TWENTY-FOURTH YOUNG RESEARCHERS' CONFERENCE

MATERIALS SCIENCE AND ENGINEERING

December 2 – 4, 2026, Belgrade, Serbia

Program and the Book of Abstracts

Materials Research Society of Serbia
&
Institute of Technical Sciences of SASA

2026

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Aim of the Conference

Main aim of the conference is to enable young researchers (post-graduate, master or doctoral student, or a PhD holder younger than 35) working in the field of materials science and engineering, to meet their colleagues and exchange experiences about their research.

Topics

Biomaterials
Environmental science
Materials for high-technology applications
Materials for new generation solar cells
Nanostructured materials
New synthesis and processing methods
Theoretical modelling of materials

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Results of the Conference

Beside printed «Program and the Book of Abstracts», which is disseminated to all conference participants, selected and awarded peer-reviewed papers will be published in journal "Tehnika – Novi Materijali". The best presented papers, suggested by Session Chairpersons and selected by Awards Committee, will be proclaimed at the Closing Ceremony. Part of the award is free-of-charge conference fee at YUCOMAT 2026.

Sponsors

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Programme
Twenty-Fourth Young Researchers Conference
Materials Science and Engineering

Wednesday, December 2nd, 2026

09.20 – 09.30 Opening Ceremony
Dr. Smilja Marković, Presidents of 24YRC Sientific committee

09.30 – 10.00 Master Class 1 - Biomaterials
From Tissue to Tumor Engineering: Biomimetic 3D Cell Cultures Using Biomaterials and Bioreactors
Prof. Dr. Bojana Obradović
University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia

10.00 – 11.30 1st Session – Biomaterials I
Chairpersons: Prof. Dr. Bojana Obradović and Katarzyna Pastuszak

10.00 – 10.15 Multifunctional 3D-Printed Scaffolds for Extracellular Vesicles Release and Antimicrobial Activity
Teodora Jakovljević[1], Tamara Stajić[2], Marija Milivojević[1], Vukašin Ugrinović[1], Miloš Papić[3], Biljana Ljujić[3], Tamara Vlajić Tovilović[4], Milena Radunović[4], Đorđe Veljović[2]
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10.15 – 10.30 Dualism of pulmonary surfactant – the key factor of innate immunity that bacteria use to adapt
Katarzyna Pastuszak[1], Marta Palusińska-Szysz[2], Małgorzata Jurak[1]
[1]Department of Interfacial Phenomena, Institute of Chemical Sciences, Faculty of Chemistry, Maria Curie-Skłodowska University, Maria Curie-Skłodowska Sq. 3, 20-031 Lublin, Poland, [2]Department of Genetics and Microbiology, Institute of Biological Sciences, Faculty of Biology and Biotechnology, Maria Curie-Skłodowska University, Akademicka 19, 20-033 Lublin, Poland

10.30 – 10.45 Influence of cell concentration on the rheological properties of oxidized cellulose bioink

Rauany Lopes Panis, Nathalie Neta Domingos, Mônica Rosas Costa Iemma, Eliane Trovatti
University of Araraquara (Uniara) – Araraquara, São Paulo, Brazil

10.45 – 11.00 Influence of solvothermal synthesis parameters on the properties of PEI-functionalized $NaY_{1-x}Gd_xF_4$:Yb/Er up-converting nanoparticles for bioimaging applications

Miljana Piljevic[1], Ivana Dinic[2], Lidija Mancic[2], Marina Vukovic[2], Maria Eugenia Rabanal[3], Mihailo D. Rabasovic[1]
[1]Photonic Center, Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, Zemun, 11080, Belgrade, Serbia, [2]Institute of Technical Sciences of SASA, Kneza Mihaila St. 35, 11000, Belgrade, Serbia, [3]Department of Materials Science and Engineering and Chemical Engineering, Universidad Carlos III de Madrid and IAAB, 28903, Madrid, Spain

11.00 – 11.15 Effects of Hydrothermal Aging and Staining on the Optical Properties of Three Dental Composites Fabricated by Different Methods

Nikola Živković[1], Marina Vuković[2], Miloš Tomić[2], Lidija Mančić[2], Jelena Mitrić[3] Aleksandra Milić-Lemić[1]
[1]School of Dental Medicine, University of Belgrade, Rankeova 4, 11000, Belgrade, Serbia, [2]Institute of Technical Sciences of SASA, Kneza Mihaila St. 35, 11000, Belgrade, Serbia, [3]Institute of Physics, University of Belgrade, Pregrevica 118, 11000 Belgrade, Serbia

11.15 – 11.30 A sweetener and an antibiotic: a potentially bioactive pairing in research on antibacterial biomaterials

Olivér Csákány[1,2,3,4], Richard Mihalcea[4], Zalán Zsombori[4], Annamária Vitos[4], Szilárd Fejér[1,2]
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11.30 – 11.45 Break

11.45 – 13.15 2nd Session – Biomaterials II
Chairpersons: Dr. Ivana Drvenica and Nikola Bajčetić

11.45 – 12.00 Physicochemical and Antioxidant Properties of Lamotrigine-Fullerenol nanoformulations
Jelena Tomić, Neda Gačić, Danica Jović, Aleksandar Djordjevic, Ivana Borišev
University of Novi Sad, Faculty of Sciences, Department of chemistry, biochemistry and environmental protection, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia

12.00 – 12.15 Plasmolyzed and Autoclaved Spent Brewer's Yeast as Probiotic Carriers: A Comparative Physicochemical Study
Nikola Bajčetić[1], Ana Todorović[1], Bojana Balanč[2], Verica Đorđević[3], Viktor Nedović[1] and Milica Mirković[1]
[1]Faculty of Agriculture, University of Belgrade, Nemanjina 6, 11080 Belgrade, Serbia, [2]Innovation Centre of Faculty of Technology and Metallurgy, Karnegijeva 4, 11000 Belgrade, Serbia, [3]Faculty of Technology and Metallurgy, University of Belgrade, Karnegijeva 4, 11000 Belgrade, Serbia

12.15 – 12.30 Preparation of *Urtica dioica* extracts using different solvent mixtures, and their incorporation to gelatin hydrogels
Simona Bajović[1], Nina Tomić[2]
[1]University of Belgrade – Faculty of Biology, Studentski trg 16, 11000 Belgrade, Serbia, [2]Institute of Technical Sciences of SASA, Kneza Mihaila 35/IV, 11000 Belgrade, Serbia

12.30 – 12.45 Pectin from medlar (*Mespilus germanica* L.) fruit: a new source of a functional biopolymer
Nenad Mićanović[1], Nada Ćujić Nikolić[2], Nemanja Krgović[2], Jelena Živković[2], Katarina Šavikin[2], Jelena Popović-Đorđević[1]
[1]University of Belgrade, Faculty of Agriculture, Belgrade, Serbia, [2]Institute for Medicinal Plants Research "Dr Josif Pančić", Belgrade, Serbia

12.45 – 13.00 Culture Temperature Modulates Cartilage Viability, Proteoglycan Preservation and Inflammatory Responses in Osteochondral Explants
Jelena Petrović[1,2], Fatemeh Safari[1], Sibylle Grad[1], Martin J. Stoddart[1], Zhen Li[1]
[1]AO Research Institute Davos, Davos, Switzerland
[2]University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia

13.00 – 13.15 Phlorotannin-loaded chitosan nanoparticles from *Spatoglossum asperum* ameliorate *Aβ42*-induced neurodegenerative phenotypes in *Drosophila melanogaster*
Deepika Kale[1], Blairil Vishma Dcunha[2], Sreeja Lakshmi[1], Shamprasad V. Raghu[2], Preetham Elumalai[1]
[1] Centre of Excellence and its Infrastructure for Aquatic Vaccine Development, Department of Marine Biology, Microbiology and Biochemistry, School of Marine Sciences, Cochin, University of Science and Technology, Kochi – 682016, Kerala, India, [2] Yenepoya Research Centre (YRC), Yenepoya (Deemed to be University), University Road, Deralakatte, Mangalore- 575018, Karnataka, India

13.15 – 14.15 Lunch break

14.15 – 15.45 3rd Session – Theoretical Modelling
Chairpersons: Dr. Marko Opačić and Nilesh Kumar

14.15 – 14.30 Competing Thiolate and Carboxylate Anchoring Modes of a Bifunctional Ligand on PbS Quantum Dot (111) Facets: A DFT Study
Nilesh Kumar, Matic Poberžnik, Juraj Nikolić, Darja Lisjak, Anton Kokalj
Jožef Stefan Institute, Jamova 39, SI-1000 Ljubljana, Slovenia

14.30 – 14.45 Right Energy, Wrong Exciton: Testing Screening Models in 2D Semiconductors
Nilesh Kumar
Department of Physical and Organic Chemistry, Jožef Stefan Institute, Jamova 39, SI-1000 Ljubljana, Slovenia

14.45 – 15.00 Influence of iodine substituent position on properties of nitroaromatic compounds as potential high-energy materials
Aleksandra Đunović[1], Dušan Veljković[2]
[1]Innovative Centre of the Faculty of Chemistry Ltd., Belgrade, Serbia, [2]University of Belgrade – Faculty of Chemistry, Belgrade, Serbia

15.00 – 15.15 An Artificial Neural Network-Based Surrogate Model for Predicting Transport Characteristics of THz Quantum Cascade Lasers
Mihailo Stojković[1], Nikola Vuković [1], Novak Stanojević [1,2], Jelena Radovanović [1]
[1]School of Electrical Engineering, University of Belgrade, Bulevar kralja Aleksandra 73, 11120 Belgrade, Serbia, [2]Vlatacom Institute of High Technologies, Bulevar Milutina Milankovica 5, Belgrade, 11070, Serbia

15.15 – 15.30 Entropy Generation from Surface Adsorption Fluctuations: A Stochastic Modelling Study
Jelena N. Stevanović[1], Tom Miclot[2], Florent Barbault[2], Milena Rašljić Rafajilović[1], Katarina Cvetanović[1], Ivana Mladenović[1], Ivana Jokić[1] and Olga Jakšić[1]
[1]Insitute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, Belgrade, Serbia, [2]Université Paris Cité, CNRS, F-75013 Paris, France

15.30 – 15.45 Multiband Frequency - Selective 1d Photonic Crystal Materials Optimized Via Genetic Algorithm Parameter Control
Anja Perić[1], Olga Jakšić[2]
[1]PhD student at Faculty of Physics, University of Belgrade, Belgrade, [2]Department of Microelectronic Technologies, Institute of Chemistry Technology and Metallurgy - National Institute of the Republic of Serbia, University of Belgrade, Belgrade

15.45 – 16.00 Break

16.00 – 17.15 4th Session – New Synthesis and Processing Methods
Chairpersons: Prof. Dr. Konrad Terpiłowski and Aleksandar Petričević

16.00 – 16.30 Invited: When Color Reveals Degradation: Surface Aging and Reuse Potential of Recycled High-Impact Polystyrene
Benita Malinowska[1,2], Michał Chodkowski[3], Konrad Terpiłowski[2], Maciej Nastaj[4]
[1]Polish Recycling Corporation, Metalurgiczna 15c, 20-234 Lublin, Poland, [2]Department of Interfacial Phenomena, Maria Curie-Skłodowska University, 20-031 Lublin, Poland, [3]Department of Technology and Polymer Processing, Lublin University of Technology, 20-618 Lublin, Poland, [4]Department of Dairy Technology and Functional Foods, Faculty of Food Sciences and Biotechnology, University of Life Sciences in Lublin, Skromna 8, 20-704 Lublin, Poland

16.30 – 16.45 Advanced Ni–MoO_X Composite Cathodes: Linking Surface Composition, Electrode Geometry and Hydrogen Evolution
Aleksandar Petricevic[1], Piotr Zabinski[2], Mila Krstajic Pajic[3], Vladimir D. Jovic[1], Evangelia Pavlatou[4], Maria-Anna Gatou[4], Nevenka Elezovic[1]
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16.45 – 17.00 COST STILLNESS – Building Networks, Advancing Careers, Shaping the Future
Stefana Milosavljevic, Aleksandar Petricevic, Nevenka Elezovic
University of Belgrade Institute for Multidisciplinary Research, National Institute of the Republic of Serbia, Kneza Viselsava 1, 11030 Belgrade

17.00 – 17.15 Decomposition of calcium borohydride nanoconfined inside ZIF-67
Martin Sojka[1], Olena Zavorotynska[2], Volodymyr Babizhetskyy[3], Lubomir Kral[1], Pawel Jewula[4], Zdenek Spotz[4], Ivan Saldan[4], Iaroslav Gnilitskyi[5,6]
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Thursday, December 3rd, 2026

10.00 – 12.00 MDPI Workshop
Presentation 1: **Scientific Paper Writing**, Presenter: Milica Nikolić
Presentation 2: **AI in Publishing**, Presenter: Jelena Romčević

12.00 – 12.15 Break

12.15 – 12.45 Master Class 2 - Materials for High Technology Application
High-entropy ultra-high temperature ceramics advanced materials for extreme environments
Suzana Filipović[1,2]
[1]Institute of Technical Sciences of the Serbian Academy of Sciences and Arts, Belgrade, Serbia, [2]Materials Science and Engineering, Missouri University of Science and Technology, Rolla, Missouri, United States

12.45 – 14.15 5th Session – Materials for High Technology Application
Chairpersons: Dr. Suzana Filipović and Katarina Nestorović

12.45 – 13.00 Evaluation of the significance of barrier effectiveness in preventing hazardous interactions in multicomponent energetic systems
Mirjana Krstović[1,2], Veselin Živanović[1], Teodora Stančić[1], Zoran Bajić[2], Katarina Nestorović[1,2], Danica Bajić[1,2]
[1]Military Technical Institute, Belgrade, Serbia, [2]University of Defence, Military Academy, Belgrade, Serbia

13.00 – 13.15 Experimental assessment of fragmentation and bond failure in order to examine structural integrity of solid propellant materials
Katarina Nestorović[1,2], Mirjana Krstović[1,2], Marina Simović Pavlović[3], Teodora Stančić[1], Danica Bajić[1,2]
[1]Military Technical Institute, Belgrade, Serbia, [2]University of Defense, Military Academy, Belgrade, Serbia, [3]Faculty of Mechanical Engineering, Belgrade, Serbia

13.15 – 13.30 Influence of boron particle size and incorporation method on energetic output of boron-based pyrotechnic compositions
Branka Džunić[1], Jelena Petković-Cvetković[1], Zoran Bajić[2], Mirjana Krstović[1,2], Aleksandar Ćitić[1], Danica Bajić[1,2]
[1]Military Technical Institute, Belgrade, Serbia, [2]University of Defence, Military Academy, Belgrade, Serbia

13.30 – 13.45 Influence of particle size and morphology of aluminium and magnesium powders on their oxidation and thermal behaviour
Ognjen Rajković[1], Mirjana Krstović[1,2], Aleksandar Ćitić[1], Danica Bajić[1,2]
[1]Military Technical Institute, Belgrade, Serbia, [2]University of Defence, Military Academy, Belgrade, Serbia

13.45 – 14.00 Rational Design and Synthesis of Bisphenanthro[9,10-d]imidazole-Based Donor–Acceptor Architectures for High-Performance Multilevel Resistive Memory Device Applications
Madanan Akshaya[1], Samuthira Nagarajan[1]
[1]Division of Organic Electronics, Department of Chemistry, Central University of Tamil Nadu, Thiruvarur, Tamil Nadu, 610 005, India

14.00 – 14.15 Enhanced properties and oxidation resistance of (Hf,Zr)(C,N) ceramics via compositional tuning
Egor Kuzmenko
Tomsk Polytechnic University, Tomsk, Russia

14.15 – 15.15 Lunch break

15.15 – 17.00 6th Session – Materials for High-technology Application II and Materials for New Generation Solar Cells
Chairpersons: Dr. Vladimir Rajić and Dr. Marko Jelić

15.15 – 15.30 Illumination-Intensity-Dependent Photocurrent and Open-Circuit Potential Dynamics in Ni/Co-Modified $BiVO_4$ Photoanodes
Marko Jelić[1], Zoran Jovanović[1], Janez Kovač[2], Marko V. Bošković[3], Suraj Gupta[4], Matjaž Spreitzer[4], Sonja Jovanović[1]
[1]Vinča Institute of Nuclear Sciences – National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia, [2]Department of Surface Engineering, Jožef Stefan Institute, Ljubljana, Slovenia, [3]Center for Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia, [4]Advanced Materials Department, Jožef Stefan Institute, Ljubljana, Slovenia

15.30 – 15.45 Tailoring crystallinity and interface properties of STO thin films on silicon for enhanced photoelectrochemical hydrogen evolution
Darija Petković[1], Matjaž Spreitzer[2], Zoran Jovanović[1]
[1]Laboratory of Physics, Vinča Institute of Nuclear Sciences – National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia, [2]Advanced Materials Department, Jožef Stefan Institute, Ljubljana, Slovenia

15.45 – 16.00 Fluoride-mediated phase evolution and film formation in $FAPbI_3$ perovskites: structural, optical, morphological, and thermal characterization
Barbara Ramadani, Vladimir Rajić, Miloš Milović, Milutin Ivanović
Vinca Institute of Nuclear Sciences – National Institute of the Republic of Serbia, University of Belgrade, Serbia

16.00 – 16.15 Lattice Fingerprints of Magnetic Rearrangements in Mn_3Sn_2
Gorana Madžarević[1], Ana Kanjevac[2], Jovan Blagojević[2], Jelena Pešić[2], Ana Milosavljević[2], Nenad Lazarević[2]
[1]Faculty of Physics, University of Belgrade, Belgrade, Serbia, [2]Center for Solid State Physics and New Materials, Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia

16.15 – 16.30 Strain Reveals a Hidden Lattice Response in FeSe
Jovan Blagojević[1], Ana Milosavljević[1], Tea Belojica[1], Bojana Višić[1,2], Marko Opačić[1], Andrijana Šolajić[1], Jelena Pešić[1], Enrico Di Lucente[3], Novica Paunović[1], Milorad V. Milošević[4,5], Emil S. Bozin[1], Aifeng Wang[6], Cedomir Petrovic[7,8,9,10], Zoran V. Popović[11], Rudi Hackl[12,13], and Nenad Lazarević[1]
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16.30 – 16.45 Raman signatures of anharmonic phonon dynamics in the thermoelectric material In_4Te_3

Tea Belojica[1], Jovan Blagojević [1], Ana Kanjevac[1], Petar Mitrić[1], Cedomir Petrovic[2,3,4], Ana Milosavljević[1], Nenad Lazarević[1]
[1]Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia, [2]Shanghai Advanced Research in Physical Sciences (SHARPS), Shanghai 201203, China, [3]Department of Nuclear and Plasma Physics, Vinca Institute of Nuclear Sciences, University of Belgrade, Belgrade 11001, Serbia, [4]Center for High Pressure Science & Technology Advanced Research (HPSTAR), Beijing 100094, China

16.45 – 17.00 Phonon Signatures of Electronic Anomalies in $ZrTe_5$

Ana Kanjevac[1], Ana Milosavljević [1], Jovan Blagojević[1], Qiang Li[2], Emil S Bozin[1] and Nenad Lazarević[1]
[1]Center for Solid State Physics and NewMaterials, Institute of Physics Belgrade, Pregrevica 118, P.O. Box 68, 11080 Belgrade, Serbia, [2]Condensed Matter Physics and Materials Science Department, Brokhaven National Laboratory, Upton, New York 11973-5000, USA

Friday, December 4th, 2026

09.30 – 10.00 Encouraging young researchers to apply for grants: What I learned from grants I got and grants I didn't
Dr. Nevena Antić
University of Belgrade, Institute of Chemistry, Technology and Metallurgy, Department of Chemistry, Geochemistry and Environmental Chemistry, St. Trg 12-16, 11000, Belgrade, Serbia

10.00 – 11.00 7th Session – Nanostructured Materials I
Chairpersons: Dr. Marina Vuković and Andrijana Pantelić

10.00 – 10.15 $Ti_3C_2T_x$ MXene Functionalized Textiles as Vibration Sensors
Aleksa Bakoč[1], Marko Spasenović[2], Ivan Pešić[2], Marko Bošković[2], Marija V. Pergal[2]
[1]Faculty of Physical Chemistry, University of Belgrade, Studentski trg 12-16, Belgrade, Serbia, [2]Institute of Chemistry, Technology and Metallurgy, University of Belgrade, National Institute of the Republic of Serbia, Njegoševa 12, Belgrade, Serbia

10.15 – 10.30 Carbon Fiber/MXene Hybrid Aerogels for High-Efficiency EMI Absorption
Rabia Pala, Onur Ergen
Department of Nanoscience and Nanoengineering, Istanbul Technical University, Istanbul, Türkiye

10.30 –10.45 Up-conversion luminescence thermometry and biological evaluation of Yb^{3+}, Tm^{3+} doped $MgGd_2Zr_2O_8$ nanoparticles
Andrijana Pantelić[1], Vesna Lojpur[1], Nina Tomić[2], Ljiljana Veselinović[2], Miloš Tomić[2], Lidija Mančić[2], Miljana Piljević[3], Aleksandar Krmpot[3], Tijana Stamenković[1]
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10.45 – 11.00 Titanate Nanotube-Reinforced Waterborne Polyurethane Nanocomposites
Silvia Mares Barbosa[1,2], Beata Strachota[2], Adam Strachota[2], Ewa Pavlova[2]

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11.00 – 11.15 Break

11.15 – 12.45 8th Session – Nanostructured Materials II
Chairpersons: Dr. Željko Mravik and Sara Lukovac

11.15 – 11.30 Photoluminescent properties of Yb^{3+}/Er^{3+} co-doped $NaYF_4$ and Y_2O_3 nanoparticles for infrared detection
Aleksa Stefanović, Lidija Mančić, Miloš Tomić
Institute of Technical Sciences of SASA, Kneza Mihaila St. 35, 11000, Belgrade, Serbia

11.30 – 11.45 Sustainable valorization of industrial waste from Montenegro through geopolymerization
Sara Lukovac[1], Nebojša Tadić[2], Dijana Đurović[3], Irena Nikolić[2]
[1]Institute for interdisciplinary and multidisciplinary studies, University of Montenegro, Cetinjska br. 2, Podgorica, Montenegro, [2]Faculty of Technology, University of Montenegro, Džordža Vašingtona bb, Podgorica, Montenegro, [3]Centre for Ecotoxicological Research, Bulevar Šarla De Gola 2, Podgorica, Montenegro

11.45 – 12.00 Synthesis and characterization of CQDs sourced from the plant St. John's wort
Ana Marković, Biljana Todorović Marković, Zoran Marković
Vinča Institute of Nuclear Sciences, National Institute of the Republic of Serbia, University of Belgrade, Mike Alasa 12-14, 11001 Belgrade, Serbia

12.00 – 12.15 Spectroscopic and Morphological Investigation of Gamma-Irradiated Poly(methyl methacrylate) in Chloroform
Vanja Ćirić[1], Biljana Todorović Marković[1], Janez Kovač[2], Zoran Marković[1]
[1]Vinča Institute of Nuclear Sciences, National Institute of the RS, University of Belgrade, Mike Petrovića Alasa 12-14, 11001 Belgrade, Serbia, [2]Jozef Stefan Institute, Department of Surface Engineering, Jamova 39, SI-1000 Ljubljana, Slovenia

12.15 – 12.30 Substrate dependent formation and photocatalytic performance of plasma electrolytic oxidation coatings incorporating ZSM5
Marko Dević[1], Kristina Mojsilović[1], Nenad Tadić[1], Ljiljana Damjanović-Vasilić[2], Srna Stojanović[2], Katarina Rondović[2], Rastko Vasilić[1]

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12.30 – 12.45 Effective adsorbent for the removal of methylene blue using natural serpentine/magnetite nanocomposites: Isotherm and kinetic study
Amtul Basit
Department of Materials Science and Engineering, Institute of Space Technology, Islamabad, 44000, Pakistan

12.45 – 13.45 Lunch break

13.45 – 14.15 Master Class 3 – Environmental Materials
Zeolite-Based Multifunctional Materials for Environmental Remediation: Fluorescent Detection, Adsorption, and Photocatalysis in Aqueous Media
Ljiljana Damjanović-Vasilić
University of Belgrade, Faculty of Physical Chemistry, Belgrade, Serbia

14.15 – 15.15 9th Session – Environmental Materials I
Chairpersons: Prof. Dr. Ljiljana Damjanović-Vasilić and Andrej Kukuruzar

14.15 – 14.30 Synthesis and performance of differently modified bismuth tungstate-based catalysts for methylene blue photocatalytic removal from water
Andrej Kukuruzar [1], Jovana Tomić [2], Dalibor Stanković [2]
[1]Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Serbia, [2]Faculty of Chemistry, University of Belgrade, Serbia

14.30 – 14.45 Surface chemistry and methylene blue removal in γ-irradiated *ms*-$BiVO_4$: Contributions of adsorption and photocatalysis
Nataša Tot[1], Bojana Vasiljević[1], Vesna Despotović[2], Dragana Marinković[1]
[1]Vinča Institute of Nuclear Sciences, National Institute of the Republic of Serbia, University of Belgrade, P. O. Box 522, 11001 Belgrade, Serbia, [2]University of Novi Sad Faculty of Sciences, Department of Chemistry, Biochemistry and Environmental Protection, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia

14.45 – 15.00 Valorization of Post-Extraction Lignocellulosic Forest Biomass as a Sustainable Adsorbent for Congo Red Removal from Aqueous Solutions
Galina Jevđenović[1], Nevena Ilić[2], Miona Miljković[1], Marija Milić[1], Katarina Mihajlovski[1], Mihajlo Bogdanović[1], Slađana Davidović[1]

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15.00 – 15.15 The application of Fourier-transform infrared spectroscopy in characterization of liver oil from deep-sea sharks
Elia N. Latta[1,2], Nina Tomić[2,3], Emina Karalić[2], Andrej A. Gajić[2]
[1]University of Copenhagen, Faculty of Science, [2]Sharklab ADRIA: Center for marine and freshwater biology, Vlorë, Albania, [3]Institute of Technical Sciences of SASA, Kneza Mihaila 35/IV, 11000 Belgrade, Serbia

15.15 – 15.30 Break

15.30 – 16.30 10th Session – Environmental Materials II
Chairpersons: Dr. Smilja Marković and Kristina Spasić

15.30 – 15.45 Enhanced Photocatalytic Performance of Zeolite-Modified Plasma Electrolytic Oxidation (PEO) Coatings
Kristina Mojsilović[1], Rastko Vasilić [1], Katarina Rondović[2], Ljiljana Damjanović-Vasilić[2].
[1]Faculty of Physics, University of Belgrade, Studentski trg 12-16, 11000 Belgrade, Serbia, [2]Faculty of Physical Chemistry, University of Belgrade, Studentski trg 12-16, 11000 Belgrade, Serbia

15.45 – 16.00 Electrochemical determination of ceftriaxone in aqueous solutions using ZnO/SnO_2-modified screen-printed carbon electrodes
Kristina Spasić[1,2], Katarina Aleksić Pendić[2], Ljiljana Veselinović[2], Vladimir Rajić[3], Ivana Stojković Simatović[1], Smilja Marković[2]
[1]University of Belgrade - Faculty of Physical Chemistry, Belgrade, Serbia, [2]Institute of Technical Sciences of SASA, Belgrade, Serbia, [3]Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

16.00 – 16.15 Electrochemical Sensing of Ceftriaxone Using Barium Titanate Stannate-Based Materials
Lara Lučin[1], Katarina Aleksić Pendić[2], Ljiljana Veselinović[2], Vladimir Rajić[3], Aleksa Stefanović[2], Ivana Stojković Simatović[1], Smilja Marković[2]
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16.15 – 16.30 Precious metal ions sorption using polymeric matrix impregnated with di-n-alkyl sulfide

Karolina Zinkowska, Grzegorz Wójcik
Department of Inorganic Chemistry, Institute of Chemical Sciences, Faculty of Chemistry, Maria Curie-Skłodowska University, Maria Curie-Skłodowska Sq. 2, 20-031 Lublin, Poland

16.30 Closing Ceremony

ABSTRACTS

Master Class 1 - Biomaterials

From Tissue to Tumor Engineering: Biomimetic 3D Cell Cultures Using Biomaterials and Bioreactors

Bojana Obradović

University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia

Biomimetic three-dimensional (3D) cell cultures are at the forefront of contemporary biomedical research, as they aim to recapitulate the physiological microenvironment of cells, enabling the *in vitro* imitation of complex tissues, organs, and even pathological conditions. Such systems are particularly significant in tissue engineering, where the goal is to enhance cell differentiation and extracellular matrix regeneration to create functional tissue constructs for potential clinical use. Conversely, biomimetic 3D cell cultures are also crucial for tumor engineering, allowing for the *in vitro* modeling of malignant tumors for advanced cancer research, anticancer drug testing, and the potential development of personalized therapies.

Central to both applications are systems based on biomaterials and bioreactors, which together provide the necessary support for functional, long-term cell cultures. Biomaterials mimic the native extracellular matrix, offering a 3D structure for cell attachment, organization, and appropriate mechanical properties. Bioreactors complement this by delivering efficient transport of biochemical signals, facilitating metabolite exchange, and supplying physical cues that closely resemble those found *in vivo*. The design of these systems is inherently interdisciplinary, requiring careful integration tailored to the structure and function of specific tissues.

In this lecture, examples of the development and use of such *in vitro* culture systems will be presented, with particular focus on skeletal tissues. Special attention will be given to the application of bone-mimicking systems for 3D osteosarcoma cell culture and anticancer drug testing, illustrating the translational potential of biomimetic 3D platforms in both regenerative medicine and oncology.

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1-1

Multifunctional 3D-Printed Scaffolds for Extracellular Vesicles Release and Antimicrobial Activity

Teodora Jakovljević[1], Tamara Stajić[2], Marija Milivojević[1], Vukašin Ugrinović[1], Miloš Papić[3], Biljana Ljujić[3], Tamara Vlajić Tovilović[4], Milena Radunović[4], Đorđe Veljović[2]
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Three-dimensional (3D) printing techniques, such as masked stereolithography (mSLA), enable the fabrication of precisely designed macroporous polymeric and composite structures that provide structural support for extracellular vesicle (EVs) release with the application of functional coatings. Controlled EVs release represents a promising approach to modulating cellular processes and supporting tissue regeneration. In addition, antimicrobial coatings applied to these platforms may help reduce the risk of microbial contamination during implantation.

This study aimed to develop 3D-printed macroporous polymeric scaffolds based on poly(ethylene glycol) diacrylate (PEGDA), poly(methacrylic acid) (PMAA), and gelatin, as well as composite scaffolds incorporating multi-ion-doped mesoporous bioactive glass (mMBG) particles within the polymer matrix. The polymeric scaffolds were used for EVs release from collagen coating, whereas the composite scaffolds were coated with chitosan-based formulations containing mMBG particles.

Collagen coatings incorporating EVs isolated from cultures of rat adipose-derived stromal cells (rADSCs) enabled sustained EVs release over a period of 17 days. The mMBG particles, doped with Mg^{2+}, Sr^{2+}, Cu^{2+}, and Zn^{2+} ions, were synthesized using a microemulsion-assisted sol–gel method. They exhibited an amorphous structure, a high specific surface area, and well-developed mesoporosity, as confirmed by BET and TEM analysis, alongside good cytocompatibility with BM-MSCs. Incorporating mMBG particles into the polymer matrix and applying chitosan–mMBG coatings influenced the compressive strength and swelling behavior of the scaffolds, while improving their cytocompatibility and antimicrobial properties on *Staphylococcus aureus,* as evaluated using 3D-printed cylinders. These findings highlight the potential of combining 3D-printed polymeric and composite scaffolds with coatings to develop multifunctional platforms integrating sustained EVs release and antimicrobial properties.

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1-2

Dualism of pulmonary surfactant – the key factor of innate immunity that bacteria use to adapt

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Pulmonary alveoli are the main structures responsible for gas exchange in the human body. Their internal surface is covered with a thin lipid-protein layer called pulmonary surfactant (PS). PS is composed of 80-90% of phospholipids, among which as much as 80% is zwitterionic phosphatidylcholine (PC), of which 75% is in the form of 1,2-dipalmitoyl-*sn*-glycero-3-phosphatidylcholine (DPPC). Phosphatidylglycerol (PG) in the form of 1-palmitoyl-2-oleoyl-*sn*-glycero-3-phosphatidylglycerol (POPG), phosphatidylinositol (PI), and cholesterol are also present. The primary function of PS is to reduce surface tension, which prevents alveolar collapse during the respiratory cycle and enables effective gas exchange. Furthermore, pulmonary surfactant is an important component of the innate immunity of the respiratory system. Its components support the lung's defense mechanisms, including by participating in the neutralization of pathogens and regulating the body's inflammatory response. Proper PS function is crucial for maintaining homeostasis within the alveoli, and disruptions in its function can lead to the development of respiratory diseases and increased susceptibility to infections. Nevertheless, the pulmonary surfactant can also be used by harmful microorganisms to adapt to hostile environment and grow resistant to antibiotics. The perfect example of this phenomenon is *Legionella* bacteria, which, as a molecular mimicry mechanism, uses the phosphatidylcholine building the lung surfactant to change the phospholipid composition of their membranes. The *Legionella* spp. during the infection secrete enzymes, that degrade PC of the lung surfactant to choline, and then use this choline to synthesize its own PC in the membrane by PCS pathway. This process leads to the changes in membrane physicochemical properties, thus possibly making the bacteria more resistant to commonly used antibiotics.

The aim of the presentation is to discuss the role of pulmonary surfactant as a component of innate immunity, present the consequences of its malfunction, and outline selected therapeutic applications, but also highlight the ways in which microorganisms can use PS to facilitate the infection of the human body and prevent antibiotics from working effectively.

1-3

Influence of cell concentration on the rheological properties of oxidized cellulose bioink

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The rheological characterization of any polymeric material for use in 3D printing is crucial for assessing the overall printability or injectability of the hydrogel. However, the effect of cells on the rheological profile of cell-loaded hydrogels has not been well studied. Thus, there is a significant difference between the predicted and experimental results in the structural stability of 3D-printed constructs, as well as in the cell viability, proliferation, and differentiation potential of cells incorporated into the hydrogel matrix. This study addressed the rheological effects of different cell densities ($0.1x10^6$, $0.5x10^6$, $1x10^6$, and $2x10^6$ cells/mL) of L929 cells on the flow property and modulus behaviour of our oxidized cellulose bioink. Cellulose was obtained from sugarcane bagasse and chemically treated with TEMPO reagent to obtain oxidized cellulose gel. To prepare the hydrogel, oxidized cellulose gel and calcium chloride were used as a crosslinking agent, into which L929 cells were inserted to obtain the bioink. The cell-loaded bioink demonstrated characteristic shear thinning behaviour (decreasing viscosity with increasing shear rate. Furthermore, the interaction between cell surface molecules and the ionic crosslinking of the hydrogel can alter the bioink properties, which can profoundly affect the rheological properties of the polymer mixture. Therefore, cell density of $0.1x10^6$ cells/mL were considered most suitable for extrusion-based 3D bioprinting due to their ideal rheological characteristics of printability similar to acellular hydrogel. DAPI staining was used to confirm the distribution of cells within the bioink.

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1-4

Influence of solvothermal synthesis parameters on the properties of PEI-functionalized $NaY_{1-x}Gd_xF_4$:Yb/Er up-converting nanoparticles for bioimaging applications

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Lanthanide-doped upconverting nanoparticles (UCNPs) offer a variety of biomedical applications, due to their unique ability to be excited by near-infrared light and to emit light at shorter wavelengths, enabling noninvasive tissue imaging. In order to develop nanoparticles suitable for specific molecular recognition and cell-labeling applications, the crucial synthesis step is their surface functionalization with biocompatible agents. This procees usually requires multiple modification steps, making the overall synthesis more complex. In this study, a simple, potentially more sustainable, one-step polyethyleneimine (PEI)-assisted solvothermal approach was investigated for the synthesis of amino-functionalized $NaY_{1-x}Gd_xF_4$:Yb/Er nanoparticles, as potential probes for the selective labeling of oral squamous cell carcinoma cells. The effects of key synthesis parameters, including the concentration and composition of rare earth precursors, amount of PEI, the solvent, reaction temperature and duration, were systematically investigated. The resulting nanoparticles were characterized in terms of their surface chemistry, upconversion luminescence, crystallinity, morphology and particle size using Fourier transform infrared spectroscopy (FTIR), photoluminescence spectroscopy (PL), X-ray powder diffraction (XRPD) and scanning (SEM) and transmission electron microscopy (TEM). The relationships between the synthesis conditions and the resulting nanoparticle characteristics were evaluated in order to identify parameters that promote the formation of well-defined nanoparticles with favorable optical properties for further investigation in cell-labeling applications. The results revealed that variations in the synthesis conditions significantly affect the morphology and optical behaviour of nanoparticles, highlighting the importance of synthesis optimization for controlling their physicochemical properties. Furthermore, the incorporation of PEI during synthesis provides a straightforward route toward amino-functionalized nanoparticle surfaces, eliminating the need for a separate post-synthesis functionalization step. This approach offers a promising basis for the further development of UCNPs for bioimaging and cell-labeling applications.

1-5

Effects of Hydrothermal Aging and Staining on the Optical Properties of Three Dental Composites Fabricated by Different Methods

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The growing availability of resin-based dental composites with diverse formulations and processing protocols has expanded their applications in restorative dentistry. However, differences in material composition and manufacturing procedures may affect their optical behavior, particularly following prolonged exposure to conditions resembling the oral environment. Color stability and translucency are therefore important considerations when evaluating the esthetic performance of these materials.

This study investigated the influence of hydrothermal aging and staining on three commercially available dental composites: a conventional light-cured composite (Omnichroma; Tokuyama, Tokyo, Japan), a permanent DLP 3D-printed composite (SprintRay CROWN; SprintRay, Los Angeles, CA, USA), and a temporary DLP 3D-printed composite (GC Temp PRINT; GC Europe, Leuven, Belgium). Specimens underwent 0 (T0), 5000 (T1), 10,000 (T2), or 30,000 (T3) thermocycles. Optical properties were assessed by measuring color differences (ΔE00) and translucency parameters (TP) following hydrothermal aging and subsequent immersion in coffee, Coca-Cola, and red wine. Atomic force microscopy (AFM) was used to examine surface topography, while Fourier-transform infrared spectroscopy (FTIR) provided information on aging-related chemical alterations.

The investigated composites exhibited different responses to hydrothermal aging and staining. SprintRay CROWN demonstrated the most favorable overall optical stability, with relatively limited changes in translucency, whereas GC Temp PRINT showed greater susceptibility to discoloration. Staining further affected color stability, particularly after prolonged immersion, with red wine causing the most pronounced discoloration across the investigated materials.

These findings suggest that differences in material formulation and processing protocols contribute to the optical behavior of dental composites, emphasizing the importance of selecting appropriate materials to achieve predictable long-term esthetic outcomes.

1-6

A sweetener and an antibiotic: A potentially bioactive pairing in research on antibacterial biomaterials

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An essential question in the development of antibacterial biomaterials is how compounds intended for incorporation into a carrier material exert their biological effects when combined. The importance of antibiotic resistance also motivates research into multicomponent systems in which another bioactive constituent may modify the activity of an antibiotic. Our study aims to contribute to the microbiological assessment preceding the development of such material systems. We investigate the interaction between acesulfame-K and gentamicin in a Gram-negative bacterial model based on clinical *Klebsiella pneumoniae* isolates. Growth measured under combination treatment is compared with the effects of the individual compounds, the response predicted by Bliss independence and the more effective monotherapy; we also assess the applicability and limitations of the fractional inhibitory concentration index (FICI). The observations suggest concentration- and isolate-dependent responses. From a bioengineering and medical technology perspective, this study may inform the selection of bioactive constituents for incorporation into hydrogel-based wound dressings or antibacterial coatings for medical devices. Understanding compound interactions may help identify compositions and local concentration conditions for evaluation during subsequent material development. This may be particularly important for carrier systems from which the constituents are released at different rates. The use of clinical isolates and complementary evaluation methods may therefore help guide the design of biomaterials with the intended biological function. Further development requires verification of antibacterial activity after incorporation into a material, characterisation of release behaviour and confirmation of biocompatibility.

2-1

Physicochemical and Antioxidant Properties of Lamotrigine-Fullerenol nanoformulations

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The interaction of lamotrigine (LTG) with fullerenol nanoparticles nanoparticles (FNP) was investigated as part of an effort to explore new formulation approaches for this poorly water-soluble antiepileptic drug. Mixtures containing different amounts of FNP and LTG were prepared in 0.5% aqueous ethanol. Changes in their properties were examined by UV–Vis spectroscopy, dynamic light scattering (DLS), and zeta potential measurements, while antioxidant activity was evaluated using DPPH and ABTS assays.

An increase in the intensity of the LTG absorption band near 305 nm was observed with increasing FNP concentration, even after subtracting the absorbance of FNP itself. The position of the absorption maximum did not change appreciably. These observations are consistent with an interaction between LTG and FNP. The FNP dispersions contained mainly particles in the 2–5 nm range, with zeta potentials between −32.3 and −41.7 mV. When LTG was added, the surface charge became less negative. The greatest difference was found at the lowest FNP ratio, where the zeta potential changed from −32.3 to −16.9 mV. The DLS measurements also showed particle populations around 80 and 120 nm at intermediate ratios, which were not dominant in the original FNP dispersions. A different pattern emerged from the antioxidant measurements. In the DPPH assay, each FNP/LTG combination gave a lower response than LTG alone. The opposite was observed with ABTS, although the increase in radical-scavenging activity was relatively small.

The observed spectral changes, together with differences in particle size distribution and surface charge, support noncovalent association between FNP and LTG. This association also appears to affect their antioxidant behavior, providing a starting point for further studies of LTG–fullerenol nanoformulations.

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2-2

Plasmolyzed and Autoclaved Spent Brewer's Yeast as Probiotic Carriers: A Comparative Physicochemical Study

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Spent brewer's yeast is an inexpensive brewing by-product used mainly as animal feed, while some is used in fertilizer production and some is discarded. Yeast cells and cell-wall components have immunomodulatory properties and may also serve as carriers for bioactive compounds and probiotic bacteria. This study evaluated debittered and plasmolyzed, or autoclaved, spent brewer's yeast (*Saccharomyces cerevisiae*) as a carrier for probiotic strain *Lactiplantibacillus plantarum* ZI237. The treated yeast preparations were freeze-dried; bacterial biomass was mixed with a portion of each preparation, and the resulting mixtures were freeze-dried again. Four powders with and without immobilized bacteria were characterized for physicochemical properties and powder-flow characteristics. Compared with the plasmolyzed carrier, the autoclaved carrier showed higher solubility and rehydration capacity but lower bulk density. Following bacterial immobilization, the volume-based median diameter (Dv50) decreased in the plasmolyzed system but increased in the autoclaved system. A shift towards more negative zeta potential values was observed after immobilization (from −6.94 to −14.80 mV in the plasmolyzed system and from −16.13 to −18.20 mV in the autoclaved system). In both systems, immobilization reduced solubility, moisture content, and rehydration capacity, while increasing bulk and tapped densities. These findings indicate that the physicochemical changes associated with bacterial immobilization depend on the yeast treatment and support further development of spent brewer's yeast as a carrier for probiotic powder formulations.

2-3

Preparation of *Urtica dioica* extracts using different solvent mixtures, and their incorporation to gelatin hydrogels

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Urtica dioica L. (stinging nettle) is a widely distributed herbaceous plant rich in bioactive compounds, such as polyphenols, flavonoids and other secondary metabolites. Its' leaves and root have been used traditionally for different ailments and in food preparation. Due to detected antioxidant, anti-inflammatory, and antimicrobial properties, *U. dioica* has attracted interest as a potential source of natural bioactive agents in biomedicine. Incorporation of plant extracts into biopolymer-based hydrogels, such as gelatin hydrogels, represents a promising approach for developing wound dressings that combine a hydrated environment with the potential therapeutic benefits of plant-derived compounds. As extraction procedure determines the yield and the type of bioactive compounds in the extract, we explored the use of different solvents (water, 50% ethanol in water, 70% ethanol in water, 96% ethanol, methanol and acetone) for the extraction via maceration. Water and ethanol/water mixtures resulted in the higest yield of extract. All obtained extracts were then characterized by UV Vis and FTIR spectroscopy, observing the variety dependent of the polarity of the used solvent. Antioxidative activity of extracts was compared using the DPPH assay, showing promising radical scavenging activity. Biocompatibility of all extracts up to 1 mg/mL was indicated by the *Artemia salina in vivo* toxicity assay. Then, the *U. dioica* extracts (UE) were incorported into the gelating hydrogel mixtures in different ratios. Gels were examined using the optical microscopy to assess uniformity of the distributed substance, and DPPH assay to check for antioxidative effect. Water/ethanol mixtures exhibited the best distribution, and all gels exhibited potential to reduce free radicals in the surrounding solutions. These results could further guide the choice of extracton method, and implied the general possibility of using the *U. dioica* extracts as antioxidative component in hydrogel preparations.

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2-4

Pectin from medlar (*Mespilus germanica* L.) fruit: a new source of a functional biopolymer

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Biopolymers of natural origin are attracting increasing attention due to their functional properties, biodegradability, and potential for sustainable industrial applications. Pectin is a natural biopolymer of plant origin, present in the primary cell wall and middle lamella, where it contributes to cell wall structure and the adhesion of adjacent cells. Its structure, rich in galacturonic acid residues and degree of esterification influence its physicochemical and functional properties. Owing to its ability to form gels, increase viscosity, and produce films, pectin has a wide range of applications in the food industry, pharmaceutical formulations, medical and therapeutic applications, bioactive compound encapsulation, and the development of biodegradable food packaging materials. Particular research interest has focused on obtaining pectin from various plant sources, including fruit-processing by-products, thereby contributing to the more efficient utilization of renewable biomass.

Medlar (*Mespilus germanica* L.) is an underutilized fruit species with potential as a source of valuable bioactive compounds and structural polysaccharides. In this study, pectin was isolated from fresh and lyophilized medlar fruit, as well as from the residue remaining after polyphenol extraction, using conventional extraction in an acidified aqueous medium (pH 4.17) at 89 °C for 1 h. Following centrifugation, pectin was recovered from the supernatant by ethanol precipitation, collected by filtration, and dried at 55 °C. After the extraction and purification of pectin, characterization of obtained natural-based biopolymer was performed, including comprehensive evaluation by FT-IR, XRD, DSC, and SEM analyses. The functional properties of pectin were evaluated in terms of antioxidant activity, DPPH (13.62% inhibition at 1.60 mg/mL), ABTS (IC_{50} = 2.26 mg/mL) and FRAP (22.13 μmol Fe^{2+}/g) assays, as well as potential hypoglycemic activity based on the inhibition of α-amylase (IC_{50} = 4.09 mg/mL) and α-glucosidase (8.40% inhibition at 1.20 mg/mL). Pectin showed a protective effect on cyanidin-3-*O*-glucoside stability, with a residual anthocyanin content of 98.42% in the 1.0% pectin water solution compared with 95.55% in water.

The obtained results highlight the potential of medlar pectin as a natural biopolymer with valuable structural, thermal, antioxidant, and enzyme-inhibitory properties, supporting its potential for further investigation and application in food, pharmaceutical, and biomedical fields.

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2-5

Culture Temperature Modulates Cartilage Viability, Proteoglycan Preservation and Inflammatory Responses in Osteochondral Explants

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Osteochondral explant models are widely used to study cartilage responses relevant to osteoarthritis, yet they are commonly cultured at 37°C, above the physiological temperature of the knee joint (~32°C). This study investigated how culture temperature influences cartilage viability and responses to metabolic and inflammatory conditions.
Bovine osteochondral explants were cultured at 32°C or 37°C in high- or low-glucose medium, with or without IL-1β and TNF-α (1 ng/mL). Viability, proteoglycan distribution and gene expression were assessed by Live/Dead staining, Safranin-O/Fast Green staining and RT-qPCR. nitric oxide (NO) and glycosaminoglycan (GAG) release into the medium were quantified by Griess assay and DMMB assay, respectively.
Culture at 32°C better preserved chondrocyte viability, particularly under low-glucose conditions, where cell death in the central deep cartilage zone was observed at 37°C. Non-inflammatory explants retained proteoglycan staining, consistent with low GAG release. Following inflammatory stimulation, Safranin-O staining was markedly reduced throughout most of the cartilage at 37°C, with staining largely retained only in the central region, whereas it remained largely preserved at 32°C. This corresponded with greater GAG release at 37°C than at 32°C. Inflammatory cultures at 37°C also showed higher NO release compared to 32°C. Gene expression analysis revealed lower *SOX9* at 32°C across all conditions and lower *IL6* under inflammatory conditions at both glucose levels. *MMP13* was lower at 32°C under inflammatory, high-glucose conditions. Under low-glucose conditions, *COL2A1* expression (under inflammatory conditions) and *COMP* expression were higher at 32°C, while *GLUT1* was higher at 32°C under non-inflammatory conditions.
Overall, culture temperature influenced chondrocyte viability and the molecular and biochemical responses of osteochondral explants, supporting the consideration of physiological joint temperature in ex vivo models of cartilage homeostasis and osteoarthritis.

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2-6

Phlorotannin-loaded chitosan nanoparticles from *Spatoglossum asperum* ameliorate *Aβ42*-induced neurodegenerative phenotypes in *Drosophila melanogaster*

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Marine-derived polyphenols represent promising candidates for the development of sustainable and biologically functional nanomaterials for biomedical applications. Phlorotannins, a distinctive class of polyphenolic compounds found in brown seaweeds, possess antioxidant and neuroprotective potential, but their therapeutic utility may be constrained by limited stability and bioavailability. The present study aimed to develop a chitosan-based nanodelivery system for phlorotannin-rich extract obtained from the brown seaweed *Spatoglossum asperum* and evaluate its neuroprotective potential using an experimental model of Alzheimer's disease.

Phlorotannin-loaded chitosan nanoparticles were prepared using ionic gelation with sodium tripolyphosphate and subjected to physicochemical characterisation. The biological efficacy of the developed nanocomposite was evaluated in a transgenic *Drosophila melanogaster* model expressing human amyloid-beta 42. The effects of treatment were assessed through survival analysis, locomotor performance, and neurobehavioral assays. In addition, biochemical investigations using fly head homogenates were performed to determine changes in oxidative stress, antioxidant defence, lipid peroxidation, and cholinergic function. Molecular analyses were further conducted to investigate treatment-associated modulation of genes involved in oxidative stress response, inflammation, apoptosis, and neuroprotective cellular pathways.

The study demonstrates the application of a marine-derived phlorotannin–chitosan nanosystem as a multifunctional platform combining natural bioactivity with nanostructured delivery. The integrated behavioural, biochemical, and molecular findings provide evidence supporting the potential of this formulation as a promising candidate for further investigation in neurodegenerative disease therapeutics. This work highlights the value of brown seaweed-derived compounds in the development of sustainable nanostructured biomaterials for advanced biomedical applications.

3-1

Competing Thiolate and Carboxylate Anchoring Modes of a Bifunctional Ligand on PbS Quantum Dot (111) Facets: A DFT Study

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Lead sulphide (PbS) quantum dots (QDs) are colloidal nanocrystals whose size-tunable optical and electronic properties make them attractive for photovoltaic, infrared-photodetector, and light-emitting applications. The ligand shell coating these QDs is equally decisive for device performance. It governs structural stability, colloidal stability, and electronic coupling between neighboring dots. Multifunctional ligands bearing both thiol (−SH) and carboxyl (−COOH) groups are widely employed for surface passivation and colloidal stabilization of PbS QDs. However, the preferred anchoring mechanism of such ligands on the QD surface remains insufficiently understood.

PbS QDs crystallize in the rock-salt structure and are bound by low-index facets whose identity depends on growth conditions. The polar (111) facet dominates under kinetically controlled growth and is intrinsically unstable, its instability mitigated by chemical adsorption of ligand molecules. We model this QD facet with periodic slab calculations within density functional theory (DFT), the standard approach for capturing the extended, cooperative ligand packing that governs facet-level binding. Simple molecular probes (methanol, methanethiol, acetic acid) together with the bifunctional ligand 3-mercaptopropionic acid (3-MPA) are used to identify the interactions governing surface binding on the QD (111) facet. Coverage-dependent adsorption is examined from dilute to full-monolayer regimes, assessing cooperative ligand–surface interactions relevant to QD surface chemistry.

For 3-MPA, our calculations reveal that thiolate-rich anchoring is energetically preferred over carboxylate binding across all investigated coverages. In nonpolar solvents (low dielectric permittivity), COO-anchored configurations are approximately 0.14 eV/molecule less stable than the corresponding S-anchored configuration. Polar solvents, such as water, further favor S-anchoring through favorable interactions with the outward-pointing carboxylic COOH groups, stabilizing S-anchored configurations relative to COO-anchored ones. These trends point to thiolate-rich, carboxylate-poor ligand shells as the thermodynamically favored passivation motif for PbS QDs. Beyond PbS, the approach offers a general strategy for probing anchoring competition in multifunctional ligands at nanostructured semiconductor interfaces.

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3-2

Right Energy, Wrong Exciton: Testing Screening Models in 2D Semiconductors

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The Rytova–Keldysh (RK) model is the standard way to describe how a two-dimensional semiconductor screens the interaction between an electron and a hole. Its single effective length is usually estimated from the material's polarizability, without ever being checked against a real, fully resolved exciton. This work tests whether that estimate, and the physical picture it implies, can actually be trusted.

First-principles GW and Bethe–Salpeter equation (BSE) calculations are used to build a complete picture of monolayer arsenene: its electronic structure, full optical absorption spectrum, and the character of its excitons. Quasiparticle corrections substantially widen the gap found by standard density-functional theory, and the resulting optical spectrum shows several distinct excitonic features before a broad absorption band sets in at higher energy.

Focusing on the lowest, brightest exciton, the polarizability-derived RK screening length underestimates its binding energy. Forcing the RK model to match that energy instead requires only a modest adjustment to the screening length. But getting the energy right turns out to be a low bar: the resulting exciton wavefunction looks nothing like the real one. Where the true exciton is tightly bound around the hole, the energy-matched RK model spreads it out far more broadly.

The same test applied to five further two-dimensional semiconductors shows this is not a quirk of arsenene. Materials with naturally extended excitons need a smaller screening length than the polarizability predicts. Materials with compact, tightly bound excitons need a larger one. In both cases, the shift is substantial.

Energy matching alone does not validate a screening model. This simple test needs only a BSE binding energy and a reduced mass. It gives the community a practical way to judge when a polarizability-derived screening length, and any exciton size built from it, can actually be trusted.

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3-3

Influence of iodine substituent position on properties of nitroaromatic compounds as potential high-energy materials

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Molecular parameters and properties can provide valuable insights into the factors influencing the sensitivity of energetic materials towards detonation. Such information is particularly helpful when the use of experimental techniques is limited. In this work, a combination of quantum chemical calculations and experimental techniques was used to investigate the influence of iodine substituent position relative to the nitro group on the structural and electronic properties of 1-iodo-2-nitrobenzene, 1-iodo-3-nitrobenzene, and 1-iodo-4-nitrobenzene. The molecular geometries were optimized at the MP2/cc-pVTZ level of theory. In addition, the Cambridge Structural Database (CSD) was searched for crystal structures containing the studied compounds. Quantum chemical calculations and crystallographic analysis revealed that both intra- and intermolecular non-covalent interactions influence the geometry of the nitro groups. Hirshfeld surface analysis was performed on crystal fragments to identify potential interaction sites. The largest deviation of the nitro group from the plane of the aromatic ring was observed for 1-iodo-2-nitrobenzene. Non-covalent interaction (NCI) analysis revealed significant steric repulsion between the iodine atom and the nitro group in the ortho isomer. This deviation from planarity reduces electron delocalization between the nitro group and the aromatic ring and weakens the C–NO_2 bond. This is confirmed by Wiberg (WBI), Mulliken, and Mayer bond indices, as well as by bond dissociation energy (BDE) calculations performed at the B3LYP/cc-pVDZ level of theory. FTIR and UV–Vis spectroscopic measurements were performed on crystalline samples of the three iodine-substituted nitrobenzenes. The experimental findings were consistent with the quantum chemical calculations and suggested that 1-iodo-2-nitrobenzene may be the most sensitive towards detonation among the studied compounds. Molecular electrostatic potential (MEP) analysis, performed at the B3LYP/6-311G level of theory, indicated a different trend. A positive electrostatic potential above the central region of the molecular surface is considered a strong indicator of high sensitivity to detonation. The highest positive electrostatic potential in this region was found for 1-iodo-3-nitrobenzene, which is inconsistent with the other obtained results. This difference may be explained in terms of different initiation mechanisms. While 1-iodo-2-nitrobenzene appears to be more sensitive to mechanically induced initiation due to its geometric characteristics, 1-iodo-3-nitrobenzene may show greater sensitivity to electrically or photo-induced initiation. These results may contribute to the design of new high-energy materials that combine improved detonation performance with reduced sensitivity.

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3-4

An Artificial Neural Network-Based Surrogate Model for Predicting Transport Characteristics of THz Quantum Cascade Lasers

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Terahertz quantum cascade lasers (THz QCLs) are compact, electrically pumped semiconductor lasers that emit coherent radiation at 1 to 6 THz (50–300 μm). These unipolar devices rely on intersubband transitions within the conduction band and a cascading process in which electrons tunnel from one active region to the next, emitting multiple photons along the way. THz QCLs are used primarily in high-resolution spectroscopy, non-destructive imaging, and quantum and nonlinear photonics. Because THz photon energies (~4 to 25 meV) are lower than room-temperature thermal energy (~26 meV), thermal backfilling and phonon scattering disrupt population inversion and limit operation to lower temperatures. Some modern designs have set a new temperature milestone, reaching pulsed operating temperatures of up to 261 K (-12 °C) and enabling operation with Peltier coolers instead of bulky cryostats. Nevertheless, high-temperature operation remains a central challenge for practical use. Further performance improvements require exploring layer thicknesses and operating bias across different configurations. However, transport models commonly used to simulate THz QCLs, such as Density Matrix (DM) and Non-Equilibrium Green's Function (NEGF) methods, are computationally expensive, making it difficult to search for optimal designs. In this contribution, we demonstrate that surrogate models based on multilayer-perceptron Artificial Neural Networks (ANNs) can accurately and efficiently replace a large share of these costly transport simulations. The models achieve low standardized root mean square error across all predicted quantities—material gain, current density, and operating frequency—while enabling full configuration-space exploration in minutes rather than days or weeks. This approach identifies novel designs and provides a practical, scalable framework for accelerating the development of high-temperature THz QCLs.

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3-5

Entropy Generation from Surface Adsorption Fluctuations: A Stochastic Modelling Study

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Surface adsorption is a fundamental phenomenon governing numerous material processes, including sensing, catalysis and gas-solid interactions. Due to the discrete and stochastic nature of molecular events, adsorption-desorption dynamics exhibit intrinsic fluctuations that cannot be captured by deterministic models. In this work, a Gillespie-based Stochastic Simulation Algorithm is employed to investigate adsorption-desorption kinetics on a model surface. The model tracks the occupancy state of surface adsorption sites and reproduces the temporal evolution of surface coverage under different kinetic regimes. We analyze the statistical characteristics of occupancy fluctuations and quantify the amount of information entropy contained in simulated trajectories. Furthermore, stochastic transitions are converted into binary sequences, enabling assessment of their suitability for pseudo-random number generation. This exploratory study examines the connection between microscopic surface dynamics and emergent statistical randomness; as well as the dual role of stochastic surface processes, both as a subject of theoretical materials modelling and as a potential basis for entropy generation in information-processing applications. The conclusion is that stochastic adsorption processes constitute a promising physical mechanism for generating pseudo-random information streams. The approach explores how stochastic adsorption models can be used to generate pseudo-random information streams, while recognizing that the simulations themselves rely on a pseudo-random number generator. Such findings may contribute to future developments in stochastic sensing, digital materials modelling, and entropy-based computing technologies.

3-6

Multiband Frequency - Selective 1d Photonic Crystal Materials Optimized Via Genetic Algorithm Parameter Control

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This paper evaluates the optical design and synthesis trade-offs of aperiodic 1D dielectric multilayer materials functioning as multiband frequency-selective optical reflectors. The investigated nanostructured material consists of an interleaved aperiodic stack of silicon dioxide (SiO_2) and titanium dioxide (TiO_2) deposited on a glass substrate. Incorporating dynamic material dispersion of TiO_2 across the 400 - 2700 nm spectral range, electromagnetic wave propagation is calculated using the Transfer Matrix Method (TMM) coupled with a Genetic Algorithm (GA). Full-scale GA optimization requires considerable computational resources (over 7.5 days of CPU runtime for 200 individuals across 300 generations). To address this computational bottleneck, we systematically analyze the impact of restricted GA parameters (population size of 20, 10 generations) across structural configurations ranging from 2 to 17 layer pairs. While low-complexity structures ($N \leq 7$ pairs) fail to establish distinct multiband reflectivity profiles under limited computational budgets, high-performance frequency-selective reflection ($R \approx 95\%$ - 99%) in the near-infrared (NIR) spectrum at 1064 nm and 1550 nm emerges in 16-pair and 17-pair aperiodic stacks. These results establish a material design framework that balances fabrication constraints, optical spectral selectivity, and global optimization efficiency.

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4-1

When Color Reveals Degradation: Surface Aging and Reuse Potential of Recycled High-Impact Polystyrene

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Efficient recycling of high-impact polystyrene (HIPS) requires reliable identification of material degradation that develops under real service conditions. This study examines whether surface yellowing of post-consumer HIPS recovered from discarded refrigeration equipment can serve as a practical indicator of changes in wettability, melt flow and mechanical performance. Naturally aged flakes were separated into three fractions according to colorimetric lightness ($L > 90$, $L = 87–90$ and $L < 87$), without applying laboratory-accelerated aging. Their surface characteristics were investigated using ATR-FTIR spectroscopy, water contact angle measurements and apparent surface free energy calculated from contact angle hysteresis. Melt flow index (MFI) was determined, and standardized injection-molded specimens were subjected to colorimetric and mechanical tests.

Increasing surface yellowing was accompanied by a reduction in water contact angle of the flakes from 88.3° to 68.2° and by spectral changes consistent with oxidation, including a carbonyl band near 1743 cm^{-1} in the most yellowed fraction. The MFI decreased from 4.12 to 2.95 g/10 min between the least and most yellowed fractions. Injection molding largely diminished the differences in wettability, although color differences and changes in selected material properties remained. Mechanical responses were not uniformly detrimental: impact-strength ranges overlapped substantially, while tensile properties varied among the fractions. These findings demonstrate that colorimetric classification, supported by surface analysis, can provide a simple screening approach for naturally aged HIPS recyclate. A lightness threshold near $L = 87$ may be useful for preliminary sorting and process planning, although its applicability should be confirmed for individual waste streams. The approach may help recyclers improve feedstock consistency and select appropriate reuse, blending or stabilization strategies.

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4-2

Advanced Ni–MoO_X Composite Cathodes: Linking Surface Composition, Electrode Geometry and Hydrogen Evolution

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Green hydrogen production by water electrolysis requires active and durable cathodes for energy-efficient operation. This work investigates electrodeposited nickel–molybdenum oxide (Ni–MoO_X) composite coatings, focusing on relationships between substrate geometry, surface composition and hydrogen evolution reaction (HER) performance. A mixture of non-stoichiometric molybdenum oxide nanoparticles was synthesized using a modified rheological procedure. Composite coatings were galvanostatically deposited onto nickel mesh, foams and porous foils under intense hydrodynamic conditions from electrolytes containing 2.0 M NH_4Cl, 0.2 M $NiCl_2$ and 0–5 g dm^{-3} MoO_X powder. Deposition parameters were optimized to enhance catalytic activity and stability. The coatings were characterized by XRD, XPS, SEM and EDS, while HER performance was evaluated by linear sweep voltammetry, Tafel analysis and electrochemical impedance spectroscopy (EIS). Selected samples were tested in zero-gap alkaline electrolyzer, as well. Nickel foams with average pore diameters of 1200 μm and 450 μm (NiF 1200 and NiF 450) showed particularly promising catalytic performance. For Ni–MoO_X/NiF 450, increasing the MoO_X concentration in the deposition bath resulted in a decrease in the surface nickel atomic fraction, accompanied by an increased molybdenum signal. XRD identified predominantly crystalline face-centered cubic nickel, together with a thin nickel oxide layer and minor metallic molybdenum contributions. These findings guide the design of porous Ni–MoO_X composite cathodes and the interpretation of their catalytic behavior in green hydrogen production.

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4-3

COST STILLNESS – Building Networks, Advancing Careers, Shaping the Future

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COST (European Cooperation in Science and Technology) Actions are interdisciplinary research networks that connect researchers, innovators, and stakeholders across Europe and beyond to address common scientific, technological, and societal challenges. By fostering international collaboration, knowledge exchange, and capacity building, COST Actions create a dynamic environment for scientific excellence, innovative research, and professional development. Particular emphasis is placed on empowering Young Researchers and Innovators. COST Action CA25106 – STILLNESS - Silent and Low-frequency Renewable Energy Systems for a Sustainable Future, brings together an interdisciplinary European research network dedicated to advancing innovative and sustainable renewable energy technologies. A key priority of the Action is to support Young Researchers and Innovators by providing valuable opportunities for career development through international networking, Training Schools, workshops, Short-Term Scientific Missions (STSMs), and collaborative research activities. By strengthening European research capacity, encouraging cross-disciplinary cooperation, and establishing long-lasting international partnerships, STILLNESS aims to advance environmentally friendly energy solutions and contribute to the green energy transition. Ultimately, the Action seeks to bridge scientific knowledge and technological innovation, supporting a more sustainable, energy-efficient, and climate-resilient future in line with European sustainability objectives and the Paris Agreement. This talk is intended to inform Young scientists about grant possibilities in the frame of CA25106,
https://www.cost.eu/actions/CA25106/

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4-4

Decomposition of calcium borohydride nanoconfined inside ZIF-67

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Among complex solid metal hydrides, metal borohydrides show the most promising both gravimetric and volumetric hydrogen density due to their unique crystal structure, in which H atom is connected to B atom through a covalent bond in $[BH_4]$ structural unit. Crystal structure with orthorhombic symmetry for $Ca(BH_4)_2$ does not have polymorphous crystallographic complexity as for $Mg(BH_4)_2$, where the decrease in the hydrogen coordination number from twelve (for Ca^{2+}) to eight (for Mg^{2+}) suggests that cation size is one of the reasons why $Ca(BH_4)_2$ does adopt simpler structure than that for $Mg(BH_4)_2$. Among all known borohydrides, $Ca(BH_4)_2$ is compound that can demonstrate real potential on reversible hydride decomposition:

$$Ca(BH_4)_2 \leftrightarrow 1/3\ CaB_6 + 2/3\ CaH_2 + 10/3\ H_2$$

According to the reaction 9.6 wt% H_2 can be obtained, however it needs a high temperature (>300 ºC) for hydride decomposition. The main reason is the polar covalent bonding in $Ca(BH_4)_2$ that leads to very slow kinetics for hydrogen exchange. The reaction kinetics and reversibility of solid metal hydrides can be improved using a confinement approach to keep the hydride material at the nanoscale, e.g. in the form of nanoparticles embedded in a nanoscaffold. The use of an appropriate scaffold can also protect nanoconfined material from disruptive conditions that could cause its agglomeration.

In the present work we show recent experimental results on the decomposition of $Ca(BH_4)_2$ nanoconfined inside zeolitic imidazolate frameworks of ZIF-67. Kinetics and reversibility of the decomposition reaction were discussed in detail.

MDPI Workshop

Presentation 1: **Scientific Paper Writing**, Presenter: Milica Nikolic

Presentation 2: **AI in Publishing**, Presenter: Jelena Romcevic

MDPI Academic Publishing Workshops are educational initiatives designed to help researchers better understand the academic publishing landscape, develop their scientific communication skills, and navigate the publication process with greater confidence and awareness of good publishing practices. At the 24th Young Researchers Conference for Materials Science and Engineering, the presentations will provide researchers with practical insights into key aspects of scholarly publishing from the publisher's perspective: the first presentation will focus on scientific paper writing, exploring the essential elements of a well-prepared manuscript—from structuring and presenting research findings to meeting publication standards and navigating the editorial and peer-review processes—while the second will address the ethical use of artificial intelligence in academic publishing, discussing the opportunities offered by AI tools in research and manuscript preparation as well as the potential risks and limitations associated with their use, with particular attention to research integrity, transparency, authorship responsibilities, and the importance of human oversight. Together, the presentations aim to equip participants with a better understanding of publishing expectations and encourage responsible, ethical, and effective practices throughout the research and publication process.

Master Class 2 - Materials for High-technology Application

High-entropy ultra-high temperature ceramics advanced materials for extreme environments

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High-entropy ultra-high-temperature ceramics (HE-UHTCs) represent an innovative class of advanced materials characterized by exceptional hardness and extremely high melting temperatures, making them promising candidates for applications in demanding and extreme environments. Transition-metal borides, carbides, carbonitrides, and their composites are among the most widely investigated materials for such applications. In particular, dual-phase composites consisting of high-entropy carbides and high-entropy borides (HEC/HEB) have demonstrated improved mechanical properties compared to their individual constituents. Nevertheless, the processing of these composites remains challenging, with several limitations that are difficult to overcome.

This presentation will focus on the synthesis of HE-UHTCs, with particular emphasis on crystal structure and microstructure development. The influence of transition-metal additions on their mechanical properties will be explored. Various synthesis and densification routes for high-entropy borides (HEBs) and HEC/HEB composites will also be discussed. Furthermore, the effects of transition-metal composition on material morphology, grain size, and Vickers hardness will be examined, highlighting the relationship between compositional design, microstructural evolution, and mechanical performance.

5-1

Evaluation of the significance of barrier effectiveness in preventing hazardous interactions in multicomponent energetic systems

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Ammunition effectiveness on target depends strictly on the performance of the ignition train, which converts the trigger pull into a controlled firing sequence. Such sophisticated systems integrate multiple energetic materials, typically including pyrotechnic mixtures, propellants, and high-explosive compositions. Throughout manufacturing, handling, and storage, these energetic materials are isolated by physical barriers designed to prevent premature mutual reactions and to sustain combustion only upon activation command. Because the compatibility of energetic components separated by such boundaries has not been sufficiently investigated, any compromised structural integrity of the barrier itself could be a primary cause of individual ammunition failures. This study focuses on conducting a series of chemical stability and compatibility tests to detect adverse interactions between the different energetic materials in touch. In accordance with current international standards, vacuum stability tests (VST) and dynamic thermal analysis (DTA) were performed to evaluate the mutual reactivity of the two components, pyrotechnic mixture and the propellant, in case they come into contact due to a breach in the polymer-coated aluminum foil barrier. While both materials were individually classified as chemically stable, compatibility assessments by VST under two distinct temperature regimes revealed a clear incompatibility between the two energetic matrices. At the same time, DTA recorded a subtle shift in the exothermic peak, supporting the claim of an unwanted interaction and underlying thermal instability. These results show that maintaining a physical barrier between the two energetic compositions is essential for safe storage and reliable performance, while further research in this field can be useful for better understanding of their long-term interactions.

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5-2

Experimental assessment of fragmentation and bond failure in order to examine structural integrity of solid propellant materials

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The structural integrity of solid propellant materials is an important factor in maintaining consistent combustion behaviour and reliable operation of the rocket motor. Propellant fracture can change the exposed burning surface and cause deviations from the intended operating conditions. This study examines these effects from a materials perspective, focusing on the consequences of propellant fragmentation. An experimental investigation was conducted using tubular solid propellant charges subjected to two deliberately introduced damage conditions: fragmentation of selected tubes and detachment of tubes from their holder. These conditions represented potential consequences of material deterioration, mechanical loading, or attachment failure. Five static tests were performed using different proportions of damaged or detached tubes. Chamber pressure was recorded throughout each test. Test results indicate that both damage conditions produced changes in the pressure–time response, while fragmentation affected combustion behaviour through changes in the exposed surface and the release of partially burned fragments. Attachment failure allowed displacement of individual tubes and was associated with irregular pressure profiles, including secondary pressure peaks in some tests. The results demonstrate that charge integrity depends on both the physical continuity of the propellant and its secure attachment to the holder. Although the tested configurations did not produce the destructive pressure escalation, their operating performances departed from the intended response. The findings from the study highlight the importance of preserving propellant integrity and attachment stability when assessing the reliability of solid energetic materials. They also distinguish resistance to catastrophic failure from the ability to maintain consistent operation. Although this investigation provides an experimental assessment of the consequences of physical damage, it does not directly quantify mechanical properties or establish material ageing mechanisms.

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5-3

Influence of boron particle size and incorporation method on energetic output of boron-based pyrotechnic compositions

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The performance of pyrotechnic compositions depends not only on the chemical nature and particle size of the solid components, but also on their dispersion and distribution within the mixture. This study investigates the influence of boron particle size and incorporation method on the thermal and combustion characteristics of boron/potassium nitrate (B/KNO_3) compositions containing phenolic resin as a binder. Nanosized and micron-sized boron powders were characterized prior the preparation of the mixtures regarding their particle size and morphology, using particle size analysis and scanning electron microscopy (SEM). The powders were incorporated into the mixtures in two ways: by conventional mechanical mixing, and by using an ultrasonic processor to achieve better dispersion. The resulting compositions were characterized by differential thermal analysis (DTA), calorimetric measurements, combustion-rate testing, and pressure measurements in a manometric bomb. The observed results have demonstrated that the boron particle size and dispersion quality significantly affect the energetic output of the investigated compositions. The application of ultrasonic dispersion provided more effective incorporation of nanometric boron and higher energetic performance.

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5-4

Influence of particle size and morphology of aluminium and magnesium powders on their oxidation and thermal behaviour

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Metal powders, such as aluminum and magnesium, are widely used in explosive formulations and pyrotechnic mixtures to maximize energy density and enhance performance. Their oxidation behavior and thermal stability depend strongly on particle size, morphology and surface characteristics, which influence reaction kinetics and the evolution of heat during oxidation. This study investigates the thermal oxidation behavior of selected commercial grades of aluminium and magnesium powders with different morphologies and particle sizes, from nano-size to micron-size. Particle size and shape distribution of the selected metal powders was determined via dynamic image analysis, and scanning electron microscopy was employed to characterize particle morphology and size. These properties were analyzed as a basis for evaluating their thermal response. To evaluate their reactivity and thermal stability, thermogravimetric analysis (TGA) and isoperibolic calorimetry were employed to measure mass changes and reaction rates in an oxygen atmosphere. Particular attention is given to the early stages of aluminium oxidation, where the presence of impurities or changes in the growing oxide layer may influence subsequent reaction behavior, and to the oxidation of magnesium, for which complete oxidation was observed below its melting point of approximately 650 °C. The observed findings on oxidation kinetics of metal powders of various particle sizes and shape may be helpful in further design of pyrotechnics or explosives formulations, in prediction of key thermal parameters, where it is often required to accurately predict ignition delays, reaction progress, long-term storage thermal stability and aging behavior.

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5-5

Rational Design and Synthesis of Bisphenanthro[9,10-d]imidazole-Based Donor–Acceptor Architectures for High-Performance Multilevel Resistive Memory Device Applications

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Organic resistive memory devices with multilevel switching characteristics are promising candidates for high-density, non-volatile data-storage applications. Herein, a series of phenanthro[9,10-d]imidazole-based donor–acceptor molecular systems was systematically developed to investigate the influence of molecular architecture, donor strength, and auxiliary acceptor units on resistive switching behavior. The molecular design was modified from a mono-phenanthroimidazole donor-acceptor (D-A) system to bisphenanthroimidazole acceptor-donor-acceptor (A-D-A) structures, followed by the incorporation of quinoline, triphenylamine, and methoxy-substituted triarylamine units for the regulation of intramolecular charge transfer and charge-trapping properties. The photophysical and electrochemical studies revealed efficient charge transfer from donor to acceptor and a suitable electronic structure for charge injection and transport. The compounds also demonstrate high thermal stability and form well-organized molecular thin films suitable for device fabrication. The fabricated devices exhibited stable non-volatile Write-Once-Read-Many (*WORM*) memory behavior. The mono-phenanthroimidazole derivative exhibited binary switching behavior with an ON/OFF current ratio of 105, while a significant improvement in switching behavior was achieved upon molecular extension to bisphenanthroimidazole frameworks. Remarkably, the introduction of a quinoline auxiliary acceptor resulted in ternary *WORM* memory that exhibited distinct OFF, ON1, and ON2 conductivity states with a high ON/OFF current ratio of 10^8. The multilevel switching behavior arises from the sequential trapping of charges at the quinoline and phenanthroimidazole acceptor sites, which exhibit distinct trapping characteristics. In the case of the binary devices, the methoxy-substituted derivative exhibited an ON/OFF ratio of 10^7 and a low threshold voltage of −0.73 V, owing to enhanced donor strength and improved charge injection. The devices further demonstrated stable retention for 4×10^3 s and reliable endurance over 100 read cycles. These results demonstrate that rational modification of donor–acceptor strength and molecular trap sites provides an effective strategy for controlling binary-to-ternary resistive switching and developing high-density organic memory devices.

5-6

Enhanced properties and oxidation resistance of (Hf,Zr)(C,N) ceramics via compositional tuning

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Due to the rapid advancement of science and technology, there is a growing demand for materials with increasingly stringent performance requirements. High standards are being set for the development of materials that possess a unique combination of properties, such as high hardness and strength, resistance to aggressive chemical environments, and a high melting point. In this context, ceramics based on transition metal carbonitrides—which integrate these desirable characteristics—deserve particular attention. Within this group, hafnium carbonitride holds a unique position, as it exhibits the highest melting point of any known compound, exceeding 4200 °C. However, this material is limited by its poor oxidation resistance. To address this issue, the development of solid solutions based on this compound has become a significant area of research; it is essential that the added elements have an atomic radius similar to that of hafnium. Zirconium carbonitride meets these criteria, enabling the formation of a homogeneous hafnium-zirconium carbonitride solid solution. By increasing the configurational entropy and allowing for the adjustment of elemental ratios within the cationic and anionic sublattices, it becomes possible to tune the composition and properties of the material over a wide range, making it a highly relevant subject for scientific study.

This study examines hafnium-zirconium carbonitride-based ceramics, fabricated via hot pressing and prepared across a broad stoichiometric range. The ceramics were produced using commercial carbide and nitride powders of the corresponding metals. Following consolidation, the samples were examined via X-ray phase analysis. The formation of characteristic peaks corresponding to a hafnium-zirconium carbonitride with a cubic was observed; these peaks were positioned between those of hafnium carbonitride and zirconium carbonitride. It was found that the formation of a hafnium-zirconium carbonitride solid solution enhances mechanical properties compared to ceramics based on pure zirconium carbonitride or hafnium carbonitride. This improvement is attributed to stronger chemical bonding resulting from the incorporation of additional atoms into the cationic sublattice, as well as an increase in configurational entropy. Furthermore, variations in the Hf:Zr and C:N ratios were shown to significantly alter the material's properties. Mechanical testing using a NanoIndenter G200 device revealed that increasing the hafnium content in the cationic sublattice and the carbon content in the anionic sublattice leads to an increase in material hardness, reaching values of over 23 GPa. An investigation into the oxidation behavior of these ceramics demonstrated that the formation of a solid solution enhances oxidation resistance and results in a mixed oxidation regime, which transitions from linear to parabolic over time. It has been established that a protective oxide layer, $(Hf,Zr)O_2$, forms on the surface during oxidation. As with hardness, adjustments to the chemical composition also positively influence the oxidation resistance of the samples. Specifically, hafnium-zirconium carbonitrides with higher Hf:Zr and C:N ratios exhibit superior oxidation resistance, characterized by an oxidation constant of 8.24 $mg^2 \cdot cm^{-4} \cdot min^{-1}$. Thus, the formation of a hafnium-zirconium carbonitride solid solution makes it possible to vary and improve properties relative to those of the individual monocarbonitrides.

6-1

Illumination-Intensity-Dependent Photocurrent and Open-Circuit Potential Dynamics in Ni/Co-Modified $BiVO_4$ Photoanodes

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Understanding charge-carrier dynamics under varying illumination conditions is essential for improving semiconductor photoelectrodes for solar water splitting. Here, we investigate the influence of illumination intensity and cocatalyst deposition sequence on photocurrent kinetics and open-circuit potential (OCP) dynamics in $BiVO_4$ photoanodes hydrothermally grown on fluorine-doped tin oxide (FTO) substrates and subsequently modified with 3 nm Ni and Co layers deposited individually and sequentially by sputtering. Transient photocurrent and OCP measurements were performed in 0.1 M phosphate buffer (pH 8) under illumination intensities of 25–200 mW cm^{-2}, with photocurrent responses examined at applied potentials of 0.3–1.23 V vs RHE. The Co/Ni/$BiVO_4$/FTO (BVO_Ni_Co) heterostructure exhibited approximately fivefold higher photocurrent density at 1.23 V vs RHE than pristine $BiVO_4$ under AM 1.5G illumination. At 100 mW cm^{-2}, BVO_Ni_Co exhibited substantially faster OCP dynamics, with rise and decay times of approximately 11 and 0.2 s, respectively, compared with 36 and 3.2 s for the reverse deposition sequence (BVO_Co_Ni). Notably, the light-induced OCP shift (ΔOCP), commonly used as a photovoltage indicator, did not correlate directly with photocurrent performance, as BVO_Co_Ni exhibited the largest ΔOCP despite its inferior photocurrent response. These findings demonstrate that cocatalyst deposition sequence strongly influences photoinduced equilibration and charge extraction, highlighting the importance of distinguishing open-circuit charge accumulation from photoelectrochemical performance under applied bias.

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6-2

Tailoring crystallinity and interface properties of STO thin films on silicon for enhanced photoelectrochemical hydrogen evolution

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This study explores how crystalline quality and interface engineering affect the photoelectrochemical hydrogen evolution reaction (HER) of silicon (Si) photocathodes protected by approximately 10 nm-thick strontium titanate (STO) films. The STO films were deposited by pulsed laser deposition on bare and reduced graphene oxide (rGO)-buffered Si substrates at 515 and 700 °C. Before film deposition, graphene oxide was introduced onto the Si surface by spin coating, while native silicon oxide was removed through SrO-assisted deoxidation. Morphological characterization revealed that the rGO interlayer improved STO film uniformity and reduced surface roughness. The highest structural quality of the film was achieved at 515 °C, where RHEED and XRD measurements confirmed epitaxial growth. In contrast, film deposited at 700 °C exhibited a textured structure and signs of interfacial reactions. The epitaxial STO/rGO/Si photocathode demonstrated enhanced HER activity, a more positive onset potential, and improved stability compared with its non-epitaxial counterpart. EIS analysis further revealed that the interfacial reaction products formed at elevated temperatures increased charge-transfer resistance and reduced HER activity. These findings emphasize the importance of optimizing both film crystallinity and interface chemistry to improve the efficiency and durability of Si-based photocathodes for solar hydrogen production.

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6-3

Fluoride-mediated phase evolution and film formation in $FAPbI_3$ perovskites: Structural, optical, morphological, and thermal characterization

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The incorporation of fluoride-containing compounds offers a potential route for modifying the phase evolution and physicochemical properties of metal halide perovskites. In this study, lead fluoride (PbF_2) and ammonium fluoride (NH_4F) were investigated as fluoride sources in formamidinium lead iodide ($FAPbI_3$) thin films, focusing on their influence on film formation, structural development, optical response, morphology, and surface roughness. A broad range of additive concentrations was investigated, including 1, 2, and 4% for individual additives and selected combinations of PbF_2 and NH_4F, with the PbF_2 concentration fixed at 1% in the mixed-additive compositions. UV–Vis spectra revealed additive-dependent changes in spectral shape and intensity, indicating modifications in the optical response and film formation. SEM imaging further demonstrated pronounced morphological differences, including the emergence of crystal-on-crystal growth features. XRD patterns exhibited changes in diffraction peak characteristics, with additional reflections appearing depending on the additive composition. Notably, PbF_2-containing samples showed a possible intermediate phase in the vicinity of the characteristic α- $FAPbI_3$ diffraction peak at approximately 12°, suggesting fluoride-associated changes in phase evolution. These observations motivated further investigation of the early stages of film formation through short-time annealing at 70 °C for 1, 3, 6, and 12 min, followed by XRD and UV–Vis analysis. Differential scanning calorimetry (DSC) was also employed to investigate thermal transitions potentially associated with intermediate-phase formation. AFM measurements provided additional information on surface topography and roughness. To further investigate the role of fluoride additives before film deposition, precursor powder mixtures containing formamidinium iodide (FAI), lead iodide (PbI_2), and different concentrations of PbF_2 and NH_4F were characterized using XRD and UV–Vis spectroscopy. This combined investigation provides insight into the effects of fluoride additives on precursor characteristics, phase evolution, crystallization behaviour, and surface properties, with particular emphasis on the potential formation of intermediate phases in PbF_2-modified $FAPbI_3$ thin films.

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6-4

Lattice Fingerprints of Magnetic Rearrangements in Mn_3Sn_2

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Mn_3Sn_2 exhibits successive magnetic transitions and sizable anomalous Hall and Nernst effects, while theoretical predictions identify it as a candidate magnetic topological material. Its lattice response offers insight into the relationship between magnetic configuration, crystal symmetry and electronic properties. Here, we focus on additional Raman features that emerge within narrow temperature intervals near the magnetic transitions and examine their evolution alongside anomalies in the phonon response. The strongest linewidth anomalies occur near the reported spin reorientation transition around 197 K and are accompanied by nonmonotonic changes in phonon energies. We discuss possible origins of the additional features in relation to changes in magnetic order and the weak monoclinic distortion reported near spin reorientation. Their confinement to the transition regions raises the possibility that magnetic fluctuations enhance otherwise weak Raman scattering as the magnetic state reorganizes. Understanding these interactions is relevant to the proposed use of Mn_3Sn_2 in magnetic refrigeration and its potential for transverse thermoelectric energy conversion through the anomalous Nernst effect.

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6-5

Strain Reveals a Hidden Lattice Response in FeSe

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We investigate the iron-based superconductor FeSe using polarization-resolved Raman spectroscopy under strain applied along the ⟨100⟩ and ⟨110⟩ crystallographic directions. Near the nematic transition, an additional peak A'_{1g} emerges on the low-energy side of the fully symmetric A_{1g} phonon. Strain controls both its separation from the phonon and the temperature interval over which it is resolved, with distinct responses to the two strain directions. We attribute this peak to two-phonon scattering enhanced by electron–phonon coupling. Its confinement to the transition region suggests that nematic fluctuations contribute to this enhancement. The results establish strain direction and magnitude as control parameters for the visibility of this weak lattice excitation. Understanding this sensitivity is an important step toward using strain and lattice deformation to tune the physical properties of quantum materials.

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6-6

Raman signatures of anharmonic phonon dynamics in the thermoelectric material In_4Te_3

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Indium telluride (In_4Te_3) is an anisotropic layered semiconductor that has attracted interest as a potential thermoelectric material for mid-temperature applications. Its intrinsically low lattice thermal conductivity has been associated with strong phonon anharmonicity, with theoretical studies predicting pronounced interactions in the acoustic and low-energy optical phonon regions. Despite these predictions, its vibrational properties and temperature-dependent phonon dynamics remain largely unexplored.

Using polarization-resolved Raman spectroscopy, we investigated the vibrational properties of In_4Te_3 single crystals between 80 and 300 K. The observed modes were assigned based on factor-group analysis and comparison with DFT-calculated phonon frequencies. The temperature dependence of phonon frequencies and linewidths reveals pronounced anharmonic behaviour. The temperature dependence of most analyzed modes was reasonably described using a model incorporating three- and four-phonon decay processes. However, some modes exhibit deviations from the model, suggesting that additional decay channels involving phonons of unequal energies may contribute. These results provide experimental evidence of pronounced phonon anharmonicity in In_4Te_3 and offer insight into its lattice dynamics relevant to its low lattice thermal conductivity.

6-7

Phonon Signatures of Electronic Anomalies in $ZrTe_5$

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The pronounced resistivity anomaly of $ZrTe_5$ and its unusual Hall response have been linked to temperature-driven changes in the electronic structure, although the underlying mechanisms remain debated.

Here, we investigate the lattice dynamics of $ZrTe_5$ single crystals using polarization-resolved Raman spectroscopy in the *ac* plane between 40 and 300 K. Six A_g and two B_{2g} phonon modes are observed, with no additional modes emerging over the investigated temperature range. While the phonon energies and linewidths largely follow conventional anharmonic behaviour, systematic deviations appear near 60 K and 200 K. Several A_g modes and both B_{2g} modes exhibit Fano-asymmetric line shapes, indicating coupling to the electronic continuum. The Fano asymmetry follows different temperature trends for individual phonon modes. These phonon anomalies coincide with characteristic temperatures associated with the resistivity maximum and changes in the Hall response reported in previous transport studies. Together, these results demonstrate a close connection between lattice dynamics and the evolution of the electronic properties of $ZrTe_5$.

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Encouraging young researchers to apply for grants

What I learned from grants I got and grants I didn't

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Students at all levels of study, from undergraduate to doctoral, have access to a wide range of international mobility, training and funding opportunities. Many of these remain underused, mainly because students do not know they exist. This contribution aims to bring these opportunities closer to students and to show, through a personal example, how they can shape an academic career. My own path includes international internships, summer schools and exchanges, a Short-Term Scientific Mission, staff training, participation in and leadership of bilateral projects, leadership of a work package, participation in international conferences, and travel grants from scientific associations, some of which were awarded only after an initial rejection. Beyond presenting research, conferences offer roles that are open to early-career researchers but rarely sought: proposing sessions, moderating sections and co-organizing international conferences. This personal perspective aims to encourage students to apply actively, to treat rejection as part of the process, and to use these opportunities as stepping stones toward international collaboration and professional growth.

7-1

$Ti_3C_2T_x$ MXene Functionalized Textiles as Vibration Sensors

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MXenes are a promising class of two-dimensional materials owing to their high electrical conductivity, mechanical flexibility, and suitability for wearable electronics. In this work, $Ti_3C_2T_x$ MXene was synthesized from the Ti_3AlC_2 MAX phase and deposited onto cotton, bamboo, polyamide, and polyester textiles. The main objective was to determine the most suitable textile substrate and deposition method for wearable vibration sensing applications.

MXene-coated textiles were characterized by FTIR, XRD, SEM, and EDS analyses to confirm successful coating formation and evaluate their morphology and composition. Vacuum-assisted filtration and spray coating were compared in terms of MXene retention and electrical performance. Polyester and polyamide exhibited the lowest electrical resistance, with four-point probe resistances of 533 and 182 Ω, respectively, indicating the formation of efficient conductive networks. For strains between 4 and 10%, MXene-coated polyamide, polyester, and cotton showed maximum gauge factor values of 2.04, 1.86, and 1.59, respectively, demonstrating good electromechanical sensitivity.

Wearable vibration sensors were fabricated by sputter-coating a thin titanium layer onto MXene-functionalized textiles, followed by the attachment of copper-wire electrodes using conductive silver paste. The sensors were tested for detecting throat movements and voice-induced vibrations. MXene-coated polyester exhibited the strongest and most reproducible response, successfully detecting swallowing, coughing, head movements, and vocal vibrations. These results identify MXene-coated polyester as the most promising candidate for flexible and wearable vibration sensing applications.

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7-2

Carbon Fiber/MXene Hybrid Aerogels for High-Efficiency EMI Absorption

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The rapid development of modern radar and high-frequency communication technologies has intensified the necessity for ultralight electromagnetic interference (EMI) shielding structures capable of efficient wave dissipation. Carbon-based cellular architectures, particularly aerogels, have emerged as prominent candidates due to their ultra-low mass density, expansive specific surface area, and highly tunable dielectric characteristics. In this investigation, lightweight hybrid aerogels comprising interconnected carbon fibers (CF) and two-dimensional $Ti_3C_2T_x$ MXene nanosheets were synthesized to evaluate their electromagnetic attenuation mechanisms within the microwave regime. The complex scattering parameters (S_{11} and S_{21}) were systematically monitored across the X-band (8.2–12.4 GHz) employing a calibrated vector network analyzer interfaced with a precision rectangular waveguide system to decouple the relative contributions of reflection, transmission, and genuine absorption. Experimental evaluations revealed that tailoring the relative content of fibrous carbon and conductive MXene flakes drastically modulates the internal charge transport pathways and interfacial loss dynamics. Among the investigated formulations, the hybrid composite with balanced loading exhibited superior attenuation performance centered at 12 GHz, recording a total shielding effectiveness (SE_T) of approximately 10.4 dB, with the absorption component (SE_A) accounting for 9.4 dB—representing an effective power absorption efficiency of nearly 88.5%. This absorption-dominated microwave response is directly ascribed to the formation of an interconnected conductive skeleton that promotes micro-current conduction losses alongside polarization relaxation occurring at abundant internal heterojunctions. Furthermore, the three-dimensional multi-scale pore topology effectively multiplies internal scattering and prolongs the wave–matter interaction path without provoking dominant impedance-mismatch reflections. These findings demonstrate that bridging fibrous carbon networks with 2D MXene sheets provides an effective design pathway for lightweight, absorption-driven microwave absorbers.

7-3

Up-conversion luminescence thermometry and biological evaluation of Yb^{3+}, Tm^{3+} doped $MgGd_2Zr_2O_8$ nanoparticles

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This study presents a newly synthesized host material $MgGd_2Zr_2O_8$ doped with varying concentrations of Yb^{3+} (2, 4 and 6 at%) and Tm^{3+} (0.5 and 1 at%) *via* the sol-gel method. X-ray powder diffraction (XRPD) coupled with Rietveld structural refinement confirmed crystalline nature of the samples, revealing fluorite-type cubic structure (space group $Fm\bar{3}m$), with crystallite size of just above 5 nm. Transmission electron microscopy (TEM) and high-resolution TEM (HR-TEM) showed clusters of agglomerated particles, up to 200 nm in size, composed of smaller crystallites. Energy dispersive spectroscopy (EDS) confirmed uniform elemental distribution. Selected area electron diffraction (SAED) verified the polycrystalline nature of the material, while energy-dispersive spectroscopy (EDS) confirmed a homogeneous distribution of all constituent elements. UV-Vis spectroscopy revealed the characteristic *f-f* transitions of the dopant ions. Photoluminescence (PL) emission spectra obtained under 978 nm excitation indicated an optimal dopant concentration of 4 at% Yb^{3+} and 0.5 at% Tm^{3+}, and time-resolved measurements showed a mono-exponential decay with a lifetime of $\tau = 206.7\ \mu s$. Temperature-sensing performance was evaluated using the luminescence intensity ratio (LIR) between $^1G_{4(a)}$ and $^1G_{4(b)}$ levels of Tm^{3+}, yielding a maximum relative sensitivity of $0.593\ \%K^{-1}$ at 298 K. Biocompatibility of the best-performing sample was assessed with *in vitro* MTT cytotoxicity assays on MRC-5 normal fibroblast cells giving an IC_{50} value greater than 2.5 mg/mL, while *in vivo* toxicity screening using *Artemia salina* showed a survival rate exceeding 90%. These findings highlight Yb^{3+}/Tm^{3+} co-doped $MgGd_2Zr_2O_8$ is a promising biocompatible phosphor for optical thermometry and bioimaging.

7-4

Titanate Nanotube-Reinforced Waterborne Polyurethane Nanocomposites

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While classical polyurethane dispersions (PUDs) offer exceptional performance, their high volatile organic compound (VOC) emissions remain a major drawback. Although waterborne polyurethane dispersions (WPUDs) successfully reduce VOCs, they typically suffer from compromised thermal and mechanical strength. In order to improve WPUD-based materials, this study explores titanate nanotubes (TiNTs) as a low-cost, one-dimensional nanofiller. To suppress the agglomeration issues common with dried powders, we introduced a novel technique for blending TiNTs directly from an aqueous suspension into the WPUD matrix. Nanocomposites with filler loadings ranging from 1 to 5 wt% were successfully formulated. Transmission electron microscopy verified uniform dispersion and structural integrity of the nanotubes, and ash analysis confirmed precise filler concentrations. The resulting nanocomposites exhibited substantial increases in moduli, driven by robust physical bonding between the TiNTs and the polymer matrix. This reinforcement effect was particularly pronounced in highly crosslinked matrices, demonstrating efficient load transfer and establishing TiNTs as a promising additive for high-performance WPUD nanocomposites.

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8-1

Photoluminescent properties of Yb^{3+}/Er^{3+} co-doped $NaYF_4$ and Y_2O_3 nanoparticles for infrared detection

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To extend low-cost silicon photodetectors beyond their intrinsic ~1100 nm cutoff into the 1.55 μm telecommunication band, without resorting to expensive InGaAs sensors, we propose up-converting nanoparticles (UCNPs) that convert 1.55 μm infrared (IR) radiation into visible light detectable by standard silicon CMOS, CCD and MPPC sensors. Here, we evaluate the up-conversion luminescence of Yb^{3+}/Er^{3+}-codoped $NaYF_4$ and Y_2O_3 nanoparticles under broadband ~1.55 μm excitation and, for comparison, under conventional 976 nm excitation. Under 1.55 μm excitation, $NaYF_4$: Yb^{3+}/Er^{3+} exhibited green (541 nm) and red (654 nm) emission, with log-log power dependence slopes of 1.85 and 1.92, respectively, over the investigated power range (up to 10 mW). Under 976 nm excitation, the same nanoparticles showed blue (407 nm), green (541 nm) and red (654 nm) emission, with slopes of 1.22 (green) and 1.35 (red). In contrast, Y_2O_3: Yb^{3+}/Er^{3+} exhibited green (563 nm) and red (660 nm) emission under 976 nm excitation (slopes of 1.43 and 1.29), but only red emission under 1.55 μm excitation (slope of 2.15). These host dependent differences indicate that lattice phonon energy and excitation wavelength govern the up-conversion pathways and their efficiency. Overall, the visible emission obtained under broadband ~1.55 μm excitation demonstrates the potential of Yb^{3+}/Er^{3+} codoped UCNPs as spectral converters for extending silicon-based photodetection to longer infrared wavelengths.

8-2

Sustainable valorization of industrial waste from Montenegro through geopolymerization

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Montenegro is facing significant challenges in the transition to an eco-friendly and sustainable waste management system where one of the most concerning ones is to find a balance between the consumption of natural resources and the consequences of environmental pollution caused by industrial by-products generated during coal combustion, flotation of valuable ores and secondary aluminum production. Surface disposal of flotation tailings is a well-established and relatively low-cost practice that has been widely adopted by the mining industry. However, this method does not represent a sustainable long-term solution for tailings management. On the other hand, aluminum salt cake, generated during secondary aluminum production, presents an environmental hazard due its elevated content of soluble alkali salts like NaCl. This study investigates the possibility of using fly ash (FA) as non-hazardous product and aluminosilicate precursor for the synthesis of raw FA-based geopolymers (FO) and geopolymers contaminated with toxic industrial waste like aluminum salt cake (ASC) and Pb-Zn flotation tailings (Pb-Zn FTs) in the range from 1 to 50%. Raw materials and geopolymer specimens were subjected to physico-chemical and mechanical characterization to provide a deeper insight into the mechanism of toxic waste immobilization and potential application in construction, while the results of Toxicity Characteristic Leaching Procedure (TCLP) and European Standard EN 12457-2 contribute to a better understanding of waste nature and environmental risk assessment. The addition of more than 3% ASC led to deterioration of the geopolymer structure and reduced compressive strength from 8.39 MPa for 1% ASC to 7.85 MPa for 3%, while the higher content of Pb-Zn FTs (≥30%) also resulted in disruption of the geopolymer structure followed by higher porosity, while the geopolymer specimens up to 10% meet the criteria for application in construction with a decreasing trend in compressive strength from 13 MPa for 1% to 11.37 MPa for 10%. The elevated chloride content in raw ASC (34120 mg/kg) was successfully reduced below the limits defined by EN 12457-2 (<25000 mg/kg). Similarly, toxicity of Pb-Zn FTs was confirmed with elevated lead content (50.55 mg/L) in the TCLP leachate, while the lead concentration in geopolymer leachates was significantly below regulatory limits (<5mg/L).

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8-3

Synthesis and characterization of CQDs sourced from the plant St. John's wort

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Bacterial infections are commonly transmitted through indirect contact with contaminated inanimate surfaces. Developing novel antibacterial materials is a promising strategy to prevent the spread of infection. In recent years, carbon quantum dots (CQDs) have attracted attention due to their unique physicochemical properties and potential photodynamic antibacterial activity. The main goal of our research is to synthesize a novel type of CQDs that may act as antibacterial agents in polyurethane coatings under blue-light irradiation. In this study, we used an extract of dried aerial parts of St. John's wort (*Hypericum perforatum*) as a starting precursor. We focused on hypericin, the plant's primary antibacterial component. The extract was prepared by using a two-step solvent extraction. The synthesis was performed in a laboratory beaker at three temperatures (50, 120, and 200 °C) in the presence of H_3PO_4 and H_2SO_4. Obtained colloids were purified by extraction in toluene. The obtained colloids were characterized optically and structurally. Excitation-dependent photoluminescence of the obtained colloids was explored by PL spectroscopy. Atomic force microscopy (AFM) was used to visualize the structures and determine their size. We characterized the chemical composition of the obtained materials by Fourier-transform infrared spectroscopy (FTIR). Photogeneration of singlet oxygen ($^1O_2$) by CQDs as a photosensitizer was detected through its characteristic emission at 1270 nm. The CQDs showed good photostability under blue-light irradiation and potential for use in synthesizing antibacterial polyurethane coatings.

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8-4

Spectroscopic and Morphological Investigation of Gamma-Irradiated Poly(methyl methacrylate) in Chloroform

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Poly(methyl methacrylate) (PMMA) is a widely used thermoplastic polymer that, owing to its optical transparency, chemical stability, and ease of processing, is used in medicine, optics, photonics, nanotechnology, and construction. Its use in fabricating thin polymer films and nanostructured materials is particularly important. In this study, the effect of gamma irradiation on the chemical structure of PMMA dissolved in chloroform was investigated. The prepared solutions were exposed to gamma irradiation at absorbed doses of 300, 400, 500, and 600 kGy. Radiation-induced chemical changes were investigated using X-ray photoelectron spectroscopy (XPS), Fourier-transform infrared spectroscopy (FTIR), and Raman spectroscopy, while surface morphology was examined using atomic force microscopy (AFM). XPS analysis revealed changes in the surface chemical composition and the relative abundance of chemical bonds. With increasing absorbed dose, the relative proportion of O–C=O bonds, the O/C ratio, and chlorine concentration on the sample surfaces increased. These results indicate radiation-induced modifications to PMMA surface chemistry, potentially involving products of chloroform radiolysis. The XPS results are consistent with FTIR and Raman spectroscopy, further supporting radiation-induced changes in PMMA's chemical structure. AFM analysis revealed changes in the surface morphology of PMMA following gamma irradiation. These results provide a better understanding of how gamma irradiation affects PMMA's chemical structure in the presence of chloroform and indicate the potential to modify its surface properties through ionizing radiation. This study provides a basis for further characterization of the physicochemical properties of irradiated PMMA and the exploration of its potential applications.

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8-5

Substrate dependent formation and photocatalytic performance of plasma electrolytic oxidation coatings incorporating ZSM5

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The investigation of incorporation of ZSM5 zeolite into oxide coatings formed by plasma electrolytic oxidation (PEO) was carried out on three different substrates (Al1050, AZ31, and Ti6Al4V). To ensure comparability, all coatings were produced under identical experimental conditions, using the same electrolyte composition and DC PEO mode at a constant current density of 200 mA/cm². The electrolyte consisted of an aqueous solution containing sodium phosphate, potassium hydroxide, and sodium tungstate, which has previously been demonstrated to provide stable PEO processing on all three substrate materials. Additionally, pure and Eu ion-exchanged ZSM5 zeolite was introduced into the electrolyte, with the idea of potentially enhancing photocatalytic activity.

Formed coatings were characterized by scanning electron microscopy equipped with energy-dispersive X-ray spectroscopy, as well as by X-ray diffraction analysis. It was demonstrated that the morphological and structural characteristics of the synthesized coatings strongly depend on the substrate material. Characterization confirmed the inert incorporation of zeolite into oxide coatings formed on the AZ31 alloy.

The study showed different substrates under identical synthesis conditions provided coatings of different photocatalytic performance. Photocatalytic measurements were taken under UV irradiation measuring the degradation of methylene blue.

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8-6

Effective adsorbent for the removal of methylene blue using natural serpentine/magnetite nanocomposites: Isotherm and kinetic study

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The rapid growth of textile and dyeing industries has resulted in the release of large quantities of coloured wastewater into aquatic environments, creating serious ecological challenges. This study presents the development of a magnetic serpentine/Fe_3O_4 nanocomposite synthesized from naturally available serpentine collected from Skardu, Pakistan, using a co-precipitation approach for the efficient removal of methylene blue dye from aqueous media. The prepared material was characterized through FESEM, EDX, FTIR, XRD, BET, and VSM analyses to examine its structural, morphological, surface, and magnetic properties. Characterization results confirmed the successful incorporation of Fe_3O_4 nanoparticles onto the serpentine surface, leading to increased surface area and improved adsorption capability. Adsorption experiments were conducted under varying conditions of adsorbent dosage, dye concentration, and contact time to evaluate the removal performance of the synthesized nanocomposite. The composite achieved a maximum methylene blue removal efficiency of 98 %, demonstrating superior adsorption behaviour compared to untreated serpentine. Adsorption equilibrium data were best represented by the Freundlich isotherm model, while kinetic analysis followed a pseudo-second-order mechanism, indicating heterogeneous multilayer adsorption dominated by chemisorption interactions. In addition, the magnetic nature of the composite enabled easy recovery of the adsorbent after treatment using an external magnetic field. The findings suggest that the serpentine/Fe_3O_4 nanocomposite is a sustainable, economical, and environmentally friendly adsorbent with strong potential for practical wastewater remediation applications

Master Class 3 – Environmental Materials

Zeolite-Based Multifunctional Materials for Environmental Remediation: Fluorescent Detection, Adsorption, and Photocatalysis in Aqueous Media

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The persistent release of emerging water contaminants, including pharmaceuticals, pesticides, and personal care products, from domestic and industrial sources presents a critical global environmental challenge. To address this problem, our research focuses on the application of zeolites, which are hydrated crystalline aluminosilicates characterized by high thermal stability, large specific surface areas, and uniform microporous architectures of channels and cavities. These materials are highly effective for adsorption, separation, and catalytic processes.

Hybrid photocatalysts based on natural (clinoptilolite) and synthetic (ZSM-5 and 13X) zeolites combined with nano sized TiO_2 particles were synthesized via a simple, cost-effective solid-state dispersion method. These composites proved efficient in removing various contaminants, such as atenolol (ATL) and bisphenol A (BPA) from aqueous solutions, as well as herbicides from pesticide factory wastewater. Under simulated sunlight, ZSM-5-based hybrid photocatalysts exhibited superior performance, completely eliminating ATL within 70 minutes and removing more than 60% of the detected herbicides after 3 hours.

Furthermore, loading lanthanide cations to structurally different zeolites via an aqueous ion-exchange procedure yielded multifunctional materials capable of both detecting and eliminating widely used fluoroquinolone antibiotics, such are norfloxacin (NOR) and ciprofloxacin (CIP), which are frequently found in aquatic environments. Eu^{3+}-exchanged zeolites 13X, β, and natural zeolite mordenite succescfully removed NOR via adsorption, during which a gradual increase in Eu^{3+} emission was observed. The influence of pH on the adsorption and emission characteristics of these Eu^{3+}-exchnaged zeolites was also thoroughly investigated. Additionaly, Tb^{3+}-exchanged ZSM-5 and β zeolites proved effective as fluorescence-based sensors for detecting CIP in aqueous solutions, with fluorescence response depending on terbium loading, zeolite structure and solution pH.

Characterized by the X-ray powder diffraction (XRPD), FTIR spectroscopy, diffuse reflectance spectroscopy (DRS), SEM-EDS, low temperature N_2 adsorption, and zeta potential measurements, these prepared materials offer a promising approach for advanced environmental applications.

9-1

Synthesis and performance of differently modified bismuth tungstate-based catalysts for methylene blue photocatalytic removal from water

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Photocatalytic degradation is an emerging method for pollution abatement and wastewater remediation. For the photocatalytic degradation of methylene blue (MB), an industrial dye representing a common model environmental pollutant, a series of differently modified bismuth tungstate catalysts was synthesized. The catalytic materials were fabricated through a hydrothermal synthesis and modified by using a surfactant-assisted method, doping with gadolinium, and using silica microspheres as a support. Uniform flower-like microspheres of Bi_2WO_6 were obtained, charaterized, and tested for photocatalytic performance under visible light irradiation. The adsorptive capabilities of the catalysts were also studied. The process of MB photocatalytic degradation was optimized by finding the best combination of working conditions, including MB concentration, catalyst loading, and starting pH. Under the optimal conditions, a degradation degree of 97% for MB was achieved after 2 h of treatment. Additionally, the effects of different anions (Cl^-, SO_4^{2-}, NO_3^-, CO_3^{2-}) present in solution during photodegradation were investigated. Finally, the degradation mechanism was elucidated using scavanging experiments and catalyst reusability was tested. The developed method shows improved performance in terms of smaller catalyst dose, relativelly short treatment time, and a high degradation degree compared to previous studies. On the other hand, the high energy consumption, unsuitable for practical applications, and poor catalyst reusability require further research.

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9-2

Surface chemistry and methylene blue removal in γ-irradiated *ms*-$BiVO_4$: Contributions of adsorption and photocatalysis

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The influence of γ-irradiation on dark adsorption and light-driven methylene blue (MB) removal was investigated in relation to the structural, surface, and defect-related properties of monoclinic scheelite $BiVO_4$ (*ms*-$BiVO_4$). Nanoparticles were synthesized by a microwave-assisted method at 170 °C for 10 min and subsequently exposed to ^{60}Co γ-rays at absorbed doses of 20 and 200 kGy. X-ray diffraction confirmed preservation of the monoclinic phase, with crystallite sizes of 22–24 nm, while optical measurements indicated modest band-gap variations. X-ray photoelectron spectroscopy revealed an increased high-binding-energy O 1s contribution, indicating changes in the surface oxygen environment, whereas Bi^{3+} and V^{5+} remained the dominant oxidation states. Electron paramagnetic resonance (EPR) revealed a non-monotonic variation in the relative intensity of V^{4+}-related centers. MB removal was evaluated using 40 mg of material in 50 mL of a 5 mg L^{-1} MB solution at pH 7, following 12 h of dark equilibration and 120 min of illumination. Dark adsorption decreased from 67.97% for pristine *ms*-$BiVO_4$ to 6.00% and 12.22% after irradiation at 20 and 200 kGy, respectively. The light-driven contributions were 27.66%, 40.50%, and 12.01% for pristine *ms*-$BiVO_4$ and samples irradiated at 20 and 200 kGy, respectively, expressed relative to the initial MB concentration. The pronounced suppression of adsorption, despite phase retention, points to altered dye–surface interactions associated with changes in surface oxygen chemistry and particle organization. The lowest relative EPR intensity coincided with the largest light-driven contribution at 20 kGy; the reverse trend at 200 kGy suggests a possible link between defect-related states and light-driven removal, although the underlying mechanism remains unresolved. The increased light-driven contribution at 20 kGy did not offset the loss of adsorption, and total removal decreased from 95.63% to 46.50% and 24.23% at 20 and 200 kGy, respectivey. Overall, the decline in MB removal was dominated by the loss of adsorption capacity, despite preservation of the monoclinic structure and an increased light-driven contribution at 20 kGy [1].

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9-3

Valorization of Post-Extraction Lignocellulosic Forest Biomass as a Sustainable Adsorbent for Congo Red Removal from Aqueous Solutions

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The increasing accumulation of lignocellulosic waste and the discharge of dye-contaminated wastewater represent significant environmental challenges, emphasizing the need for sustainable waste management and water treatment solutions. This study investigates the potential of forest biomass residues obtained after microwave-assisted extraction of bioactive compounds from cones of *Cupressus sempervirens*, *Pinus nigra*, and *Thuja orientalis* as effective adsorbents for Congo red removal from aqueous solutions. The adsorption efficiencies reached 87.97% for *C. sempervirens*, 65.56% for *P. nigra*, and 41.89% for *T. orientalis*, demonstrating their potential as alternative adsorbent materials. Surface morphology and porosity were characterized using scanning electron microscopy (SEM), revealing a relationship between surface porosity and Congo Red adsorption efficiency, with the most porous biomass exhibiting the highest dye removal. Adsorption kinetics and mechanisms were further investigated to elucidate adsorption behavior, mass-transfer processes, and potential diffusion limitations. The results demonstrate the potential of post-extraction lignocellulosic residues as efficient adsorbents for Congo Red removal. This study highlights the value of transforming underutilized forest biomass into functional materials, offering a promising and environmentally sustainable approach that simultaneously reduces biomass waste and contributes to the remediation of dye-contaminated wastewater.

9-4

The application of Fourier-transform infrared spectroscopy in characterization of liver oil from deep-sea sharks

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Rapid analytical methods are particularly valuable in environmental research, where sampling may occur intermittently or opportunistically, while large sampling events may yield numerous samples requiring prompt analysis due to their limited stability during storage. These challenges are especially relevant to deep-sea elasmobranchs, for which samples may be scarce due to low population abundance or limited access to their deep-water habitats. Many also exhibit low resilience to fishing mortality due to late maturity and relatively low fecundity. Biological material obtained from fisheries bycatch therefore provides valuable research opportunities, highlighting the importance of maximizing the information obtained from each available specimen. However, conventional methods can be time-consuming and costly, limiting the number of samples that can be analyzed within the available timeframe, after which sample quality may deteriorate. Spectroscopic techniques have been used to characterize shark liver oils, yet their application in comparative studies remain limited. The aim of this study was to explore the use of FTIR spectroscopy for characterizing liver-oil spectral profiles and assessing variation both within and among shark species sampled in the southern Adriatic Sea, with particular focus on deep-sea species. Individual FTIR spectral fingerprints were characterized, and species-average spectra were calculated when possible. The spectra exhibited characteristic lipid profiles, with variation in peak intensities and positions observed both among and within species. Following validation by conventional methods, and with integration of morphological and histological information, these spectra could contribute to the development of a new, rapid method for assessing physiological condition and long-term monitoring of shark populations.

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10-1

Enhanced Photocatalytic Performance of Zeolite-Modified Plasma Electrolytic Oxidation (PEO) Coatings

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Photocatalytic degradation has appeared as a promising approach for the removal of organic pollutants; however, conventional systems based on suspended photocatalyst powders are hindered by particle agglomeration, limited light penetration, and the need for catalyst separation after treatment. Plasma electrolytic oxidation (PEO) offers an attractive alternative through the fabrication of immobilized photocatalytic coatings directly on metallic substrates. Owing to the ability of PEO to incorporate electrolyte constituents into the growing oxide layer, composite coatings containing zeolite particles can be readily synthesized.

Recent advances in zeolite-modified PEO coatings demonstrate that the incorporation of natural and synthetic zeolites can significantly influence coating morphology, composition, porosity, and functional performance. In addition to providing adsorption sites for pollutant molecules, zeolites can serve as carriers for photocatalytically active species, enabling the development of multifunctional composite materials. The combination of the porous oxide matrix formed during PEO and the adsorption capacity of zeolites results in photocatalytic efficiency enhancement and subsequent broadening of the application potential of these coatings. Current research demonstrates that tailoring both the PEO processing conditions and zeolite modification strategies provides an effective pathway for engineering coating microstructures and optimizing the functional performance of immobilized photocatalytic systems.

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10-2

Electrochemical determination of ceftriaxone in aqueous solutions using ZnO/SnO_2-modified screen-printed carbon electrodes

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Ceftriaxone (CFRX) is a third-generation cephalosporin antibiotic widely used to treat various bacterial infections. Due to its extensive use and potential release into the environment, its presence in aquatic ecosystems raises concerns regarding environmental contamination and the development of antimicrobial resistance. Therefore, the development of sensitive and reliable analytical methods for its detection in aqueous solutions is of considerable importance.

In this work, screen-printed carbon electrodes modified with a ZnO/SnO_2 composite with a ZnO-to-SnO_2 mass ratio of 9:1 were investigated for the electrochemical determination of CFRX. The composite was prepared by mechanically milling commercial oxide powders, followed by thermal treatment at 400 and 700 °C. The structural and morphological properties of the prepared materials were characterized using X-ray powder diffraction and field-emission scanning electron microscopy. The prepared composites were subsequently used for electrode modification by applying a suspension containing the material, carbon black, Nafion, ethanol, and distilled water. The electrochemical response to CFRX was studied by cyclic voltammetry and differential pulse voltammetry in 0.1 M phosphate buffer solution (pH 3.0). Electrochemical measurements were performed following successive additions of CFRX solution. The analytical performance of the modified electrodes was evaluated in terms of sensitivity, limit of detection, and limit of quantification.

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10-3

Electrochemical Sensing of Ceftriaxone Using Barium Titanate Stannate-Based Materials

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Electrochemical sensors have attracted considerable attention for the detection and monitoring of environmental pollutants due to their high sensitivity, rapid response, and portability. Electrode modification with various materials, including noble metals, metal oxides, polymers, and carbon-based materials, represents an effective strategy for further improving their analytical performance, particularly in terms of sensitivity and selectivity. One of the pharmaceuticals of environmental concern is ceftriaxone, a widely used antibiotic that may contribute to antimicrobial resistance and pose environmental and human health risks.

In this study, previously synthesized barium titanate stannate (BTS) was further processed using three different approaches: thermal treatment at 1100 °C for 24 h (BTS), microwave treatment for 1 min (BTS-mw), and incorporation of polyethylene oxide (PEO) at a BTS-to-PEO mass ratio of 90:10 (BTS-PEO), with the aim of modifying screen-printed carbon electrodes for the electrochemical detection of ceftriaxone (CTX). The investigated materials were characterized using X-ray diffraction, field-emission scanning electron microscopy, and photoluminescence spectroscopy. Cyclic voltammetry (CV) and differential pulse voltammetry (DPV) were employed for the electrochemical determination of CTX. Electrode inks were prepared by dispersing 10 mg of each investigated material and 1.5 mg of carbon black in a mixture of 40 µL of 5% Nafion solution, 225 µL of ethanol, and 225 µL of distilled water. CV and DPV measurements were conducted in phosphate buffer (0.1 M, pH 3.0) at different CTX concentrations. The analytical performance of the modified electrodes was evaluated by determining the sensitivity, limit of detection, and limit of quantification.

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10-4

Precious metal ions sorption using polymeric matrix impregnated with di-n-alkyl sulfide

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Precious metals owe their name to the extraordinary properties that set them apart from other metals. The market price of these metals is gradually rising due to their scarcity in the Earth's crust, which leads to higher mining costs. In addition, demand for these metals is constantly increasing because they cannot be substituted in many applications. For this reason, secondary resources – such as waste electrical and electronic equipment or spent automotive catalytic converters – are becoming a good alternative source for obtaining precious metals. Conventional methods for recovering precious metals can be divided into two main categories: pyrometallurgical and hydrometallurgical. Pyrometallurgical methods include combustion, smelting in a plasma arc furnace or a blast furnace, slag removal, sintering, melting, and high-temperature gas-phase reactions. However, this method requires a high energy input, which makes it very costly. Other drawbacks include the production of toxic slag and low metal recovery rates. Hydrometallurgical methods have the advantage of consuming significantly less energy and not requiring expensive pre-treatment. It is suitable for materials with a low precious metal content. The process involves leaching using chloride, cyanide, or bromide/iodine solutions, followed by separation, which results in the recovery of high-purity metals. Separation can be carried out using precipitation, solvent extraction, or sorption on various types of sorbents. Among separation techniques, the sorption of precious metal ions on Solvent-Impregnated Resins (SIRs) deserves special attention. These resins combine the advantages of solvent extraction and ion exchange: the extractant's selectivity toward the desired metals, a simple mechanism of interaction between ions and the extractant's functional group, no formation of a third phase (emulsion) as in liquid-liquid extraction, and the ability to use unpurified solutions without pretreatment. In traditional impregnation methods, organic solvents such as chloroform, benzene, toluene, etc., are used to dilute the extractant. In the presented study, we used our patented impregnation method called "warm impregnation," which does not use toxic organic solvents. Impregnation involves directly mixing the selected sorbent with an extractant that is selective for precious metals, which has been previously heated to a high temperature not exceeding its boiling point. The study focused on examining several factors affecting the sorption of precious metal ions (Au(III), Pd(II), Pt(IV), Rh(III)). The effects of HCl concentration, phases contact time, and the mass of sorbent used were investigated to determine the optimal conditions for the recovery of precious metal ions. A di-n-alkyl sulfide was used to impregnate the polymer matrix; due to the sulfur atom in its structure, it can bind the precious metal chlorocomplexes formed in chloride solution.

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