertilizers.

Keywords: Amide-aldehyde; Melamine; Oligomer; Formaldehyde;

ACKNOWLEDGEMENT

The abstract was prepared within the framework of the project № FR-23-29704 - "A method for obtaining polymer nitrogen fertilizers of prolonged action containing a functional group", funded by the Shota Rustaveli National Science Foundation of Georgia.

BIOGRAPHY:

Ilia Chachava is a food technology specialist. He graduated from the Faculty of Food Product Technology at the Agricultural University of Georgia in 2013. From 2013 to 2015, he completed his Master's degree at the Faculty of Informatics and Control Systems of the Georgian Technical University (GTU). Subsequently, from 2015 to 2018, he pursued his doctoral studies at the GTU Faculty of Transport and Machine Building. Since 2018, he has held the degree of Academic Doctor of Mechanics, Engineering, and Technology. Since 2024, Dr. Chachava has been a Scientific Researcher in the Laboratory of High-Molecular Compounds at the PetreMelikishvili Institute of Physical and Organic Chemistry of Ivane Javakhishvili Tbilisi State University. He has authored several scientific publications in local and international high-impact journals. He actively participates in national and international scientific events and local research grant projects as a Young Scientist.

Shorena Gvachliani

Petre Melikishvili Institute of Physical and Organic Chemistry of Ivane Javakhishvili Tbilisi State University, Tbilisi, 0186, Georgia

Seed Pelleting And Encapsulation Using Biodegradable Amide-Aldehyde Oligomers For Improved Wheat Germination

ABSTRACT:

The development of biodegradable polymeric materials for agricultural applications represents an important direction in modern sustainable agriculture. Controlled-release polymeric nitrogen fertilizers based on amide-aldehyde oligomers have attracted particular attention due to their ability to regulate nutrient release while remaining environmentally compatible. Such polymers gradually degrade under the influence of soil microorganisms, releasing nitrogen in forms accessible to plants. Owing to their functional structure and controlled biodegradability, these materials can be applied not only as fertilizers but also as technological components in seed treatment processes.

One promising application of these materials is their use as fixing agents in seed pelleting and encapsulation technologies. In multicomponent pelleted fertilizer compositions, the fixing agent plays a crucial role by ensuring the adhesion and stabilization of active ingredients on the seed surface. The results of the present study demonstrated that amide-aldehyde oligomers, particularly melamine-formaldehyde derivatives, can effectively serve as both fixing agents and encapsulating materials. This approach is technologically advantageous because the polymer coating simultaneously performs two functions: it stabilizes the seed coating composition and acts as a biodegradable controlled-release nitrogen source.

High-quality seed material is one of the key prerequisites for achieving stable crop yields. However, seed performance is strongly influenced by numerous environmental and biological factors, which may lead to significant yield losses in cereal crops. In some cases, crop losses may exceed 30%, and under unfavorable conditions complete crop failure may occur. Therefore, the development of effective technologies for protecting seeds and improving germination characteristics represents an important agronomic challenge.

To address this problem, a novel pelleting and encapsulation method for cereal crop seeds was developed. Four types of pelleting compositions were investigated. In the first composition, traditional fixing agents such as starch or molasses were used. The other compositions contained mixtures of aqueous melamine-formaldehyde oligomer solutions with starch solutions of different concentrations. The adhesive properties of the oligomer were optimized by adjusting its molecular weight in order to ensure effective fixation of the active components while maintaining biodegradability.

Laboratory and field experiments were conducted using winter wheat seeds of the cultivar "Bezostaya-1" cultivar. The obtained results demonstrated that pelleted and encapsulated seeds exhibited slightly lower laboratory germination rates compared with untreated seeds, which can be explained by minor mechanical damage during the pelleting process. However, under field conditions, a significant improvement in germination was observed. Field germination rates ranged from 90.6% to 93.0%, exceeding the control by 14-16%.

An important factor influencing germination efficiency was the thickness of the coating layer formed on the seed surface. Excessive fertilizer application resulted in thicker coatings that slowed water penetration and germination. Conversely, reduced fertilizer application rates produced thinner coatings that facilitated water absorption, oxygen exchange, and seedling emergence.

Overall, the pelleting-encapsulation method significantly improved field germination and provided effective protection of seeds against microorganisms, pests, and environmental stress factors. The developed polymer-based technology, therefore, represents a promising approach for improving crop productivity while simultaneously reducing fertilizer losses and ensuring environmentally safe agricultural practices.

Keywords: Encapsulation; Biodegradable; Amide-aldehyde; Fertilizer;

ACKNOWLEDGEMENT

The abstract was prepared within the framework of the project № FR-23-29704 - "A method for obtaining polymer nitrogen fertilizers of prolonged action containing a functional group", funded by the Shota Rustaveli National Science Foundation of Georgia.

BIOGRAPHY:

Shorena Gvachliani is a faculty at Petre Melikishvili Institute of Physical and Organic Chemistry of Ivane Javakhishvili Tbilisi State University, Georgia

Alberto Garcia Penas

Instituto de Ciencia de Materiales de Madrid, ICMM/CSIC, Sor Juana Inés de la Cruz 3, 28049 Madrid, Spain

Thermoresponsive Hybrid Materials for Water Remediation and Photocatalysis

ABSTRACT:

Smart materials have attracted considerable interest for environmental applications because of their tunable properties and selective response to external stimuli. In this study, a thermoresponsive copolymer was prepared through the copolymerization of N-isopropylacrylamide (NIPAM) with a small amount of dopamine methacrylamide (DMA), thereby introducing catechol functionalities into the polymer backbone. These catechol groups exhibit a strong affinity for metal oxide surfaces, enabling the effective anchoring of iron oxide magnetic nanoparticles (MNPs) and the formation of polymer–nanoparticle hybrid materials.The presence of MNPs significantly improved the thermal responsiveness of the copolymer, resulting in a more distinct phase transition above the cloud point temperature (Tc). Once the temperature exceeded Tc, the hybrid material rapidly formed visible aggregates that could be efficiently recovered from the aqueous medium through magnetic separation. Beyond their stimuli-responsive behavior, the catechol moieties provided active binding sites for the adsorption of Cr(VI) ions from contaminated water, while the embedded magnetic nanoparticles facilitated the straight forward removal of the polymer–metal complexes. Owing to this combination of selective adsorption, temperature-triggered aggregation, and magnetic recoverability, the developed hybrid system represents a promising platform for efficient and controllable water treatment. Furthermore, the versatility of these hybrid materials extends beyond water purification, making them attractive candidates for applications such as photocatalysis.

ACKNOWLEDGMENT

This work has been supported by the Madrid Government (Comunidad de Madrid Spain) under the Multiannual Agreement with UC3M ("Fostering Young Doctors Research", PHOGASUPHY-CM-UC3M) in the context of the VI PRICIT (Research and Technological Innovation Regional Programme).

BIOGRAPHY:

Dr. Alberto García-Peñas is associate professor in the department of Materials Science and Engineering at University Carlos III of Madrid. Furthermore, he is Director of the master's degree in Circular Engineering, Secretary for Academic Affairs of "Álvaro Alonso Barba" Institute of Chemistry and Materials Technology, Founder of the Cirmat Symposium, Computer Council Member, and Laboratory Safety Officer at University Carlos III of Madrid.

The outcome of his research work includes more than 60 SCI-publications in reputed journals such as Chemical Engineering Journal, Carbohydrate Polymers or Chemosphere. He contributed to 5 book chapters and edited 2 books.
Dr. García-Peñas has received 11 awards and distinctions, four of them derived from his PhD Thesis, devoted to correlation between microstructural features and final properties of polypropylenic architectures: the world "Borealis Student Innovation Award"; the recognition of the Spanish National Research Council (CSIC) for his doctoral thesis; and, the awards from the specialized groups of Polymers and Calorimetry and Thermal Analysis (GEP and GECAT, respectively) of the Real Sociedad Española de Química and the Real Sociedad Española de Física.

Halevy Itzhak

Unit of Nuclear Engineering, Faculty of Engineering Sciences, Ben Gurion University of the Negev, Israel

A Mass Spectrometrynovel detector for fission track analysis with the Lexan-Aerogel detector for Advancing Nuclear Forensics

ABSTRACT:

Fission track analysis is a technique employed in nuclear forensics to identify and examine fission isotopes.

We created a novel detector for fission track analysis with the Lexan detector.
This innovative detector exhibits more dispersion between the fission tracks, enhancing separation and analysis.

In this innovative approach, we adhered aerogel to the Lexan. The aerogel has a low absorption coefficient; hence, it does not substantially obstruct the fission products in the detector. The incorporation of aerogel modifies the geometric configuration, enlarges the dimensions of the fission track stars, and increases the separation between individual tracks, as seen in Fig. 1.A fission track star of a size of 150 microns can reach 350 microns with the aerogel configuration.

Given that the fission products are distributed isotopically while the aerogel is two-dimensional, it is necessary to employ spectroscopic projection to facilitate their integration.

An illustration of this enhancement is seen in Figure 1, where the dimensions of the fission track star are greater and the tracks are more widely spaced.

The newly developed analytical program, Finder [2], may utilize a 2D representation, whether actual or simulated, of a fission track star to conduct analysis and provide 3D evaluations, therefore illustrating the fission yield of the fission isotope.

The two humps are like a mass spectrometry separating between the heavy and the light fission elements. Till today we can do it with ICP-MS, but we are limited to micron-sized particles.

The fission isotope size could be as small as part of a picogram, this amount of sample could not be measured easily by other techniques like ICP-MS.
This new detector enables us to analyze fission track stars and differentiate between the common fission isotopes like 233U, 235U or 239Pu.

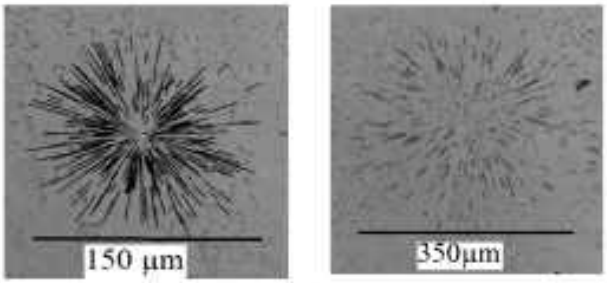


Fig 1. Fission track picture without aerogel (left), Fission track length analysis with 4 µm aerogel (right).

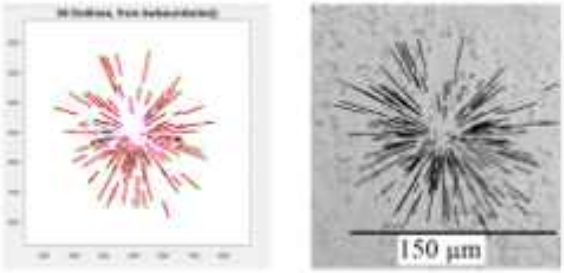


Fig 2. Fission track image (left), fission track length analysis (right).

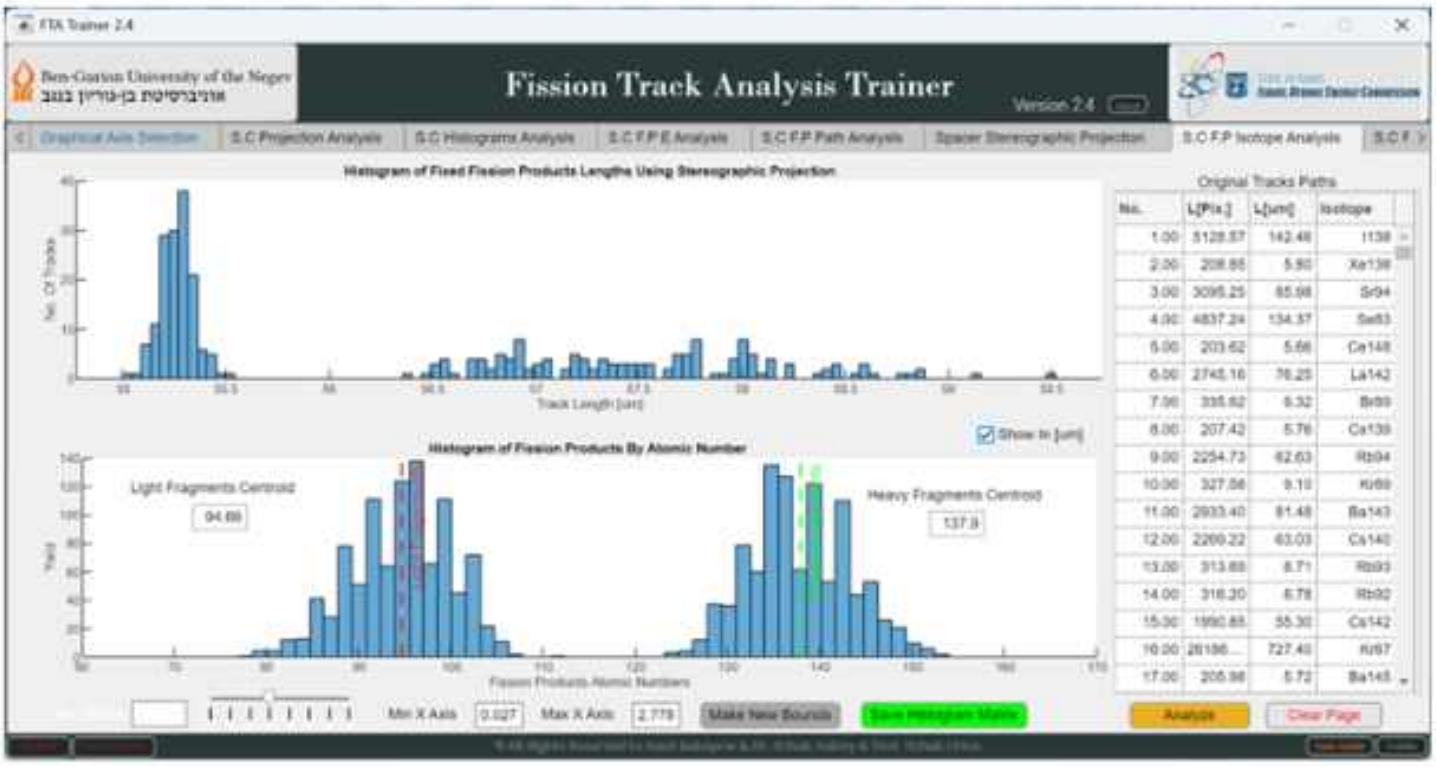


Fig 3. Fission track analysis of 235U star. Upper fission track length from fission to the detector. Lower fission tracks isotopic separation (mass spectrometry).

BIOGRAPHY:

Prof. Itzhak Halevy, Research Associate in the Department of Nuclear Engineering at Ben-Gurion University of the Negev. Research areas: nuclear forensics (fission-track detection/analysis, deep-learning-based image segmentation of fission tracks), nuclear safeguards, powder X-ray diffraction, phase transitions, crystal structure and magnetic properties of materials, and radioactive decontamination methods (e.g., hydrogel-based Cs-137 decontamination).

Jiang Yang

Department of Petrochemical Engineering, Liaoning Petrochemical University, Fushun, Liaoning, China

Lignin-Derivatives for Dispersing Phthalocyanine Nano-pigments and Enhancing Oil Recovery

ABSTRACT:

Lignin is a natural, abundant, renewable and green polymeric material. Copper phthalocyanine (CuPc) was used as a model pigment. Copper phthalocyanine (CuPc) is a widely usedorganic blue pigment with color brilliance, light fastness, and lowcost. However, its poor dispersibility in aqueous solutions limitsits application. Lignin's aromatic hydrophobic polymer core and hydrophilicsubstitutestructure makes it a potential good dispersant. Lignin carboxylic acid (–COOH) and amine (–NH2)derivatives were synthesized and investigated as dispersant for CuPc in aqueous solutions. The results showed that lignin amine derivativegave the best suspension stability of CuPc. The dispersion is correlated to zeta potential, particlesize, and adsorption on pigment surface. High molecular weight Ligninsamine derivatives gave the betterCuPcdispersion in acryliccoatingformulations, enhancing the tinting strengthof CuPc.

Additionally, nanoparticles(LNPs) were prepared and applied to enhanced oil recovery.LNPsformed Pickering emulsion and washed crude oil from surface(>90%) due to emulsification and the alteration of wettability of surfaces. The performance is correlated to its physical chemical properties such ascontact angle, zeta potential, interfacial tension, and emulsion stability. The EOR testresults showed that LNPs can enhance oil recovery over 14%.

BIOGRAPHY:

Dr. Yang received Ph.D degree in Chemistry from the University of Missouri-Rolla, USA in 1994. After two years postdoctoral fellowship at Clarkson University, USA, he worked at Solvay, Unilever, Baker Hughes in US for 20 years. Then, he joined Liaoning Petrochemical University as Professor. His research interests include surfactants, polymers, nanomaterials applications as dispersant, emulsifier, thickener, corrosion inhibitors. He has published 120 papers, and is the inventor or co-inventor of 60 US and China patents. Dr. Yang has received multinational corporate awards for his research achievement andhas been named on the list of Stanford-Elsevier's top 2% scientists worldwide for career-long citation impact since 2023.

Yun Hyuk Choi

Department of Advanced Materials and Chemical Engineering, Daegu Catholic University

Air-Induced Oxygenation Triggers n/p-TypeTransitions and Heterojunction-Enhanced Gas Sensing in Orthorhombic SnS and Hexagonal SnS2

ABSTRACT:

Metal chalcogenides are promising low-power sensing materials, yet oxygenation in ambient air at mild operating temperatures (≤250 °C) is often underestimated, which has contributed to inconsistent reports on intrinsic conduction type and apparent n/p-type conversion during sensing. This issue is particularly evident in 2D TMDs (e.g., MoS2), where oxygen adsorption/substitution at sulfur vacancies and partial oxidation toward MoOx can introduce acceptor-like states, shift the Fermi level, and invert gas-response polarity under heated conditions. Motivated by these unresolved behaviors, we establish a mechanistic framework using two tin chalcogenides with distinct structures and surface chemistries.Orthorhombic SnS and hexagonal SnS2 crystallites were synthesized hydrothermally and systematically examined before and after air annealing (300 °C, 1 h). Surface-sensitive XPS and thermal analyses reveal S⊠O anionic exchange accompanied by surface oxidation, yielding a SnO2-rich surface layeron SnS (~96% SnO2 with ~4% SnS) and a SnS2-dominant surface with minor SnO2 on SnS2 (~74.6% SnS2 with ~18% SnO2). Mott–Schottky results confirm that initially p-type SnS becomes n-type after annealing, providing a direct explanation for why nominally p-type chalcogenides frequently exhibit n-type sensing behavior at 200–300 °C due to oxygenation-driven surface phase evolution. After stabilization at 300 °C and operation at 250 °C, both sensors show stable, reversible n-type responses to NO2 (0.5–10 ppm) and reducing gases (H2, ethanol, acetone, HCHO, and H2S). The p-SnS/n-SnO2 sensor achieves responses of 18.55 (1000 ppm H2), 6.34 (100 ppm HCHO), 23.67 (10 ppm H2S), and ~10 (5 ppm NO2), while the n-SnS_2/n-SnO2 sensor exhibits competitive responses, notably toward ethanol and acetone. We attribute the enhanced sensitivity to interfacial barrier modulation in oxygenation-induced p–n (SnS/SnO2) and n–n (SnS2/SnO2) heterojunctions. Overall, the results identify oxygenation as a decisive, surface-governed factor controlling polarity and sensitivity and suggest pre-annealing/controlled oxygenation as a practical route to stabilize and tune chalcogenide-based gas sensors in air.

BIOGRAPHY:

Prof. Dr. Yun-Hyuk Choi is affiliated with the Department of Advanced Materials and Chemical Engineering at Daegu Catholic University, Republic of Korea. He previously worked as a researcher at Samsung Advanced Institute of Technology and conducted postdoctoral research at Texas A&M University. His research focuses on functional oxide and chalcogenide materials for electronic, energy and environmental applications, including electrocatalytic water splitting, high-entropy oxide catalysts, and semiconductor gas sensors. His recent work emphasizes defect chemistry, oxygen incorporation, phase transformation, and structure–property relationships in advanced ceramic and two-dimensional materials. Through these studies, he aims to elucidate the mechanisms governing catalytic activity, electronic conduction, and gas-sensing performance under practical operating conditions.

Carlos M. Pereira

Centro de Investigação em Química da Universidade do Porto/ Instituto de Ciências Moleculares (CIQUP/IMS), Porto, Portugal

Photo-Electrochemical Approaches for Waste Degradation: A Sustainable Solution for Environmental Remediation

ABSTRACT:

Industrial wastes pose severe environmental and public health threats. In particular, the leather industry has been known to generate significant negative environmental impact due to the need for intensive chemical treatment to preserve and confer on leather the properties that make it a classic consumer product, namely, durability and comfort. The liquid effluents generated during leather processing, from raw hide to the finished product, amount to 45-50 m3/ton of raw hide [1].
Conventional waste treatment methods often fail to fully degrade these pollutants, necessitating the development of innovative and sustainable remediation strategies. In this study, we explore two advanced degradation techniques:

(i) photocatalytic degradation using TiO_2-carbon composites;
(ii) electrochemical degradation employing a Ni-TiO_2@C composite electrode.

The TiO_2-carbon composite, synthesized via an electrochemical method using a deep eutectic solvent (DES), exhibited a high specific surface area and enhanced photocatalytic efficiency for dye degradation under both UV and visible light irradiation [2]. This material achieved up to 98% degradation efficiency, demonstrating its potential as a sustainable photocatalyst for wastewater treatment.

The complementary nature of these photocatalytic and electrochemical approaches highlights their potential for integration into industrial wastewater treatment systems. This work provides a promising pathway for the sustainable and efficient degradation of leather industry pollutants, contributing to environmental preservation and circular economy initiatives.

ACKNOWLEDGMENTS

National and European funds financially supported the work through FCT under Research Grant UIDB/00081/2025 (https://doi.org/10.54499/UIDB/00081/2025)- CIQUP, LA/P/0056/2020 (https://doi.org/10.54499/LA/P/0056/2020) - IMS and Portuguese Recovery and Resilience Plan and by the NextGeneration EU European funds in its component 12 – Sustainable Bioeconomy, Investment under project Bioshoes4All (TC-C12-i01).

Keywords: Industrial waste; Photo-Electrochemical; waste treatment.

BIOGRAPHY:

[1] J. Kanagaraj, T. Senthilvelan, R.C. Panda, S. Kavitha, Journal of Cleaner Production, 2015, 89, 1-17. https://doi.org/10.1016/j.jclepro.2014.11.013.
[2] A.T.S.C. Brandão, S. State, L.B. Enache, R. Costa, G.V. Mihai, J.A. Vázquez, J. Valcarcel, L. Anicai, M. Enachescu, C.M. Pereira, Nanomaterials 2026, 16(9), 538; https://doi.org/10.3390/nano16090538

Baris Cetin

FNSS Savunma Sistemleri A.Ş., R&D Center, 06830, Gölbaşı, Ankara
Turkey

A Computational Based Framework Strategy on Driveline System Components Design at FNSS

ABSTRACT:

Armored combat vehicles undergo highly demanding life-cycle scenarios, subjecting driveline systems to severe payloads and mechanical or thermal shocks. To ensure robust performance, a concurrent design strategy built on a computational framework is essential to deliver time- and cost-effective solutions. This study presents a computational method-embedded design strategy developed at FNSS, aimed at reducing development iterations, enhancing reliability predictions, and supporting informed trade-offs between weight, durability, and producibility. The workflow -in particular- utilizes KissSys analysis to generate spectrum-calibrated, misalignment, and transient loads, which serve as inputs for structural finite element analysis (FEA) within the Ansys environment.For some criticalapplications, thermo-mechano-metallurgical simulations are also run to define and predict a more robust process recipe regarding heat and surface treatment applications. Finally, this work demonstrates the alignment between these computational efforts and their subsequent experimental validations.

Keywords: Driveline systems, computational framework, KissSys

BIOGRAPHY:

Barış Çetin graduated from Middle East Technical University (Ankara/Turkey), Mechanical Engineering Department in 2003.After 10 years of experience in automotive industry, he has been working at R&D Center of FNSS Savunma Sistemleri A.S.as SME – Advanced Material Technologiessince December 2013. By January 2017, he completed his M.Sc.at Atılım University (Ankara/Turkey), Manufacturing Engineering Department and he received his Ph.D. degree from the Dept. of Mechanical Engineering at the same university.He has professional experience in theory of plasticity, terminal ballistics,metal forming processes, mechanical characterization, computational metallurgy, quantitative metallography and Advanced High Strength Steels (AHSS). He has several journal articles and conference papers regarding to these scientific fields.

Caner Bakrac

FNSS Savunma Sistemleri A.Ş., R&D Center, 06830, Gölbaşı, Ankara
Turkey

A Computational Based Framework Strategy on Driveline System Components Design at FNSS

ABSTRACT:

systems to severe payloads and mechanical or thermal shocks. To ensure robust performance, a concurrent design strategy built on a computational framework is essential to deliver time- and cost-effective solutions. This study presents a computational method-embedded design strategy developed at FNSS, aimed at reducing development iterations, enhancing reliability predictions, and supporting informed trade-offs between weight, durability, and producibility. The workflow -in particular- utilizes KissSys analysis to generate spectrum-calibrated, misalignment, and transient loads, which serve as inputs for structural finite element analysis (FEA) within the Ansys environment.For some criticalapplications, thermo-mechano-metallurgical simulations are also run to define and predict a more robust process recipe regarding heat and surface treatment applications. Finally, this work demonstrates the alignment between these computational efforts and their subsequent experimental validations.

Keywords: *Driveline systems, computational framework, KissSys*

BIOGRAPHY:

Caner Bakraç received his B.Sc. degree in Manufacturing Engineering from Atılım University (Ankara/Turkey) in 2012. Following early engineering roles in the aviation and machinery sectors, he joined the R&D Center of FNSS Savunma Sistemleri A.Ş. in 2016 and currently serves as Subject Matter Expert in Driveline Systems Design and Development. With approximately 14 years of experience, his technical expertise is centered on driveline architectures for armored military platforms. His work encompasses gearbox design and verification, macro–micro gear geometry development, load distribution analysis, spline and shaft interface design, bearing arrangement engineering, and lubrication/cooling system development. He is also engaged in system-level modeling and performance assessment using advanced computational tools and design standards.