Advanced Ceramics and Applications XIV

New Frontiers in Multifunctional Material Science and Processing

Serbia, Belgrade

September 21st–23rd, 2026

СРПСКО КЕРАМИЧКО ДРУШТВО
THE SERIAN CERAMIC SOCIETY

Golden Tulip Zira Hotel, Ruzveltova 35

Serbian Ceramic Society Conference
ADVANCED CERAMICS AND APPLICATION XIV
New Frontiers in Multifunctional Material Science and Processing

Serbian Ceramic Society
Institute of Technical Sciences of SASA
Institute of Chemistry Technology and Metallurgy
Institute for General and Physical Chemistry

PROGRAM AND THE BOOK OF ABSTRACTS

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Serbia, Belgrade, 21-23 September 2026.

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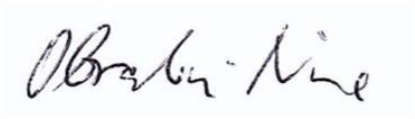
Dear colleagues and friends,

We have great pleasure to welcome you to the Advanced Ceramic and Application XIV Conference organized by the Serbian Ceramic Society in cooperation with the Institute of Technical Sciences of SASA, Institute of Chemistry Technology and Metallurgy, and Institute for General and Physical Chemistry.

We are very proud that we succeeded in bringing the scientific community together again and fostering the networking and social interactions around an interesting program on emerging advanced ceramic topics. The chosen topics cover contributions from fundamental theoretical research in advanced ceramics, computer-aided design and modeling of new ceramics products, manufacturing of nano-ceramic devices, developing of multifunctional ceramic processing routes, etc.

Traditionally, ACA Conferences gather leading researchers, engineers, specialists, professors and PhD students trying to emphasize the key achievements which will enable the widespread use of the advanced ceramics products in the High-Tech industry, renewable energy utilization, environmental efficiency, security, space technology, cultural heritage, etc.

Serbian Ceramic Society was initiated in 1995/1996 and fully registered in 1997 as Yugoslav Ceramic Society. Since 2009, it has continued as the Serbian Ceramic Society in accordance with Serbian law procedure. Serbian Ceramic Society is almost the only one Ceramic Society in South-East Europe, with members from more than 20 Institutes and Universities, active in 9 sessions. Thanks to all of you for being with us here at ACA XIV.



Dr. Nina Obradović
President of the Serbian Ceramic Society

Conference Topics

- Basic Ceramic Science & Sintering
- Nano-, Opto- & Bio-ceramics
- Modeling & Simulation
- Glass and Electro Ceramics
- Electrochemistry & Catalysis
- Refractory, Cements & Clays
- Renewable Energy & Composites
- Amorphous & Magnetic Ceramics
- Heritage, Art & Design

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Dr. Lidija Mančić

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Institut za opštu i fizičku hemiju,
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Institute of Technical Sciences of SASA
Hotel Zira

Conference Program and Abstracts

Program and Abstract's Contents

The Fourteen Serbian Ceramic Society Conference "Advanced Ceramics and Application"

Conference Information:

Conference location: Belgrade (Beograd) – the capital of Serbia, Serbian culture, education, science and economy, having about 2.5 million habitants. Belgrade is situated in South-Eastern Europe, on the Balkan Peninsula, at the confluence of the Sava and Danube Rivers in north-central Serbia. The official language is Serbian, while foreigners can use English.

Conference venue: Hotel Zira, Ruzveltova Str. 35, Belgrade, Serbia.

Dress code: We kindly ask you to respect a dress code and not to wear short skirts and pants (above the knee); tank top and sleeveless shirts; flip-flops and open-toed sandals.

Conference fee: Standard fee for foreign participants: 600 EUR; Standard fee for domestic participants: 20000 RSD; **Discounts**: Members of SCS, Plenary lectures and PhD Students; and the last year winners (oral and poster presentations): Free of charge.

Invoice and bank details for Conference fee payment: Banka Intesa ad Beograd, Account No. 160-380150-55, notification: Conference fee – participant name.

Paying for the conference fee and Gala dinner at site will be available only in cash

Registration:

21-23.09.2026. (8.00-9.00 A.M.-2nd Floor)

Posters installation:

21.09.2026. (8.00-9.00) Mikonos Hall

After poster session, participants should remove their posters!

Useful telephone numbers:

Police:192

Firemen:193

Ambulance:194

Taxi services: For the taxi services from Belgrade Nikola Tesla Airport to any destination in Belgrade area and further, please contact TAXI INFO desk, located in the baggage area.

Time zone: Belgrade and Serbia are located in the Central European time zone region GMT + 1

Electricity: The electricity voltage in Belgrade is 220V. Electrical outlets are standard EU.

Currency: The official currency in Serbia is dinar, abbreviated RSD. Money may be exchanged in all banks and authorized exchange offices. Exchange rate for 1 EUR is around 118 RSD. Cash may be taken from ATMs 24 hours a day. Credit cards are accepted in shops, hotels and restaurants.

Water: Tap water in Belgrade is safe to drink.

Abstracts and papers publication: The official language of the conference is English. Conference abstracts will be published in the **Book of Abstracts**.

Limited number of papers presented at the conference will be possible to publish in **Science of Sintering** and **Tribology and Materials.**

Type of presentation: Visuals for oral presentations should be in Microsoft PowerPoint (.ppt or .pptx) or Adobe Acrobat Reader 9 (.pdf). Any animation or video files must be compatible with Windows 7 and Windows Media Player. Bring your presentation to speaking desk at the beginning of the day when your presentation will be. Posters should be prepared in dimension: 70x100 cm. The official language on conference is English.

Additional Conference information president@serbianceramicsociety.rs
http://www.serbianceramicsociety.rs/about.htm

Recommended places near the Conference venue:

Hotel: Hotel Zira, Ruzveltova Str. 35; http://zirahotels.com/

Tourist Information Centre: Kneza Mihaila 5, http://www.tob.rs/en

	Time	Programme	Place, Floor, Room
21st September Monday	**08.00-09.00**	**Registration and Poster/Exhibitions Installation**	Hotel Zira 2nd Floor
	09.00-09.30	**Opening Ceremony (President of SeCerS, music program, sponsors)**	Mikonos Hall
	09.30-12.05	**Nano, Opto and Bio-ceramics (L. Mančić & S. Marković)** 09.30-10.00 Jordi Llorca Pique (PL1) 10.00-10.30 Ronald O'Malley (PL2) 10.30-10.50 Aleksandar Krmpot (INV1) 10.50-11.10 Jelena Lazović (INV2) 11.10-11.30 Maria Eugenia Rabanal (INV3) 11.30-11.50 Ana Stanković (INV4) 11.50-12.05 Nikola Živković (ORL1)	
	12.05-12.45	**Coffee Break**	Hallway
	12.45-14.35	**Renewable Energy and Composites (S. Maslovara)** 12.45-13.15 Patrick Fortin (PL3) 13.15-13.45 Maria Vesna Nikolić (PL4) 13.45-14.15 Monica Ferraris (PL5) 14.15-14.35 Zvezdana Baščarević (INV5)	Mikonos Hall
	14.35-15.30	**Buffet Lunch**	Zira Restaurant
	15.30-18.10	**Electrochemistry and Catalysis (M. Pagnacco & M. Vujković)** 15.30-16.00 Andrea Strakova Fedorkova (PL6) 16.00-16.30 Igor Pašti (PL7) 16.30-16.50 Jelena Živković (INV6) 16.50-17.10 Dejan Đokic (INV7) 17.10-17.30 Ana Dobrota (INV8) 17.30-17.50 Marko Opačić (INV9) 17.50-18.10 Nebojša Potkonjak (INV10)	Mikonos Hall
	18.10-19.00	**Exhibition and coffee**	Mikonos Hall
	19.00-23.00	**Conference dinner**	Rhodes Hall
22nd September Tuesday	**08.30-09.00**	**Registration**	Hotel Zira 2nd Floor
	09.00-11.40	**Basic ceramics and Sintering (S. Filipović & A. Peleš Tadić)** 09.00-09.30 Bill Fahrenholtz (PL8) 09.30-10.00 Antonio Vinci (PL9) 10.00-10.30 Scott McCormack (PL10) 10.30-11.00 Farid Akhtar (PL11) 11.00-11.20 Elizabeth Pritchett (INV11) 11.20-11.40 Miloš Dujović (INV12)	Mikonos Hall
	11.40-12.15	**Coffee Break**	Hallway
	12.15-14.15	**Basic ceramics and Sintering (D. Kosanović & N. Labus)** 12.15-12.45 Karel Maca (PL12) 12.45-13.15 Dušan Galusek (PL13) 13.15-13.35 Daniel Drdlik (INV13) 13.35-13.55 Vojtech Marak (INV14) 13.55-14.15 Vladimir Prajzler (INV15)	Mikonos Hall
	14.15-15.15	**Buffet Lunch**	Zira Restaurant
	15.15-16.50	**Basic ceramics and Sintering (S. Filipović & A. Peleš Tadić)** 15.15-15.35 Suzana Filipović (INV16) 15.35-15.55 Nebojša Labus (INV17) 15.55-16.15 Tamas Csanadi (INV18) 16.15-16.35 Peter Tatarko (INV19) 16.35-16.50 Jelena Živojinović (ORL2)	Mikonos Hall
	17.00-18.00	**Poster Session and coffee**	Mikonos Hall
	18.00-18.30	**Poster Removal**	Mikonos Hall
	08.30-09.00	**Registration**	Hotel Zira 2nd Floor
	09.00-11.40	**Modelling and Simulations (I. Trajković & G. Mladenović)** 09.00-09.30 Chris Weinberger (PL14) 09.30-10.00 Tessa Davey (PL15) 10.00-10.30 Goran Mladenović (PL16) 10.30-11.00 Dušan Dimić (PL17) 11.00-11.20 Maria Čebela (INV20) 11.20-11.40 Isaak Trajković (INV21)	Mikonos Hall
	11.40-12.00	**Coffee Break**	Hallway
	12.00-13.35	**Modelling/Heritage (I. Trajković & O. Klisurić & M. Gajić Kvaščev)** 12.00-12.15 Katarina Telebak (ORL3)	Mikonos Hall

23rd September Wednesday		12.15-12.30 Zoran Stojanović (ORL4) 12.30-12.50 Olivera Klisurić (INV22) 12.50-13.10 Maja Gajić Kvaščev (INV23) 13.10-13.35 Vladimir Pavlović (MOVIE)	
	13.35-14.30	**Buffet Lunch**	Zira Restaurant
	14.30-15.00	**Awards and Closing ceremony**	Mikonos Hall
	16.00-18.00	**Excursion:** **Kalemegdan fortress & Belgrade Underneath Belgrade**	Belgrade city

Book of Abstracts

PL1

3D-Printed Ceramic Catalytic Materials

Jordi Llorca Pique

Universitat Politècnica de Catalunya – BarcelonaTech. Eduard Maristany 10-14, 08019 Barcelona, Spain

Materials used in heterogeneous catalysis typically consist of a ceramic oxide support combined with an active phase in the form of metal nanoparticles. Traditionally, industrial catalysts are shaped as pellets or monoliths to facilitate mass transfer within catalytic reactors and enable straightforward replacement. Recent advances in 3D printing technologies for ceramic materials now allow the fabrication of catalysts with virtually unlimited geometries, opening up promising opportunities for catalyst design and process intensification. These structures can be produced either by printing the ceramic support followed by post-synthetic incorporation of the active phase, or by directly printing the fully formulated catalytic material. In addition, thermal treatments can be used to tailor both the mechanical strength and porosity of the resulting structures. In this contribution, I will present recent progress achieved at the Universitat Politècnica de Catalunya (UPC) and demonstrate the application of 3D-printed ceramic catalysts in a range of reactions of energy and environmental relevance.

PL2

Fiber Optic Sensors for Extreme Environments

Ronald J. O'Malley

F. Kenneth Iverson Chair Professor & Director,
PSMRC Mat. Sci. & Eng. Missouri S&T, 284 McNutt Hall 1400 N. Bishop Ave.
Rolla, MO, USA

Fiber optic sensors offer many benefits for distributed sensing of temperature, strain, and slag chemistry in the harsh environment of steel manufacturing. Several examples of fiber optic technologies will be reviewed, including Rayleigh backscattering optical frequency domain reflectometry that is capable of high resolution sensing at sub-millimeter resolution at temperatures of up to 700 C using single mode silica optical fibers, fiber brag grating sensing at cm level resolution at temperatures of up to 1800 C using multi-mode sapphire fibers, and remote fiber optic Raman sensing of structures in slags and fluxes at temperatures of up to1600 C. Examples of these technologies that have been demonstrated in production steelmaking environments will be presented and discussed.

PL3
Nb-Doped TiO_2-Supported Ir Catalysts for PEM Water Electrolysis

Sara Andrenacci,[a] Greta Giarola,[b], Yang Hu,[b] Patrick Fortin[a]

[a]SINTEF, Norway
[b]Technical University of Denmark, Denmark

Green hydrogen is routinely cited as a major pillar of the clean energy transition and research efforts are well underway to develop innovative materials with better performance, longer lifetimes, lower costs, and increased sustainability. Proton exchange membrane water electrolysis (PEMWE) is a promising route towards large-scale green hydrogen production but currently relies on significant amounts of iridium as the anode catalyst for the oxygen evolution reaction (OER). The use of supported iridium catalysts can provide several distinct benefits such as reduced iridium loadings, higher electrochemically active surface areas, and improved catalyst utilization.
This presentation will highlight both the advantages and the current limitations of supported iridium catalysts, exploring the use of Nb-doped TiO_2-supported Ir as a high performance OER catalyst. A particular emphasis will be placed on understanding electrochemical performance and durability of the Ir/Nb-TiO_2 catalysts using various ex-situ and in-situ characterization techniques. Rotating disk electrode (RDE) voltammetry measurements demonstrate high mass activity, low overpotential, and good stability of the synthesized Ir/Nb-TiO_2 catalysts while their incorporation into single cell PMEWE devices showcases their suitability as OER catalysts under real-world operating conditions and cell architectures. The performance and durability of the Ir/Nb-TiO_2 catalyst has been benchmarked against a commercial Ir catalyst and progress towards key performance, durability, and sustainability performance indicators will be discussed.

PL4
Nickel Manganites: Engineering Multifunctional Materials for Sensing and Energy

Maria Vesna Nikolić

University of Belgrade – Institute for Multidisciplinary Research, National Institute of the Republic of Serbia, Kneza Višeslava 1, Belgrade, Serbia

Nickel manganites are highly versatile mixed metal oxides with a broad spectrum of applications, ranging from energy storage and catalysis to environmental sensing and advanced electronics. They have been investigated since the 1960s as negative temperature coefficient (NTC) thermistors and more recently have become “emerging” materials used in advanced technology solutions. Engineering these materials to achieve the optimal balance of chemical composition, surface area, morphology, and crystallite size presents a major scientific challenge, making the choice of synthesis method a significant factor influencing electrical and electrochemical performance. Nickel manganite is most often synthesized in the cubic spinel form ($NiMn_2O_4$) where electrical conductivity occurs through electron “hopping” between Mn^{3+} and Mn^{4+} cations in the octahedral B-sites. However, more recently the ilmenite $NiMnO_3$ form has been investigated in view of energy storage applications. The aim is to present an overview of synthesis methods used in our research for obtaining nickel manganites starting

with solid state synthesis for NTC thermistor ceramic and thick film applications, and then further focusing on sol-gel combustion and electrospinning synthesis methods. It is combined with a detailed structural and morphological characterization of synthesized nickel manganite nanopowders to explore the application potential of nickel manganites as sensors for temperature or humidity or supercapacitor electrodes.

PL5

Joining of Ceramics and Ceramic Matrix Composites for energy applications

Monica Ferraris

Science and Technology of Materials at Politecnico di Torino, Italy

Advanced ceramics and Ceramic Matrix Composites show significant potential for several industrial and energy applications: however, their reliable and user-friendly joining and integration methods remain a critical challenge.
This talk explores several strategies for joining these materials to themselves and to metals by using glasses, brazing alloys, adhesives and polymer-derived ceramics.
Innovation in processing and characterization of joined components developed at GLANCE-Glasses, Ceramics and Composites research group at Politecnico di Torino, Italy, will be presented and discussed.
The combination of advanced design of interfaces and joining materials/technologies, selective matrix removal from the surface, laser structuring and mechanical machining of the ceramic/metal surfaces will be discussed and compared to existing solutions.
The work done with the aim of developing reliable and user-friendly international standard tests to measure the shear strength of joined components will also be reviewed.
Finally, J-TECH@PoliTO (https://www.j-tech.polito.it/), Advanced Joining Technology research center at Politecnico di Torino, will be described together with collaboration actions and opportunities for common research activity on joining.

PL6

Next-Generation Hybrid Energy Storage: Synergizing Li-S and Redox Flow Batteries through Advanced Ceramic Materials and Modelling

Andrea Straková Fedorková[1], Veronika Niščáková[1], Ivana Šišoláková[1], Jakub Leščinský[1]

[1]Institute of Chemistry, Faculty of Science, P. J. Šafárik University, Moyzesova 11, 041 54 Košice, Slovakia

Aim This study explores the strategic synergy between Lithium-Sulfur (Li-S) batteries and Redox Flow Batteries (RFBs), focusing on integrated chemical and material innovations to address the multi-scale demands of modern power grids and electric mobility.
Methods Utilizing advanced atomistic modelling and high-throughput computational screening (HTCS), we identified novel electrolyte additives and membrane coatings to mitigate parasitic crossover. Furthermore, 2D time-transient reactive transport models were deployed to simulate ion migration and fluid dynamics, providing a unified framework for optimizing

electrode porosity and minimizing ohmic resistance. Operando electrochemical measurements were used to validate system performance.

Conclusion The convergence of these technologies establishes a robust pathway for next-generation hybrid energy storage systems (HESS). This research highlights that advanced ceramic materials can be effectively utilized within these systems—specifically as solid-state electrolytes, ion-selective separators, and protective anode coatings—to drastically suppress the polysulfide shuttle effect and enhance thermal stability. Ultimately, leveraging ethically sourced ceramic components and circular economy principles ensures that the lifecycle of both Li-S and RFB technologies aligns with global sustainability goals, offering a scalable and environmentally responsible solution for a carbon-neutral landscape.

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

PL7

From Support to Active Interface: DFT Insights into TiO_2-Based Ceramic Catalysts for Electrocatalysis and Photocatalysis

Igor A. Pašti[1,2]

[1]University of Belgrade − Faculty of Physical Chemistry, Studentski trg 12-16, 11158 Belgrade, Serbia
[2]Serbian Academy of Sciences and Arts, Knez Mihailova 35, 11000 Belgrade, Serbia

Titanium dioxide is one of the most widely investigated ceramic oxide materials owing to its chemical stability, abundance, tunable surface chemistry, and ability to interact strongly with supported catalytic species. Beyond its classical role in photocatalysis, TiO_2 has increasingly attracted attention as a support or active component in electrocatalytic systems, where metal-oxide interactions, surface defects, dopants, and interfacial charge transfer can strongly influence catalytic activity and stability. In this contribution, we summarize our recent theoretical work on TiO_2-supported electrocatalysts and photocatalysts, with particular emphasis on the role of Density Functional Theory (DFT) calculations in rationalizing experimentally observed trends. The investigated systems include TiO_2-based materials modified by supported metal atoms, clusters, or oxide-derived active sites, as well as defect-engineered TiO_2 surfaces. Using DFT calculations, we analyzed adsorption geometries, binding energies, charge redistribution, electronic structure changes, and reaction-relevant intermediate binding, with the aim of identifying the microscopic factors that govern catalytic performance. The results show that TiO_2 is not merely an inert support, but can actively participate in catalyst stabilization and activity modulation. Oxygen vacancies and the local coordination environment can alter the electronic structure of TiO_2 and promote stronger interaction with catalytically active species. In electrocatalytic systems, these effects influence the adsorption strength of key intermediates and may improve activity toward reactions relevant to sustainable energy conversion. In photocatalytic systems, defect-induced electronic states can affect charge separation, light absorption, and surface reactivity, thereby modifying photocatalytic efficiency. These findings demonstrate how theoretical insights can complement experimental studies and support the rational development of stable, efficient, and multifunctional ceramic-based catalysts.

Acknowledgment: The author acknowledges the financial support provided by the Serbian Ministry of Science, Technological Development, and Innovations (contract no. 451-03-

137/2025-03/200146), the Serbian Academy of Sciences and Arts (project F-190), and the NATO SPS programme (project SeaCAT, G-6230).

PL8

Design of High Entropy Borides as New Superhard Ceramics

William G. Fahrenholtz

Missouri University of Science and Technology, Rolla, MO, United States

The effects of composition on the hardness of compositionally complex boride ceramics were investigated. The study focused on $(Hf,Mo,Ti,V,W)B_2$ and varied the amounts of the metals to tailor key descriptors including differences in the valence electron concentration, atomic sizes, bond lengths, electronegativity, and configurational entropy. Compositions were synthesized by boro/carbothermal reduction of oxides of the constituent metals with carbon and boron carbide as reductants. Reacted powders were densified by spark plasma sintering. Several compositions had hardness values over 40 GPa, which is the threshold for classification as superhard. The presentation will discuss the factors that have the most significant impact on hardness to guide future studies to produce new compositions with even higher hardness values.

PL9

Additive-free α-SiC-TiB_2 ceramics: densification, microstructure and properties

Laura De Bellis[1], Diletta Sciti[1], Antonio Vinci[1], Jacob Stacy[2], Jeremy L. Watts[2], William G. Fahrenholtz[2], Greg E. Hilmas[2]

[1]CNR-ISSMC, National Research Council of Italy (CNR) - Institute of Science, Technology and Sustainability for Ceramics (ISSMC), Via Granarolo 64, I-48018 Faenza, RA, Italy
[2]Materials Science and Engineering Department, Missouri University of Science and Technology, Rolla, MO 65409, United States

Silicon carbide (SiC) and titanium diboride (TiB_2) are key ceramic materials for extreme environments due to their exceptional properties and thermal stability. When combined, they can form electrically conductive ceramics suitable for a wide range of applications. This study examined the sintering behavior and resulting properties of α-SiC-TiB_2 ceramics with TiB_2 contents of 20, 40, 60, and 80 vol.%, that were densified without additives by spark plasma sintering.
TiB_2-rich compositions achieved relative densities over 98% when sintered at 2100°C for 15 min, with the 80 vol.% TiB_2 composition exceeding 99% relative density. In contrast, SiC-rich compositions exhibited lower relative densities, with the composition containing 20 vol.% TiB_2 reaching only 95.5% relative density when sintered at 2200°C with an additional 10 min of dwelling time.
For each composition, an in-depth microstructural analysis is reported. Mechanical properties, including hardness, fracture toughness, and flexural strength, were investigated at room temperature, with strength also measured at elevated temperatures. Finally, thermal diffusivity and conductivity were characterized at elevated temperature, also electrical resistivity was measured at room temperature. All samples could be cut by electrical discharge machining,

demonstrating the feasibility of additive-free α-SiC-TiB_2 ceramics for electrically assisted shaping and encouraging further optimization of SiC-rich compositions.

PL10

Thermodynamics of Transition Metal Diborides at Ultra-High Temperatures

Scott J. McCormack

University of California, Berkeley

Transition metal diborides MB_2 are considered an ultra-high temperature refractory ceramic due to their relatively low reactivity and high melting point. While these properties are appealing, they also make it difficult to fully characterize their thermochemical and thermophysical properties up to melting. This work will discuss high temperature levitation methods using a conical nozzle levitator system equipped with lasers to investigate the melting points along with in-situ high temperature X-ray diffraction to study crystallography up to ~3000 ˚C. In addition, drop solution calorimetry methods to measure formation enthalpies will be discussed. The development of the above techniques will be applied to Group IV – Group V diborides to elucidate their thermodynamic properties. This presentation will highlight key contributions made by the McCormack Laboratory to the thermochemical and thermophysical properties of MB_2 over the past 6 years.
Specifically, we will highlight melting points along with direct experimental evidence of invariant eutectic reactions in all investigated binary (Group IV – Group V) transition metal diboride systems: $(Ti,Nb)B_2$; $(Ti,Ta)B_2$; $(Zr,Nb)B_2$; $(Zr,Ta)B_2$; $(Hf,Nb)B_2$; $(Hf,Ta)B_2$. Phase diagrams for these systems previously did not include the invariant eutectic reactions. Eutectic microstructures were achieved through laser heating and cooling from the melt. In addition, the existence of a eutectic in the $(Zr,Ta)B_2$ binary system is further verified with calorimetric measurements of excess enthalpies and a preliminary updated phase diagram is presented for the $(Zr,Ta)B_2$ binary system. These results highlight that phase diagrams presented for these transition metal diborides need to be updated to reflect the observed eutectic reactions.

PL11

Entropy-Stabilized Ultra-High Temperature Ceramics: From Design to Extreme-Environment Performance

Farid Akhtar

Department of Engineering Sciences and Mathematics, Luleå University of Technology, Luleå 97187, Sweden

Ultra-high-temperature ceramics (UHTCs) are among the most promising materials for next-generation aerospace, energy, and hypersonic systems, where exceptional resistance to extreme temperatures, oxidation, ablation, and mechanical degradation is essential. Entropy-stabilized ceramics have introduced a new strategy for designing UHTCs through compositional complexity, enabling the formation of novel single-phase materials with enhanced thermal and mechanical performance. This presentation highlights recent advances in the computational design, processing, and high-temperature behavior of entropy-stabilized transition-metal diborides and boron-carbide-based ceramics. Density functional theory and entropy-based

descriptors are used to accelerate the discovery of new high-entropy compositions, while spark plasma sintering and ultrafast high-temperature sintering enable rapid densification and entropy-driven phase stabilization. Particular emphasis is placed on the entropy-stabilized $(Ti_{0.25}V_{0.25}Zr_{0.25}Hf_{0.25})B_2$ system, whose transformation from a metastable dual-phase microstructure to a stable single-phase diboride results in improved hardness, oxidation resistance, and thermal stability through lattice distortion and sluggish diffusion effects. The presentation also discusses oxidation behavior up to 1500 °C, entropy-stabilized protective coatings for graphite under ablative conditions exceeding 2200 °C, and the integration of density functional theory, molecular dynamics, finite element modeling, and advanced characterization to reveal the mechanisms governing phase stability, oxidation, thermal transport, and thermomechanical performance in extreme environments.

PL12

High Temperature Dilatometry as a Tool for Sintering Studies

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Although the primary purpose of high-temperature dilatometry is to determine the coefficient of thermal expansion of materials, it can also be advantageously used to study the sintering of various types of materials. The sintering processes are accompanied by volume changes, i.e. by shrinkage. The use of dilatometers for sintering purposes is advantageous in that it allows continuous monitoring of sample shrinkage. This method is therefore used in ceramic technology to determine the sintering behaviour of powder compacts and also to calculate the sintering activation energy via application of selected theoretical models, e.g. Master Sintering Curve (MSC) or Wang&Raj model. To describe more complex sintering profiles and to describe anisotropic sintering we have developed modifications of MSC Two-Stage Master Sintering Curve (TS-MSC) and Master Shrinkage Curve (MShC) With their help, for example, Two Step Sintering of various monolithic ceramics and sintering of laminated alumina/zirconia composites were described. In these cases, multiple activation energies are required to describe the sintering process, the physical interpretation of which will be also presented. Much of our work in this field, in addition to the Journal of the European Society, has been published in the Science of Sintering journal.

PL13

Cold Sintering of Glass

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Cold sintering is an emerging low-temperature densification approach that enables consolidation of glass powders at temperatures below ~350–400 °C by combining uniaxial pressure with a transient liquid or surface activation. This abstract summarizes recent progress in extending cold sintering from ceramics to a broad range of glass systems, with emphasis on silicate and bioactive glasses. The key challenge in glass cold sintering lies in achieving high density while suppressing crystallization, which typically degrades functional properties such as bioactivity or optical transparency. Experimental studies demonstrate that appropriate surface activation—using water, alkaline solutions, or solid fluxes such as hydrated sodium silicates—induces partial dissolution of glass surfaces and formation of ≡Si–OH groups. Subsequent dissolution–precipitation and condensation reactions under pressure promote strong interparticle bonding at temperatures far below the glass transition. Cold sintered bioactive glasses (e.g. 45S5 and 13-93) reach relative densities above 95–98 % while retaining or even enhancing biologically relevant phases. The use of solid fluxes enables partial transparency in cold-sintered silicate glasses, opening routes to low-energy fabrication of optical and functional glass components. Overall, cold sintering of glass offers a versatile, energy-efficient alternative to conventional viscous flow sintering, enabling processing of metastable compositions, complex shapes, and hybrid structures that are difficult or impossible to produce by traditional glass technologies.

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PL14

Hardness of the Cubic Transition Metal Carbides and Nitrides

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It is well known that the hardness, as well as many of their properties, of the cubic transition metal carbides and nitrides vary with carbon content and transition metal content. Further, the mechanisms of deformation under indents change between plasticity and fracture; even the types of slip systems under the indent can change. However, the exact origins of mechanisms of hardness and how it changes are not completely understood. This need for understanding is further motivated by the development of high entropy carbides and nitrides, where the interplay between chemistry, processing, and properties are quite complex. In this talk we will explore this hardness variability, how it changes with metal type and carbon content, and connect this through mechanistic insights. Experimentally, the hardness behavior can be explored through hardness anisotropy measurements or through microscopic examination of the deformation directly under the indents. The results from such studies are combined with theoretical models of dislocation plasticity and fracture to uncover the structural and electronic origins of hardness

in these hard ceramics. These results provide a general understanding of the origins of hardness in these materials, explain the origins of the anomalous hardness, and provide guidance towards developing new ultrahard ceramics.

PL15
Designing ultra-high temperature ceramics using atomistic simulations

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Ultra-high temperature ceramics are a class of advanced materials with applications in extreme environments, due to their extremely high melting points, favourable thermal properties, and retention of mechanical properties close to the melting temperature. Many of these ceramics, such as the transition metal carbides, have wide ranges of stoichiometry, where the desired composition may be tuned according to the application. However, challenges in precise compositional control in fabrication and characterisation mean that systematic experimental data is not available across the potential composition and structural space. Furthermore, high-entropy or compositionally complex ultra-high temperature ceramics have recently become of interest thanks to their potentially improved properties such as melting point, hardness, ductility, and oxidation resistance. This significantly enhances the compositional space, making it extremely challenging to explore experimentally.
In order to better understand the potential properties, first-principles calculations have been applied to understand the underlying mechanisms governing the atomic arrangements and phase stability in ultra-high temperature ceramics. This talk presents atomistic simulation of compositionally complex transition metal carbides with varying carbon and metal ratios, putting the results in the context of designing optimised ceramics for particular applications.

PL16
Simulation and Optimization of Small Manufacturing Systems

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Planning and management of manufacturing processes present big issue in management of production systems. There are a lot of methods for simulation of manufacturing systems in literature which works are based on different methods. The main task of all simulations models is to create conceptual frame which describes real system. The use of simulation models is mainly in design of production systems before building of real system, but it can be also used later in optimization or modification of existing manufacturing systems. Nowadays, discrete event simulations modeling is mostly in use. Based on discrete event models every machine in production system can be described as separate event. Based on designed manufacturing process for every part machining time is defined for each machine and it present its holding on

defined machine. Using software solution for discrete simulation it was generated virtual model of production system based on selected products which require manufacturing in system. Varying the input data for manufacturing parameters and predicted machines it was experimentally determined required number of machines for production without bottlenecks. For all the machines it was generated chart for its utilization which has the big impact on optimization of size and shape of manufacturing system.

Keywords: *Manufacturing systems, discrete simulation, production optimisation*
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PL17

Computational Chemistry in Forensic Science: From Spectroscopic Identification to Biological Activity of Psychoactive Substances

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The rapid emergence of new psychoactive substances (NPS) presents a major challenge for forensic science due to their structural diversity, limited reference data, and complex behavior in real samples. This lecture highlights recent applications of computational chemistry and molecular modeling in the forensic investigation of psychoactive compounds, with emphasis on the integration of density functional theory (DFT), molecular docking, and molecular dynamics simulations. DFT calculations were applied for structural characterization and prediction of spectroscopic properties of illicit drugs and their analogs, enabling reliable simulation and interpretation of IR and NMR spectra even in the absence of reference standards. Selected case studies include LSD derivatives and interactions of lorazepam with common adulterants and excipients, where theoretical models successfully reproduced experimentally observed spectral changes and provided insight into noncovalent interactions governing mixture behavior. The lecture further addresses the biological relevance of emerging synthetic opioids through docking studies of methylenedioxynitazene metabolites at the μ-opioid receptor, revealing how structural modifications influence ligand–receptor interactions and potential activity. These examples demonstrate how computational approaches can complement experimental forensic analysis by connecting molecular structure, spectroscopic behavior, intermolecular interactions, and biological activity in complex forensic systems.

INV1
Nonlinear Laser Scanning Microscopy for Material Science and Biomedical Applications

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Nonlinear Laser Scanning Microscopy (NLSM) is advanced imaging techniques that utilizes ultrashort (femtosecond) laser pulses and relay on the detection of nonlinear optical effects like two photon excitation fluorescence (TPEF), up conversion (UC), second and third harmonic generation (S/THG). In this study, TPEF and UC modality of home built NLSM setup is employed for imaging of cancer cells selectively labeled by rare earths doped up converting nanoparticles (UCNPs) conjugated with. These nanoparticles show significant potential for application in biomedical sciences, primarily for diagnostic purposes as biomarkers. Since these materials can be excited by near infrared light (700-1200nm) the negative impact on biological samples is significantly reduced. In combination with TPEF modality used for (auto) fluorescent imaging of the cancer cells, the UC modality can provide exact location of UCNPs binding points on or inside the cells. In addition, other selected application of NLSM modalities relevant for material science and biomedical imaging will be demonstrated.

INV2
Lanthanide-Doped Bioactive Glass for Multimodal Imaging

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To enable multimodal imaging, bioactive glass (BG) formulations are extended to include lanthanides such as Gd^{3+}, Eu^{3+} and Yb^{3+}/Er^{3+}. The presence of Gd^{3+} enhanced contrast in magnetic resonance imaging (MRI), while presence of lanthanides enhanced contrast in computed tomography (CT).
BGs were synthesized via sol–gel (SG) methods to obtain undoped: 60 wt% SiO_2 + 27.4 wt% CaO + 2.6 wt% Na_2O + 6 wt%P_2O_5 and doped: SG-BGdown + 1.5 wt% Gd_2O_3 + 2.5 wt% Eu_2O_3 and SG-BGup +1.5 wt% Gd_2O_3 + 15 wt% Yb_2O_3 + 2.5 wt% Er_2O_3 samples. Transverse (T_2) and longitudinal (T_1) relaxation times were measured using 7 T Bruker MRI. Ex-vivo contrast evaluation on MRI and micro-CT, was done by injecting SG-BGdown or SG-BGup into a mouse. Undoped BGs are slightly diamagnetic. Lanthanides doped SG-BGdown and SG-BGup had similar longitudinal relaxivity r_1(SG-BGdown)=0.272 ± 0.009 [$(mg/ml)^{-1}s^{-1}$] and r_1(SG-BGup) =0.300 ± 0.007 [$(mg/ml)^{-1}s^{-1}$], while SG-BGdown had doubled transverse relaxivity r_2(SG-BGdown)=39.62 ± 3.26 [$(mg/ml)^{-1}s^{-1}$] vs r_2(SG-BGup)=19.04 ± 0.55 [$(mg/ml)^{-1}s^{-1}$] for SG-BGup. The presence of lanthanides resulted in high X-ray absorption of SG-BGdown and SG-BGup easy visualization on 3D rendered micro-CT image, confirming potential lanthanide-doped bioactive glasses for multimodal imaging.

Developed lanthanide-doped BGs are suitable for multimodal imaging.

INV3

Photocatalysis as a Green Technology: Advancing Sustainable Environmental Remediation

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Semiconductors are widely studied due to their low cost, flexibility, lightweight nature, and multifunctional properties. The photocatalytic degradation of emerging pollutants is essential for reducing environmental impact in wastewater treatment. In this context, the development of codoped ZnO-based semiconductors (with rare earth and alkali elements) and the optimization of their electronic structure are crucial for enhancing their properties and applications. In this study, doped and codoped ZnO nanoparticles with optimized photocatalytic performance were synthesized via a cost-effective, environmentally friendly polyol method. The relationships between morphology, chemical composition, and particle size were systematically analyzed. Characterization techniques included X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), Brunauer–Emmett–Teller (BET) surface area analysis, photoluminescence (PL), Raman spectroscopy, and X-ray photoelectron spectroscopy (XPS).
All samples exhibited a single-phase wurtzite structure. The lattice parameters and crystallite size were determined, while FESEM and HRTEM analyses revealed morphological and size variations depending on composition and Zn:RE:Li atomic percentage. XPS and μ-Raman spectroscopy confirmed the incorporation of dopants into the ZnO lattice. The photocatalytic performance was evaluated using Rhodamine B dye, and the reaction kinetics followed the Langmuir-Hinshelwood model.

INV4

Microwave-Assisted Green Synthesis of ZnO Nanoparticles: Influence of Surfactants on Physicochemical Properties and Antitumor Activity

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The development of sustainable nanomaterials with enhanced biomedical performance has become an important research focus in cancer nanomedicine. In this study, zinc oxide (ZnO) nanoparticles were synthesized using an environmentally friendly microwave-assisted method in the presence of two surfactants, citric acid (CA) and cetyltrimethylammonium bromide (CTAB), to investigate the influence of surface modification on their physicochemical characteristics and antitumor activity.

ZnO nanoparticles were prepared from zinc chloride and sodium hydroxide precursors with varying concentrations (5, 10, and 20 wt.%) of CA and CTAB. The synthesized materials were comprehensively characterized by X-ray diffraction (XRD), Raman spectroscopy, field-emission scanning electron microscopy (FE-SEM), Fourier-transform infrared spectroscopy (FTIR), Brunauer–Emmett–Teller (BET) surface area analysis, inductively coupled plasma optical emission spectroscopy (ICP-OES), and zeta potential measurements. Their cytotoxic effects were evaluated against human glioblastoma U251 cells using MTT and crystal violet assays.
XRD analysis confirmed the formation of highly crystalline hexagonal wurtzite ZnO regardless of the surfactant type. Although the crystal structure remained unchanged, FE-SEM revealed significant surfactant-dependent variations in particle morphology, while Raman spectroscopy indicated a high concentration of intrinsic defects associated with oxygen vacancies. Surface charge and Zn^{2+} ion release was also strongly influenced by the surfactant, suggesting different mechanisms governing nanoparticle–cell interactions. All samples exhibited dose-dependent cytotoxicity toward U251 cells, accompanied by pronounced morphological changes characteristic of apoptosis. The observed biological activity is attributed to the combined effects of reactive oxygen species generation, Zn^{2+} ion release, and tailored surface properties. These findings demonstrate that microwave-assisted surfactant-controlled synthesis provides a rapid, cost-effective, and environmentally friendly strategy for engineering ZnO nanoparticles with tunable physicochemical properties and promising antitumor potential. The proposed approach offers a flexible platform for the development of ZnO-based nanomaterials for future biomedical and anticancer applications.

INV5

Activation Methods to Increase Reuse Potential of The Waste Materials Originating from Thermal Power Plants in Construction Materials Industry

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Global annual production of fly ash, waste material originating from coal combustion in thermal power plants, is estimated to be between 500 and 750 million tons, making it one of the most abundant anthropogenic materials. Although utilization rates of fly ash, mostly by construction industry, are assessed to be ~90 % in EU, ~70 % in China and ~40 % in USA, global average is only ~25 %. Very often, possibilities to reuse local fly ash are limited by its properties i.e., reactivity.
This works demonstrates effects of mechanical and chemical activation of different ash samples on ash properties, as well as properties of a construction material based on the ash. Mechanical activation was done in planetary ball mill. Notable improvement in ash properties, in terms of particle size distribution and reactivity, was already achieved with very low ball-to-powder ratio, such as 3 or 5.
Both starting and mechanically activated ash samples were used as raw materials for geopolymers and high-volume fly ash binders. It was found that with proper chemical

activation of the ash samples it was possible to produce binder materials with mechanical properties comparable, or even superior, to traditionally used Portland cement.

INV6

Influence of Metal Coordination on Hydrogen Bonding Properties of Ethylenediamine and Its Application in Organometallic Catalysis

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Ethylenediamine is a highly effective bifunctional organocatalyst for the one-pot synthesis of aryl nitroalkenes via the Henry reaction and subsequent dehydration, where even small amounts (1–2 mol%) enable efficient condensation of aryl aldehydes with nitroalkanes under mild conditions [1]. Its catalytic activity arises from the presence of two amino groups that facilitate proton-transfer processes, activate both the nucleophile and the carbonyl substrate, and stabilize key reaction intermediates. In addition to its catalytic role, the hydrogen bonding ability of ethylenediamine, both in noncoordinated and metal-coordinated forms, was investigated through analysis of data from the Cambridge Structural Database (CSD) and complementary DFT calculations. For coordinated ethylenediamine, CSD data show that d_{OH} distances have a maximum in the range of 2.0–2.1 Å, while the hydrogen bond angle α is predominantly between 150 and 160° [2]. The calculations reveal that coordination to a metal center significantly enhances hydrogen bond strength, increasing interaction energies from −2.30 kcal/mol in the noncoordinated system to −4.00 to −28.00 kcal/mol depending on the metal ion and complex's charge. A strong correlation between hydrogen bond strength and the electrostatic potential at the interacting hydrogen atom was observed, with both oxidation state and coordination number of a complex playing a key role.

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INV7

Raman Spectroscopy and Trainable Neural Models for Non-Invasive Quality Assessment of Serbian Slivovitz

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Serbian plum brandy slivovitz presents a compelling case for objective, non-invasive quality evaluation, a task traditionally entrusted to certified sensory panels whose assessments, while expert, are inherently subjective and difficult to scale. We present a framework combining high-resolution Raman spectroscopy with a generative autoencoder neural network to correlate spectral fingerprints with expert organoleptic grades, without opening the bottle. Raman spectra were collected from several tens of certified slivovitz samples, each independently scored by accredited tasting panels. Regression performed within the learned latent representation of the autoencoder reveals nontrivial, nonlinear correlations with perceived quality descriptors: spectral signatures that remain invisible to conventional peak-assignment analysis. The approach is fully non-invasive, requires no sample preparation, and is executable directly through intact bottle glass, making it immediately applicable to quality control and authenticity certification workflows. This work establishes a proof-of-concept for autoencoder-mediated Raman quality assessment of traditional distilled spirits and points toward a portable, objective grading instrument for regulatory and industrial use.

INV8

Doping Hexagonal Boron Nitride into Better HER Catalytic Performance - in Theory

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Defect engineering of hexagonal boron nitride (h-BN) offers a promising route toward the stabilization of single atom catalysts (SACs), yet the identification of catalytically active and electrochemically robust metal-vacancy motifs remains challenging. In this work, density functional theory (DFT) calculations were employed to systematically investigate transition and coinage metals anchored at boron, nitrogen, and boron-nitrogen vacancies in h-BN for the hydrogen evolution reaction (HER). Comparisons with the cohesive energies showed boron vacancies provide the strongest thermodynamic stabilization of isolated metal atoms, while electronic structure calculations show that the type of vacancy strongly influences conductivity and metal charge state. Evaluation of atomic hydrogen adsorption free energies identifies

copper at nitrogen vacancy and palladium at boron vacancy as the most promising HER candidates, exhibiting near-thermoneutral hydrogen binding comparable to Pt(111). To assess their practical viability, electrochemical stability was further examined through Pourbaix analysis. This additional screening step demonstrates that copper at nitrogen vacancy is unstable under acidic conditions and prone to hydroxyl poisoning, whereas palladium at boron vacancy remains stable and catalytically accessible over a broad range of potentials and pH values. The results highlight the importance of combining activity descriptors with electrochemical stability criteria and establish a general computational framework for the rational design of SACs on defect-engineered 2D materials.

INV9
Temperature Dependent Raman Spectra of Tio$_2$ Brookite Nanopowder: Is Brookite Phase Photocatalytic Active?

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Due to the fact that pure brookite phase of TiO_2 is extremely difficult to synthesize, literature concerning experimental data on brookite is very scarce. The main goal of this research is the analysis of temperature dependent Raman spectra of TiO_2 nanopowder in a pure brookite phase. Twenty-four Raman active modes were observed and assigned, based on DFT calculations and by comparison with earlier Raman works. From the fits of energy and linewidth temperature dependence of the selected modes, the thermal expansion coefficients in some crystallographic directions are estimated for the first time, showing significant anisotropy. By comparing the Raman spectra of as-prepared and a sample after annealing, it was observed that Raman modes are narrower and more pronounced in a latter case, which can be ascribed to more regular stoichiometry of the annealed sample. Brookite phase, as the least investigated phase of TiO_2, shows exceptional photocatalytic activity in both types of samples. Slightly better efficacy in degradation of RO16 dye exhibits as-prepared sample, probably due to higher specific surface area, mesopore volume and the most frequent pore diameter.

INV10
Michael Pupin's Doctoral Dissertation: A Neglected Contribution to the Early Development of Physical Chemistry

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Michael Pupin (1858–1935) is widely recognized as a distinguished Serbian-American scientist, inventor, and professor at Columbia University whose contributions to

telecommunications and X-ray imaging have been recognizable worldwide. Far less recognized is that his doctoral dissertation represents one of his earliest scientific contributions to the emerging field of physical chemistry. Entitled *Osmotic Pressure and Its Relationship to Free Energy*, the dissertation was completed under the supervision of Hermann von Helmholtz and publicly defended on 20 July 1889, only two years after the founding of *Zeitschrift für Physikalische Chemie*. The study re-examines Pupin's doctoral work within its historical and scientific context, highlighting its foundations to the contemporary development of chemical thermodynamics, and its significance for the early evolution of physical chemistry. Although Pupin's later achievements have been extensively documented, his doctoral research has remained largely overlooked by both historians of science and the physical chemistry community. By bringing renewed attention to this neglected work, the present study contributes to a more comprehensive understanding of Pupin's scientific legacy in pioneer days of physical chemistry.

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INV11
Thermal and Electrical Properties of (Mo,Nb,Ti,V,Zr)C_x High-Entropy Carbides

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High-entropy carbide (HEC) ceramics are a class of ultra-high temperature ceramics, known for their strength retention above 1800°C and melting point exceeding 3000°C. These properties position HECs as attractive materials for structural thermal insulators in extreme environments, such as hypersonic and atmospheric reentry vehicles. This study aims to address the knowledge gap that exists regarding composition-property relationships in HECs. (Mo,Nb,Ti,V,Zr)C_x compositions were synthesized varying carbon stoichiometry with x = 0.6, 0.8, and 1, via metal hydride additions. Carbothermal reduction and carbide-hydride reactions were utilized to produce carbide powders, followed by densification and solid solutioning through spark plasma sintering. The compositions will be characterized by x-ray diffraction, scanning electron microscopy, and energy dispersive spectroscopy to determine the phases present, lattice parameters, elemental makeup, and homogeneity of the microstructure. Bulk density and grain size will also be measured. Thermal diffusivity and electrical resistivity will be determined from room temperature up to 2000°C. Thermal, electrical, and magnetic properties will also be collected from room temperature to cryogenic temperatures on a physical property measurement system. These analyses will determine the effect of defects and compositional variances on properties for HECs.

INV12
MAX Phases: Making Them, Breaking Them, Understanding Why

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MAX phases, a class of atomically layered ternary carbides and nitrides, are lightweight, elastically stiff, thermodynamically stable at high temperatures, and resistant to harsh environments, while also exhibiting damage tolerance, high electrical and thermal conductivity, and machinability. These unusual properties make them promising for structural and functional applications across numerous engineering fields. When MAX phases undergo selective etching of their A-layer, they form two-dimensional nanosheets known as MXenes, which exhibit tunable surface chemistry and exceptional electronic and mechanical properties. This study addresses three key aspects of MAX phases: (i) expanding the compositional space through synthesis of MAX-phase solid solutions, (ii) understanding deformation and fracture mechanisms at the single-crystal level, and (iii) probing the selective etching of the A-layer at the atomistic scale. M_2AlC phases containing multiple M-site elements (Cr, Ti, Ta, V, and Nb) were synthesized using pre-formed MAX precursors, enabling systematic control of M-site chemistry. Of 26 compositions examined, nine formed single-phase MAX structures, while the remaining compositions decomposed into competing phases. Microscale mechanical testing revealed the inherent instability of the layered structure as a precursor to kink-band formation and highlighted the critical role of crystallographic orientation in fracture. Finally, MAX-to-MXene etching revealed the topochemical nature of this transformation.

INV 13
Multi-Component Oxide Ceramics: Effects of Chemical Composition, Disorder and Microstructure on Optical Properties

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High-entropy materials have recently emerged as a promising platform for tailoring functional properties through controlled chemical and structural disorder. While their potential has been extensively explored in structural and energy-related applications, their relevance for optical materials remains largely unexplored. This study examines whether the high-entropy concept offers tangible advantages for photoluminescent (PL) materials. The study focuses on oxide

systems with technologically relevant crystal structures, including bixbyite, garnet, and zirconate-type phases (defective fluorite and pyrochlore). These structures differ in lattice symmetry, cation coordination, and tolerance to disorder, enabling a systematic comparison of their response to chemical complexity under conditions that preserve phase stability. The interplay between chemical complexity and the resulting structural disorder is addressed in terms of a distribution of local environments governing the photoluminescent response. Key PL characteristics are considered, including emission spectra, decay dynamics, quantum efficiency, and thermal quenching behaviour. A clear and reproducible increase in PL intensity is observed in high-entropy compositions compared to corresponding Y-based reference oxides co-doped with Er^{3+}/Yb^{3+}. This indicates that disorder can enhance radiative processes by modifying the local environment. Further measurements, including decay dynamics, quantum efficiency, and thermal quenching, provide a more complete picture of the underlying mechanisms. In parallel, the role of individual elements is assessed to separate compositional effects from those driven by configurational disorder. Overall, the results indicate that the high-entropy approach can be used to tune photoluminescent properties via controlled disorder, offering a promising pathway toward efficient and thermally stable luminescent materials.

INV14
Abnormal Grain Growth and Functional Properties of Batio$_3$ Prepared by Rapid Sintering Methods

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The demand for faster sintering methods is increasing due to the need for energy-efficient processing of advanced ceramics. $BaTiO_3$, a key lead-free electroceramic, presents a challenge due to its microstructure being prone to abnormal grain growth. This study compares sintering of $BaTiO_3$ using conventional pressure-assisted and pressureless spark plasma sintering, and rapid pressureless sintering. All methods produced tetragonal $BaTiO_3$ samples with a relative density above 99 %. Abnormal grain growth occurred over temperature intervals narrower than 50 °C in the rapid sintering techniques, compared to 100 °C in conventional sintering. The onset temperature difference was attributed to different energy transfer mechanisms and the presence of applied pressure. A trade-off was observed between dielectric and piezoelectric performance in relation to microstructural evolution. These results demonstrate the ability of fast pressureless sintering techniques to densify $BaTiO_3$ in minutes, while providing tuneable properties and significant time and energy savings without restrictions on shape.

INV15
Ultrafast High-Temperature Sintering of High-Entropy (Vnbtamow)$C_{0.8}$

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High-entropy carbides (HECs) are promising ultra-high temperature ceramics; however, their densification is hindered by relatively slow diffusion and complex phase evolution. This work explored ultrafast high-temperature sintering (UHS) as a processing route for (VNbTaMoW)$C_{0.8}$ produced from high-entropy alloy powders with carbon addition. UHS enabled rapid densification above 95% within 30 s, demonstrating its ability to overcome diffusion limitations. At ~95% of theoretical density, the microstructure remained chemically homogeneous with predominantly closed porosity, whereas a further increase in sintering temperature led to the formation of cavities and chemical partitioning, particularly associated with Mo- and V-rich regions. In comparison, spark plasma sintering achieved near-theoretical density (~99.9%) but required longer processing times, while conventional sintering resulted in limited densification. These results identify a critical processing window in UHS, where homogeneous, near-dense HECs can be produced and potentially fully densified by post-processing routes such as hot isostatic pressing, enabling the fabrication of complex-shaped HEC components.

INV16
Dependence of Hardness on WB Content in (Hf,Ti,W,Zr)B_2/(Hf,Ti,W,Zr)C-Based Ceramics

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Dual phase ceramics combining compositionally complex high entropy borides (HEBs) and high entropy carbides (HECs) are materials with potential applications as cutting tools, armor, and components for hypersonic aerospace vehicles due to their high hardness coupled with melting temperatures above 3000 °C. Compositionally complex (Hf,Ti,Zr,W)B_2/(Hf,Ti,Zr,W)C-based ceramics were produced by boro/carbothermal reduction from mixture of transition metal oxides with different boride and carbide phase contents by varying the C/B_4C molar ratio. Among (Hf,Ti,Zr,W)B_2/(Hf,Ti,Zr,W)C-based ceramics, a monoboride phase based on WB was detected in all compositions. As the C/B_4C ratio was varied, the WB content decreased from 23.7 vol% for a C/B_4C ratio of 6.0 to 15.3 vol% for a C/B_4C ratio of 10.3, resulting in hardness increase to 27.8 GPa for a ceramic containing 15.3 vol% WB. Further increase in the C/B_4C ratio increased the WB content. The Vickers hardness

decreased as the content of the softer WB phase increased, indicating the hardness was dominantly induced by its content.

INV17

Comparison of the Spark Plasma Sintering and Conventional sintering on ZnO, $ZnTiO_3$ and $(Y,Gd)O_3$ oxide powders

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Spark plasma sintering is very prominent due to a short sintering duration and low energy consumption. It represents rather direct current-pulse sintering than plasma, which is accompanied by a low pressure, 50 MPa compaction. Conventional sintering refers to a separate compaction at 200 MPa and subsequent oven heating by a temperature program 10 ^oC/min up to 1300 ^oC and 10 minutes holding, trying to resemble as much as possible SPS heating parameters. Materials sintered were ZnO obtained by a microwave-assisted synthesis, commercial $ZnTiO_3$ nanopowder, and $(Y,Gd)O_3$:Eu synthesized by the nitrate hydrothermal route. Comparison was observed on the sintered specimens regarding the following properties: density of the specimens, hardness determined by indentation, XRD phase composition, microstructure determined by SEM, dielectric properties, dilatation during sintering, DTA-TGA, and UV-VIS luminescence. Results indicate that the high sintering rate obtained during spark plasma sintering brings a completely different microstructure compared to microstructure evolved by conventional sintering.

INV18
Enhanced Fracture Toughness in Novel $VNbTaXWC_5$ (X=Cr, Mo) High-Entropy Carbides

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Enhancing the room-temperature fracture toughness of transition metal carbides is crucial for advancing ultra-high temperature ceramics. This study investigates novel high-entropy carbides (HECs), $VNbTaXWC_5$ (X=Cr, Mo), designed with a high valence electron concentration (VEC) of 9.4 to promote brittle-to-ductile transition. Single-phase rock salt structures with homogeneous elemental distribution were successfully synthesised via carbothermal reduction and spark plasma sintering of oxide and carbide precursors. Toughness testing using the standardised single-edge V-notch beam (SEVNB) method revealed that Cr-containing compositions outperform Mo-containing variants, achieving a fracture toughness of K_{IC}=3.8-4.1 $MPam^{0.5}$, depending on the precursor quality and processing routes. These values are more than 30% higher than those measured for TaC (3.1 $MPam^{0.5}$) in this work, known as the highest fracture toughness rock salt monocarbide. The present results verify the critical role of VEC in overcoming the intrinsic brittleness of carbides, offering a robust pathway for toughening high-entropy ceramic systems.

Keywords: High-entropy carbides (HECs); fracture toughness; single-edge V-notch beam (SEVNB); plasticity

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INV19
Development and Integration of Novel Ultra-High Temperature Ceramics

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High-entropy ultra-high temperature ceramics (UHTCs) have emerged as highly promising materials for extreme environment applications due to their exceptional thermal stability, high melting temperatures, oxidation resistance, and superior mechanical performance at elevated temperatures. However, the practical implementation of these advanced ceramics critically depends on the development of reliable joining technologies.
This work presents the development of high-purity single-phase high-entropy carbides (HECs), such as (HfZrTaNbTi)C and (MoNbTaVW)C, together with innovative approaches for joining these novel UHTCs. The presentation is divided into two parts. The first part focuses on the wetting and joining behaviour of (MoNbTaVW)C using a NiTa eutectic alloy interlayer. The addition of 17.2 at.% Ta to Ni effectively reduced interfacial reactions and dissolution of the HEC while maintaining excellent wetting characteristics.
The second part presents a pioneering approach employing a compositionally compatible high-entropy alloy (HfZrTaNbTi) for joining (HfZrTaNbTi)C HEC. The central concept was to utilise the same transition metals in both the ceramics and the interlayer alloy to promote chemical compatibility, controlled diffusion, and enhanced interfacial stability. Joining was performed through solid-state diffusion via SPS. Detailed microstructural characterization using EBSD, HR-SEM, and HR-TEM revealed homogeneous, crack-free, and well-bonded interfaces. Mechanical testing demonstrated excellent joint strengths, with no significant deterioration up to 1000°C.
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INV20
Tailoring Functional Properties of Multiferroic Oxides: An Integrated Experimental and Theoretical Perspective

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Multiferroic oxides, in which two or more ferroic orders coexist and mutually interact within a single phase, represent one of the most compelling frontiers of modern materials science,

offering unprecedented opportunities for the design of next-generation magnetoelectric devices, spintronic architectures, and non-volatile memory elements. Realizing this potential, however, demands a fundamental and precise understanding of the intricate interplay between crystal structure, chemical composition, and functional properties at the nanoscale — a challenge that calls for a truly multidisciplinary approach.
Here, we present a comprehensive investigation of multiferroic $BiFeO_3$ nanopowders substituted with silver (Ag) and, independently, with holmium (Ho), synthesized via the hydrothermal method — a low-temperature, energy-efficient route enabling the controlled fabrication of phase-pure nanoparticles with well-defined morphology and compositional homogeneity. Structural characterization by high-resolution X-ray powder diffraction, Rietveld refinement, and electron microscopy reveals how systematic Bi-site substitution with Ag and Ho progressively modulates lattice parameters, atomic bonding geometry, and particle morphology in a dopant-specific manner. Magnetic measurements performed across an exceptionally wide temperature range — from 2 K to 720 K — using a SQUID magnetometer equipped with a high-temperature oven option demonstrate the progressive enhancement of weak ferromagnetism and magnetic irreversibility upon substitution, while the Néel temperature remains remarkably invariant ($T_N \approx 630$ K), attesting to the robustness of the underlying magnetic lattice against compositional disorder.
These experimental observations are rationalized and extended through crystal structure prediction via bond valence calculations and ab initio density functional theory employing the GGA+U approach, which together unveil a rich polymorphic landscape of stable and metastable perovskite phases exhibiting a striking diversity of electronic character — from semiconducting and half-metallic to semimetallic — with direct implications for spintronics and magnetoelectric coupling. Collectively, our results establish a robust framework for the composition-directed engineering of multiferroic oxides with tailored functional properties, and underscore the indispensable role of integrated experimental–theoretical strategies in advancing this scientifically rich and technologically consequential field.

INV21
Sintering in Additive Manufacturing: Engineering Challenges, Process Optimization and Mechanical Properties

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Additive manufacturing (AM) depends on sintering to transform powders and filament-based composites into solid, functional components, yet this thermal post-processing step introduces challenges related to shrinkage, porosity and anisotropy. Without appropriate parameter selection, AM parts remain mechanically deficient; for example, variations in energy density during selective laser sintering markedly influence the tensile and fatigue performance of polymer parts, while binder-jet steels require precise control of binder burn-out and firing profiles to achieve densities and properties comparable to conventionally wrought alloys. Metallic and ceramic systems generally demand multi-step sintering at high temperatures to attain full densification; extrusion-derived aluminium alloys exhibit enhanced ductility after optimized sintering, whereas digital-light-processing-printed ceramics require carefully tailored temperature–time schedules to develop stable microstructures. Innovations such as fibre reinforcement in ceramic matrices improve reliability and resistance to thermal shock,

and advanced sintering methods (e.g. spark-plasma sintering) enable near-theoretical density and superior thermal conductivity. The goal of this paper is to illustrate how process optimization—from material selection, through powder/binder formulation and debinding, to controlled thermal regimes—leads to components with high mechanical performance and geometrical fidelity. Case studies across multiple technologies (SLS, binder jetting, material extrusion, DLP) will be presented to highlight common and localized issues, proposed solutions and the advantages of optimized sintering for industrial implementation.

INV22

Dual-Energy Computed Tomography in Cultural Heritage: From Ceramic Fabrics to Pigment Identification

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Dual-energy computed tomography (DECT) is emerging as a fully non-destructive tool for cultural heritage, where morphology and composition must be examined without sampling. Earlier work established that clinical DECT can characterize ancient ceramic fabrics, distinguishing Black Gloss and Vesuvian Sigillata wares from Pompeii and revealing compositional inhomogeneity within individual Italian Sigillata vessels through effective atomic number and material decomposition. Building on this foundation, the present study extends DECT to natural pigments in the paint layer of an 18th-century Serbian icon. Images were acquired on a clinical multi-slice CT scanner at four tube potentials (80, 100, 120, and 140 kV); material fingerprinting identified 80 and 120 kV as the optimal pair. Using white lead and cinnabar as a decomposition basis, maps of lead- and mercury-based pigments were generated and validated against energy-dispersive X-ray fluorescence measurements, allowing red ochre, cinnabar, and red lead to be distinguished. Together these applications show that DECT delivers compositional information across diverse cultural heritage materials, from ceramics to pigments, while fully preserving artifact integrity, complementing established spectroscopic methods.

INV23

Application of Machine Learning in Archaeology and Study of Archaeological Ceramics

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Machine learning (ML) has become one of the fastest-growing fields in archaeology. It is increasingly employed to process the large volumes of data acquired through satellite and drone surveys, geophysical measurements, 3D scanning, photography, spectroscopy, and laboratory analyses. Machine learning techniques are applied to accelerate data analysis, identify patterns that are difficult to detect using conventional approaches, and support the formulation of scientifically grounded conclusions.

Archaeological pottery represents the most abundant category of finds at archaeological sites and, owing to its relative stability over time, provides valuable information about the period in which it was produced. These two characteristics form the basis of all archaeometric investigations of archaeological pottery. Methodologies that were originally based exclusively on archaeological approaches began, in the mid-twentieth century, to incorporate analytical chemistry and materials science techniques to support the interpretation of archaeological evidence. The accumulated knowledge and extensive datasets generated through these studies have provided a solid foundation for the application of machine learning methods.

This paper presents machine learning methods applied in the study of archaeological pottery, illustrated through selected case studies. Particular attention is given to the opportunities and challenges associated with the use of machine learning, outlining the complete research workflow—from the definition of an archaeological problem, through analytical investigations, to the implementation of machine learning techniques to achieve the conclusions. Examples drawn from previous studies are used to demonstrate some of the results achieved to date. Finally, the paper discusses current trends toward deep learning and the development of ready-to-use solutions designed for end users.

ORL1

Hydrothermal Aging of Dental Composites:Optical, Surface, and Overall Effects

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Esthetic performance of dental composites is strongly correlated with their long-term degradation and surface alterations, making it a crucial factor in material selection. Since comparative studies among commercially available dental composites remain limited, this study investigated the aging behavior of differently manufactured resin composites: the light-cured direct composite G-ænial A'CHORD (LCC), the CAD-CAM milled composite BreCAM.HIPC (MC), and the 3D-printed composite Saremco Print Crowntec (PC). The materials were subjected to three cycles of hydrothermal aging, and their optical and surface properties were evaluated before and after degradation. Optical characterization included color change (ΔE00) and translucency parameter (TP) measurements, while atomic force microscopy (AFM) and Raman spectroscopy were used to assess surface degradation and structural changes. The results demonstrated that hydrothermal aging significantly affects the organic matrix of all investigated composites, leading to measurable surface degradation and altered esthetic properties.

ORL2

Mechanical Activation Enables Low-Temperature Synthesis and Enhanced Dielectric Performance of $Gd_2Zr_2O_7$ Ceramics

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Mechanical activation offers an effective route for reducing the synthesis temperature and improving the functional properties of advanced ceramic materials. Here, the influence of high-energy ball milling on the synthesis and dielectric behavior of $Gd_2Zr_2O_7$ ceramics was investigated. Stoichiometric mixtures of ZrO_2 and Gd_2O_3 were mechanically activated for 15–60 min and subsequently sintered in air at 1200–1600 °C. Structural and microstructural analyses revealed that prolonged milling accelerated phase formation, enabling the preparation of phase-pure $Gd_2Zr_2O_7$ at 1400 °C compared with 1600 °C for the non-activated powder. Mechanical activation also promoted densification and microstructural refinement, which were directly reflected in the dielectric permittivity and dielectric loss of the sintered ceramics. These findings demonstrate that high-energy milling is an efficient strategy for lowering processing temperatures while improving the structural and electrical performance of $Gd_2Zr_2O_7$ ceramics.

Keywords: sintering, phase composition, microstructure, electrical properties, ceramics, $Gd_2Zr_2O_7$.
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ORL3

Review of Materials and Additive Manufacturing Technologies for Air Spargers in Bubble Column Bioreactors: A Comparison of Ceramic and Polymeric Solutions

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The efficiency of bubble column bioreactors (BCRs) strongly depends on gas distributor design, which determines bubble size, oxygen mass transfer, and system homogenization. The rapid development of additive manufacturing (AM) has enabled the fabrication of complex and customized distributors, overcoming the limitations of conventional manufacturing methods. This review examines the application of 3D printing in the development of gas spargers for BCRs, focusing on the comparison between polymeric and ceramic materials. Polymeric solutions produced by fused deposition modeling (FDM) are analyzed, with emphasis on the influence of infill density and layer thickness on mechanical properties and gas channel precision. In parallel, ceramic materials, such as silicon oxycarbide fabricated by stereolithography (SLA) of preceramic monomers, are evaluated for their superior thermal and chemical stability, high mechanical strength, and near-zero porosity. Special attention is given to the effect of sparger geometry on preventing gas leakage and ensuring uniform gas distribution. Computational fluid dynamics (CFD) and experimental studies are discussed as validation tools, providing guidelines for selecting optimal AM technologies and materials for laboratory-scale and industrial bioreactor applications.

Keywords: *Bubble column bioreactors, additive manufacturing, 3D printing, gas spargers, ceramic and polymeric materials*

ORL4

Reproducible Data Extraction from Ceramics and Materials Science Literature Using Retrieval-Augmented Large Language Models

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The volume of ceramics and materials science literature is expanding faster than researchers can manually extract structured data—processing parameters, phase composition, and characterization results—from published PDFs. This work aims to develop an open-source, reproducible pipeline for automated extraction of such data with full traceability to its source. The pipeline combines multi-source acquisition (PubMed, arXiv, Semantic Scholar, CrossRef), section-aware document parsing (GROBID, lxml), and persistent storage (PostgreSQL, Qdrant) with a Retrieval-Augmented Generation (RAG) architecture: relevant document sections are retrieved via semantic search and passed to a large language model constrained to a domain-specific JSON schema, with automatic repair of invalid outputs. Each extracted value carries an explicit evidence chain—article, section, chunk, and verbatim quote—enabling reviewers to verify any data point directly against the source text without re-running the model. The architecture was validated on a biomedical literature dataset and is domain-agnostic, directly transferable to ceramics and materials literature for extracting sintering conditions, phase and microstructural data, and mechanical or electrical properties. This approach addresses the black-box limitation of existing commercial literature-mining tools and enables scalable, verifiable meta-analyses across large bodies of published research.

P1

Evidence of Early Metallurgy in Northwestern Serbia

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There is a general consensus within the scholarly community that the development of copper metallurgy played a significant role in transforming the organization and character of the Vinča culture, particularly during its late, or more precisely its final phase. Northwestern Serbia is characterized by a diverse geological composition that has resulted in the presence of numerous ore deposits and mineral resources. Several prehistoric mining sites are known from the archaeological literature, including Srebrne Rupe on the slopes of Mt. Cer, the Hram site in the village of Selenac near Ljubovija, Voljevci near Mali Zvornik, and a series of mining shafts located in the immediate vicinity of the hillfort settlement of Ostenjak in Likodra. Copper and tin ores are believed to have been exploited at these sites during different prehistoric periods.
Northwestern Serbia has also yielded a substantial number of copper artifacts, most notably Jászladány-type axes. Nevertheless, because prehistoric settlements in this region remain insufficiently investigated, reliable evidence of ore smelting and other metallurgical activities has yet to be established.
Potential evidence of metallurgical activity has been identified at settlements radiocarbon-dated to the period spanning the 47th-46th to the 43rd-42nd centuries BC. Green traces, possibly derived from copper compounds, have been observed on ceramic fragments recovered from the hillfort settlements of Bodnjik in Družetić and Đipovi in Riđake, as well as from the Obrovac-type settlement of Barič in Subotica.
The analysis of the ceramic assemblages from these sites identified six fragments of coarse, thick-walled vessels bearing green surface traces. If confirmed as copper compounds, these traces may represent evidence of metallurgical activities, possibly including ore smelting, at the investigated settlements. The thick walls of the vessels would have enabled them to withstand exposure to elevated temperatures while providing increased resistance to thermal shock during the heating of the ore.
To determine the chemical composition of the green traces and test the hypothesis that they originated from copper compounds, the fragments were examined using non-destructive X-ray fluorescence (XRF) spectroscopy.

P2

Provenance Study of Pottery from the Silo at Site 11 near Pančevo

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During the 2026 rescue archaeological excavations at Site 11 along the route of the future Belgrade–Pančevo–Zrenjanin motorway, an exceptional closed archaeological context was discovered among numerous residential features – a storage pit containing the remains of 13 complete ceramic vessels. Most of the assemblage consists of storage pottery, although several vessels intended for table use were also identified. Part of the assemblage was manufactured on a slow pottery wheel using clay tempered with sand and gravel, whereas the remaining vessels were produced on a fast wheel from well-refined clay with carefully finished surfaces. One of the larger pots contained a small pot together with a ceramic spindle whorl.
Chronologically, the assemblage dates to the late 4th and early 5th century AD, when the territory of southern Banat was inhabited by barbarian communities engaged in frequent conflicts with the Roman Empire, which controlled the territory of present-day central Serbia. These repeated military campaigns and punitive expeditions may explain why the storage pit remained undisturbed and abandoned, with the vessels simply overturned onto their sides. From a formal and typological perspective, all vessels appear to represent products of local workshops, although some forms may imitate Roman ceramic types. The results of comprehensive archaeometric investigation using instrumental analytical methods will test these assumptions and clarify the provenance, manufacturing technology, and possible distribution of the pottery. An interesting question therefore arises: did these small rural settlements obtain specialized storage and table vessels from a larger regional production centre, or did each community manufacture pottery primarily for its own needs?

P3

The Use of Fourier Transform Infrared Spectroscopy in Estimating the Firing Temperature of Archaeological Pottery*

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Archaeometry is an interdisciplinary field in which scientific methods are employed to achieve a more comprehensive understanding of the material remains from the past. It is particularly important in the study of pottery, as it enables the reconstruction of individual stages of the *chaîne opératoire*.

As the final and one of the most technologically significant stages of production, firing brings about the gradual transformation of clay into ceramic material. The properties of the finished product are influenced by the maximum temperature reached, the heating duration and rate, the cooling conditions, and the firing atmosphere. The analysis of these parameters can provide insights into technological knowledge, production organization, and the behavioral patterns of the communities that produced pottery. Fourier transform infrared spectroscopy (FTIR) is one of the methods used to investigate firing processes. This method enables identification of characteristic molecular bonds and mineral components in the ceramic body by their interactions with infrared radiation, thereby allowing the firing temperature range to be estimated indirectly. The use of FTIR spectroscopy in reflectance mode enables analysis without sampling or with only minimal surface preparation, making it particularly suitable for examining archaeological material. The interpretation of the resulting spectra takes into account the initial mineralogical composition of the raw material, the type and quantity of added temper, the presence of quartz and carbonates, the firing atmosphere and duration, as well as post-depositional alterations.

Using Bronze Age pottery fragments from the Židovar archaeological site as a case study, this paper demonstrates the use of FTIR spectroscopy in reflectance mode to estimate firing temperatures through comparison with reference pottery samples made from local clay material (Orešac clay pit). The procedure used to obtain the reference spectra and the methodology employed to estimate this important technological and archaeological parameter are described in detail.

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P4

Influence of Mixing Sequence on the Properties of Alkali-Activated Mortars

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Ground brick waste was used for the production of alkali-activated mortars. Four mortar mixtures with identical compositions were prepared to investigate the effects of different mixing sequences and curing regimes on mechanical performance and fire resistance. Unlike most previous studies, which employed liquid alkaline activators cooled to room temperature, this research focused on alternative activation approaches. Fire resistance was evaluated by heating specimens to 600 °C followed by natural cooling. Residual flexural and compressive strengths, as well as mass loss, were determined, while visual inspection of specimen cross-sections supported result interpretation. The two best-performing mortars were further analyzed using FT-IR and FE-SEM-EDS, and thermal conductivity and specific heat capacity were measured for the mixture selected for its simple preparation and favorable post-fire performance. The results demonstrated that mortar performance depends not only on chemical composition but also on activation procedure. Mixing sequence strongly affects gel formation, microstructure, mechanical properties, and thermal stability. Premixing the powdered alkaline component with the dry constituents before adding the liquid phase proved to be the most effective approach, providing the best balance of mechanical performance and fire resistance.
Keywords: alkali-activated mortar; mixing sequence; fire resistance; mechanical properties; mass; FT-IR; FE-SEM-EDS analysis; thermal properties.

P5

UV-Curable Nanocomposite Coatings on Aluminum: Self-Cleaning Effects of Fe/Al LDO Nanoparticles

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This study explores the self-cleaning properties of UV-curable coatings reinforced with Fe/Al LDO nanoparticles on aluminum. Coatings containing 1, 3, and 5 wt.% of Fe/Al LDO were tested using a coffee, milk, and 50:50 coffee/milk mixture as a contamination fluid, with and without talc powder. The sliding angle method is used to evaluate the self-cleaning properties. A drop of the fluids is placed on the surface, and the angle at which the drop begins to slide off

is measured. A lower sliding angle indicates better self-cleaning ability, as the liquid more easily rolls away and removes contaminants. By comparing samples with and without talc, the influence of surface modification on self-cleaning efficiency determined. The evaluation focused on the removal of residues and the preservation of coating integrity under repeated cleaning cycles. The importance lies in the dual functionality of UV-curable composite coatings reinforced with Fe/Al LDO nanoparticles. These coatings combine enhanced hardness with self-cleaning properties, extending material durability, reducing maintenance costs, and enabling practical use in protective and functional systems. Findings reveal that the composite with 3 wt.% Fe/Al LDO demonstrates the most effective self-cleaning and mechanical performances, highlighting its potential for protective and functional applications of UV-curable nanocomposite coatings.

Keywords: Fe/Al layered double oxide, unsaturated polyester resin, self-cleaning, sliding angle, nanocomposite coatings.

Acknowledgement

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P6

Enhanced Hardness Performance of UV-UPR Coatings via Fe/Al Layered Double Oxide Nanoparticles

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The aim of this study is to develop UV-curable coatings with Fe/Al LDO nanoparticles and to determine the optimal filler concentration. The Fe/Al LDO nanoparticles were synthesized: Fe/Al LDH was obtained by coprecipitation (Fe:Al = 3:1), washed to neutral pH, and dried. Then, the LDH powder was calcined at 600 °C for three hours. The unsaturated polyester resin was synthesized using glycols and anhydrides, then stabilizers and crosslinkers were added. The aluminum was cleaned in phosphoric acid and served as substrate. Neat UV-UPR and composite coatings containing 1, 3, and 5 wt.% of Fe/Al LDO were prepared. The Vickers microhardness, pencil, and Shore tests were applied. The highest hardness was achieved in the composite with 3 wt.% (9.7 HV). In contrast, samples with 1 wt.% (2.4 HV) and 5 wt.% (4.0 HV) showed reduced hardness, highlighting 3 wt.% as the optimal concentration for mechanical reinforcement. The pencil hardness test, based on the ASTM D3363 and Shor test were used for evaluation hardness results. The composite with 3 wt.% Fe/Al LDO has 4H, the 5 wt.% sample falls around HB, while the 1 wt.% sample aligns with 5B. For the Shore A method, the 3 wt.% corresponds 92, while the 5 wt.% and 1 wt.% samples reach approximately 81 and 70 Shore A, respectively.

Keywords: Fe/Al layered double oxide, unsaturated polyester resin, composite coatings, microhardness, pencil test, Shor A.
Acknowledgement
This research was funded by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia (Contracts Nos. 451-03-34/2026-03/200135, 451-03-33/2026-03/200017, and 451-03-33/2026-03/200026).

P7

Organic Polymer-Functionalized Carbon Material

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Globally, coffee stands as one of the most heavily utilized raw materials within the modern beverage sector. Driven by evolving consumer preferences over the last decade, domestic preparation has increasingly transitioned toward espresso and filter coffee options. This behavioral shift has triggered a sharp increase in the generation of solid coffee waste, which retains substantial potential for valorization and reuse. Regrettably, the proper disposal or composting of this byproduct remains poorly regulated, causing these valuable remains to typically end up in landfills as municipal waste.The primary objective of this study is to reuse the solid residue derived from espresso coffee preparation. Through a pyrolysis process, this waste was successfully converted into a high-quality carbonaceous material. To enhance its performance, the surface of the coffee ground waste was modified using PAMAM-based dendrimers. The resulting polymer-functionalized carbon matrix exhibits exceptional physicochemical properties, while remaining environmentally sustainable and completely non-toxic. Comprehensive analytical characterization was carried out using a combination of advanced techniques, including XRD for phase identification, FTIR for functional group analysis, and BET for surface area assessment, while SEM and ICP analyses were utilized to evaluate surface morphology and elemental composition, respectively. Following the surface modification, detailed investigations were carried out to evaluate the material's potential in environmental remediation, specifically testing its performance as a CO_2 adsorbent and as an agent for dye removal from aqueous solutions.
Acknowledgments: Project "Innovation Concept "The potential of coffee in the cosmetics industry - from waste to active ingredients for the production of biocosmetics", under the Public Call for the Improvement of Cooperation Between Science and Economy in the Field of Circular Innovations - CIRCULAR VOUCHERS 2024 with the technical and financial support of The United Nations Development Programme, European Union (Ref.: 00131890/1138320/2024/01-09). Project "Development of coffee waste-based CO_2 capture materials" (Ref.: FBG-2025-6682). The research was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contract number: 451-03-33/2026-03/ 200017).

P8
Deep Drilling for Environmental Benchmarks: Oxides and Trace Elements in Sediments above a Proposed Lithium Mine

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Vertical distributions of oxides and potentially toxic elements in deep sediments are rarely studied, although they trace the history of contamination and define environmental baselines. This study aimed to assess, for the first time at such depths, the geochemistry and ecological risks of heavy metals in undisturbed deep sediments of a rural area in the western Tamnava Basin, recently designated for potential lithium and boron exploitation. A total of 250 samples from 18 boreholes (5–58.5 m) were analyzed by energy-dispersive X-ray fluorescence for 11 oxides and 21 elements, along with carbonate and organic carbon contents and grain-size residue. Contamination was evaluated using enrichment and contamination factors, the pollution load index, and the potential ecological risk index, supported by multivariate statistics. Concentrations of vanadium, thallium, and barium exceeded national limits in most samples, originating mainly from the clayey parent material, while average pollution levels indicated baseline contamination and moderate ecological risk. The clay-rich layers act as natural barriers retaining trace elements. The dataset establishes pre-exploitation reference values against which any future changes in sediment quality in this region can be measured.
Keywords: Deep sediments; Vertical geochemical profiles; Potentially toxic elements; Ecological risk assessment; Environmental baseline.
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P9
Ceramic Clay from the Bele Vode Deposit (Western Serbia): Technological Performance and Radiological Safety Assessment

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Serbian clays are gaining importance as raw materials for the European ceramic industry, requiring both technological and radiological evaluation of domestic deposits. This work presents the first integrated assessment of the kaolinitic–illitic–montmorillonitic ceramic clay from the Bele Vode surface deposit in the Tertiary Tamnava Basin. Fourteen samples were analyzed by gamma-ray spectrometry, while a technological composite of five representative samples was characterized by chemical analysis, XRD, FTIR, TG/DTA, and dilatometry, followed by shaping, drying, and firing tests at 900–1200 °C. The quartz-dominated mineral

assemblage with illite, feldspar, and kaolinite provides balanced plasticity and fluxing capacity. Upon firing, linear shrinkage increased from 5.3% to 14.1%, water absorption decreased from 14.5% to 3.4%, and flexural strength rose from 18.7 to 26.1 MPa, so that bodies fired at 1200 °C meet the EN 14411 requirements for group BIIa floor tiles. Average activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K (49.1, 55.6, and 569 Bq kg^{-1}) are comparable to worldwide averages for building materials, and the associated annual effective doses remain well below 1 mSv. The Bele Vode clay is thus technologically suitable for ceramic tile production and radiologically safe for workers and users.

Keywords: Ceramic clay; Ceramic tiles; Natural radioactivity; Radiation hazard assessment; Firing behavior.

Acknowledgments

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P10

Mechanochemically Activated $Al(OH)_3/Al_2O_3$ Nanocomposites as Flame-Retardant Additives: Synthesis, Characterization and Fire Resistance Evaluation

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Human safety in fires remains a critical concern, particularly in urban areas with high population density. In Serbia, fire departments recorded over 1,300 deaths across nearly 6,000 incidents over the past 15 years. This study synthesized $Al(OH)_3/Al_2O_3$ nanocomposite particles via mechanochemical activation (ball milling), using three mass ratios (25:75, 50:50, 75:25). These particles were added to a water-based coating to enhance fire resistance, tested on textiles, wood, and paper. Particle characterization was performed using SEM. SEM analysis revealed that the mechanochemical process produced particles smaller than the Al_2O_3 precursor (~3 μm), generating sub-nano and nano-sized fragments alongside fused $Al(OH)_3/Al_2O_3$ particles. Agglomeration was observed, indicating new nanocomposite formation. Higher Al_2O_3 content led to finer particles and more intense agglomeration, likely due to Al_2O_3 greater hardness relative to $Al(OH)_3$. Fire resistance testing showed the coatings improved flame resistance across all materials, with effectiveness increasing alongside $Al(OH)_3$ content. The 75:25 ratio consistently delayed both degradation onset and damage-zone formation most effectively. Cotton textile showed the strongest protection, avoiding stable flame development even under prolonged exposure. Wood formed a protective carbonized layer slowing degradation, while paper showed only partial improvement, eventually developing localized flame. Overall, coating effectiveness depended on material structure, with textiles benefiting most.

P11
Zeolite-Based Photocatalysts Formed by Plasma Electrolytic Oxidation on Magnesium

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The possibility of incorporating Y zeolite into oxide layers formed by plasma electrolytic oxidation (PEO) on AZ31 magnesium substrate was investigated. All coatings were synthesized under identical conditions using the same conventional DC PEO mode with a constant current density of 200 mA/cm² in water solution of sodium phosphate (Na_3PO_4) and potassium hydroxide (KOH), with addition of synthetic Y zeolite and/or zinc oxide (ZnO). Zeolites can be regarded as nanocontainers, and it was hypothesized that their incorporation, if achievable by this method, could improve the photocatalytic performance of the resulting structures.
The formed coatings were thoroughly characterized by scanning electron microscopy equipped with energy-dispersive X-ray spectroscopy, as well as by X-ray diffraction analysis. Both characterization techniques unambiguously confirmed the inert incorporation of zeolite into oxide layers formed on the AZ31 alloy. Additionally, successful code position of zinc oxide and Y zeolite into the PEO oxide coating on magnesium enables potential industrial applications, especially in water purification facilities, due to their synergistic effect of increased photocatalytic activity. Although they have a smaller active surface compared to powdered photocatalysts, PEO coatings could be superior because they do not require filtration of reaction products after the photocatalytic purification process. Also, the fact that the zeolite was successfully incorporated by the PEO process creates opportunities for new uses of zeolites with metal oxides.
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P12
Improving Sorption Characteristics of Sodium Carbonate Through Mechanochemical Activation

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Various methods have been explored for adsorbing carbon dioxide, both inside industrial facilities and directly from ambient air. Since CO_2 is often produced as a byproduct of industrial

processes, its uncontrolled release significantly contributes to environmental pollution. The buildup of human-made carbon dioxide in the atmosphere enhances the greenhouse effect, raises global temperatures, and disrupts climate systems. Mechanochemical activation of sodium carbonate has been shown to greatly improve its sorption capacity. These enhancements were analyzed using BET surface area measurements and X-ray diffraction.

P13
Characterization of Deposited SiOx Thin Films by X-Ray Photoelectron Spectroscopy and Fourier-Transformed Infrared Absorption Spectroscopy

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Silica-based thin films are widely used in a variety of industrial applications, including protective coatings, self-cleaning surfaces, heterogeneous catalysis, barrier coatings, and membranes with tunable permeability. In this work, silicon oxide (SiOx) thin films were deposited using a newly developed Miniature Microwave Inductively Coupled Plasma (MMWICP) source and evaluated for their barrier properties. In this configuration, oxygendiluted hexamethyldisiloxane (HMDSO) or tetraethyl orthosilicate (TEOS) precursor gases were exposed to a high-density flux of atomic oxygen generated by a remote MMWICP source. SiOx films were deposited on silicon wafers under various processing conditions, including different gas pressures, microwave powers, and substrate-to-plasma source distances. The deposited films were characterized by X-ray Photoelectron Spectroscopy (XPS) and Fourier Transform Infrared (FTIR) spectroscopy. The deposition rate and surface roughness were determined using a Stylus Profilometer and Atomic Force Microscopy (AFM), respectively. TEOS and HDMSO deposited films under direct atomic oxygen influence have similar infrared spectra and roughness. TEOS based films have otherwise higher percentage of C and their stohiometric ratio x is higher than HDMSO based films. Film characterization revealed distinct differences between regions that were directly exposed to atomic oxygen during deposition and those that were not. In particular, the surface roughness and Fourier Transform Infrared (FTIR) absorption spectra differed significantly. In contrast, the relative atomic concentrations of C, Si, and O determined by XPS were nearly identical for films deposited from the same precursor (HMDSO). Films deposited from TEOS and HMDSO under direct exposure to atomic oxygen exhibited similar FTIR spectra and surface roughness. However, TEOS-derived films contained a higher carbon concentration and exhibited a higher oxygen-to-silicon stoichiometric ratio than HMDSO derived films.

P14
Microstructural Characteristics and Electrical Resistivity of Doped $BaTio_3$ Ceramics

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In this paper, the electrical resistivity (ρ) and the temperature coefficient of electrical resistance (α) of Yb-doped $BaTiO_3$ ceramics were investigated, with Yb^{3+} ion concentrations ranging

from 0.01 at% to 1.0 at%. The samples were prepared by conventional solid-state sintering at 1350°C. Microstructural analysis revealed that the dopant concentration directly determined the grain size. For samples with 0.01 at% Yb, a bimodal microstructure was characteristic. The grain size ranged from 10 to 25 μm and decreased to 5–15 μm as the concentration increased to 0.1 at% Yb. A fine-grained structure was observed for samples with 0.5 at% Yb and 1.0 at% Yb, with grain sizes of 2–3 μm and 0.2–2 μm, respectively.
The electrical resistivity of the samples was characterized over the temperature range of 30°C to 170°C and the frequency range of 100 Hz to 1 MHz. With increasing temperature, resistivity increased moderately up to 100°C, then jumped sharply. On the other hand, increasing frequency decreased resistivity, a trend particularly pronounced above 200 kHz. Analysis of the temperature coefficient of electrical resistance (α) confirmed the PTC effect (positive temperature coefficient of resistance) for all tested samples in the temperature range of 30°C to 128°C.
Based on the results and analysis of the electrical resistivity and temperature coefficient of resistance, it is concluded that the optimal characteristics for practical application are observed in samples with lower additive content (0.01-0.5 at% Yb).

P15

Toughening of B_4C Ceramics Reinforced by Carbon Nanotubes, Nanofibers and Graphene Nanoplatelets

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In the present work, various high-hardness nanocomposites were synthesised using a boron carbide (B_4C) ceramic matrix to develop advanced materials for next-generation body armour. For this application, B_4C represents one of the most promising candidates owing to its exceptional physical properties, such as high thermal stability and extreme hardness. However, its widespread technical use is limited by low fracture toughness, which requires a significant optimisation. This was addressed by the design of B_4C-based nanocomposites reinforced with carbon nanotubes (CNTs), carbon nanofibers (CNFs), and graphene nanoplatelets (GNPs), which were consolidated via spark plasma sintering (SPS). The fracture toughness of the sintered samples was evaluated by the indentation method and three-point bending tests. The resulting fracture toughness values exhibited a substantial improvement compared to monolithic B_4C ceramics.
Keywords: Spark plasma sintering; carbon nanotubes; fibres; graphene nanoplatelets, fracture toughness
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P16
Mechanical Performance of Carbon Fabric/Epoxy Hybrid Composites Reinforced with Boron Carbide Nanoparticles

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Carbon fiber reinforced polymer composites are increasingly used in engineering applications where the exploitation conditions require a light weight and high mechanical performance. The incorporation of ceramic nanoparticles into polymer matrices is one of effectives approach for improving the mechanical behavior of these composites. In this study, carbon fabric/epoxy composites reinforced with nanoparticles of boron carbide (B_4C) were prepared and experimentally tested.
Composite laminates were fabricated using carbon fabric as the reinforcing phase and aero-grade epoxy resin as the matrix, and the B_4C nanoparticles as additional particulate reinforcement dispersed in the polymer matrix. These nanoparticles were introduced as ceramic reinforcement with the aim to enhance stiffness and impact resistance. They were ultrasonically deagglomerated in the polymer prior to carbon fabric impregnation and lamination. Quality of B_4C dispersion in epoxy matrix was examined via SEM/EDS analysis. The influence of nano B_4C on the mechanical properties of the composites was evaluated through Charpy impact testing and three-point bending tests. The obtained results were analyzed in terms of impact energy and flexural behavior, and compared with those of the reference composite material without addition of B_4C.
The obtained results confirmed reinforcing effect of boron carbide nanoparticles: increased impact energies and higher stiffness of carbon fabric/epoxy composites. The observed results encourage further use of B_4C nanoceramic as reinforcement in similar polymer composites and other advanced lightweight structural materials intended for demanding engineering applications.
Keywords: boron carbide nanoparticles; fiber reinforced polymer; epoxy resin; impact test; three-point bending.
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P17

Mechanical Durability of Reinforced 3D-Printed PLA – Artificial Weathering Test

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Additive manufacturing has become an established manufacturing technology for lightweight engineering components, particularly in applications requiring complex geometries, rapid prototyping, and reduced production costs. Among the available polymer materials, polylactic acid (PLA) is one of the most frequently used filaments due to its low processing temperature, good dimensional accuracy, and favorable mechanical properties. However, its long-term durability under environmental exposure remains a significant limitation for structural applications. The combined effects of moisture, ultraviolet radiation, and temperature fluctuations may alter the mechanical behavior of printed PLA components, reducing their reliability during service. Consequently, improving the environmental durability of 3D-printed PLA structures has become an important research topic. This study investigates the influence of interlayer reinforcement and printing configuration on the mechanical durability of PLA structures subjected to accelerated artificial weathering. Reinforcement was introduced during the fused deposition modeling (FDM) process using PVC and fiberglass mesh inserts positioned between printed layers. Two representative printing configurations with different internal densities were selected in order to evaluate the effect of printing parameters on the structural response after prolonged environmental exposure. Artificial weathering was carried out for 90 days under cyclic conditions including humidity, temperature variations, and combined UV/IR radiation. Mechanical characterization was performed using tensile, three-point bending, Charpy impact, and cantilever tests on full-scale drone arm structures. Standardized specimens were manufactured according to the corresponding ASTM requirements, while drone arm geometry was adopted from previous investigations in order to validate the structural behavior under realistic loading conditions. The experimental results indicate that artificial weathering does not lead to catastrophic degradation of the investigated structures. Reinforced specimens retained mechanical integrity after prolonged exposure, while the influence of printing configuration was found to be comparable to the effect of reinforcement for several loading modes. The higher-density printing configuration demonstrated superior structural performance, particularly during cantilever loading, whereas reinforced specimens exhibited improved impact resistance and more stable fracture behavior compared with unreinforced PLA. The presented results demonstrate that proper selection of printing parameters together with simple interlayer reinforcement can significantly improve the durability of 3D-printed PLA structures intended for outdoor engineering applications. The proposed approach represents a practical and cost-effective solution for increasing the service life of lightweight additively manufactured components exposed to environmental ageing.

Key words: Additive manufacturing; Polylactic acid (PLA); Artificial weathering; Lightweight structures; Mechanical performance; Drone structures.
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P18
Recycled Concrete Powder for Sustainable 3D-Printed Ceramics: A Review of Materials, Processing, and Future Perspectives

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Recycled Concrete Powder for Sustainable 3D-Printed Ceramics: A Review of Materials, Processing, and Future Perspectives Construction and demolition waste (CDW) constitutes approximately 35–40% of the total solid waste generated worldwide, while global demand for aggregates is projected to exceed 50 billion tonnes annually by 2030. These trends highlight the urgent need to develop circular economy strategies that reduce the consumption of virgin raw materials and promote the valorization of construction waste. During the production of recycled aggregates, considerable quantities of recycled concrete powder (RCP), typically with particle sizes below 150 μm, are generated as a by-product. Despite its high content of silica, calcium-bearing phases, and aluminosilicates, RCP remains largely underutilized and is primarily directed to low-value applications or disposal.
In parallel, ceramic additive manufacturing has emerged as an advanced fabrication technology capable of producing complex geometries with reduced material waste and greater design flexibility. However, the potential use of recycled concrete powder as a feedstock for ceramic 3D printing has received very limited scientific attention. This review critically examines the physical, chemical, and mineralogical characteristics of RCP relevant to ceramic processing and evaluates its applicability in ceramic additive manufacturing technologies, including direct ink writing, binder jetting, and other powder-based processes.
The paper discusses the influence of RCP on rheological behavior, printability, sintering, phase evolution, microstructure, porosity, and mechanical performance by integrating findings from recycled concrete, ceramic processing, and additive manufacturing research. Particular attention is devoted to challenges related to material variability, residual hydration products, calcite decomposition, particle size distribution, and optimization of thermal treatment.
Finally, the review identifies current knowledge gaps and proposes a research roadmap for the development of RCP-based ceramic feedstocks. By connecting recycled concrete technology with advanced ceramic processing and additive manufacturing, this work demonstrates the potential of transforming construction waste into high-value ceramic products. Such an approach supports sustainable resource management, reduces dependence on virgin mineral raw materials, and opens new opportunities for environmentally responsible ceramic manufacturing.

Key words: Recycled concrete powder (RCP); Ceramic additive manufacturing; 3D-printed ceramics; Construction and demolition waste (CDW); Circular economy
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P19
Acoustic-Based Non-Destructive Assessment of Porous Heritage Materials Using a Contactless Resonance Method

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The preservation of cultural heritage materials requires reliable non-destructive techniques capable of evaluating mechanical properties without causing damage to valuable historical objects. Conventional resonance-based methods commonly rely on contact sensors that may influence the measured response or be difficult to apply to fragile and irregularly shaped specimens. This study presents a contactless acoustic resonance approach for the simultaneous determination of dynamic elastic properties and damping characteristics of porous heritage materials. The proposed methodology combines impulse excitation with dual-microphone acoustic measurements, allowing resonance frequencies and loss factors to be determined without direct contact with the specimen. The approach was validated by comparison with standardized impulse excitation and ultrasonic testing methods using two representative materials with significantly different porosity levels: natural stone and unfired clay. Numerical simulations were performed to support resonance mode identification and to evaluate the influence of acoustic radiation on the measured damping characteristics. Experimental results demonstrated excellent agreement between the proposed method and conventional non-destructive techniques for dense stone materials, while greater damping and variability were observed for highly porous clay specimens due to their heterogeneous microstructure. Furthermore, the study demonstrates that conventional modulus–strength relationships developed for dense engineering materials cannot be directly applied to porous earthen materials. A simplified procedure incorporating elastic modulus and porosity is therefore proposed to improve strength estimation for highly porous specimens. The presented methodology provides a practical, fully non-contact framework for evaluating elastic properties and damping of cultural heritage materials while preserving sample integrity. The proposed approach offers significant potential for field investigations of historical structures and supports the development of reliable non-destructive assessment procedures for porous construction materials.
Keywords: Non-destructive testing; Acoustic resonance; Cultural heritage; Porous materials; Dynamic elastic modulus; Damping.
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P20
FeGaAlPCB Amorphous Ribbons Characterization for Matching the Wide Bandgap-Based Devices

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Technological advances in the field of soft magnetic materials are essentially aimed at achieving high performance in a number of advanced magnetic devices and their emerging sensing applications (smart mobile phones, IoT smart society, biomagnetic field detection, etc.). New wide bandgap (WBG) semiconductors (SiC and GaN-based devices) are starting to become more commercially available, as they are more efficient than their Si-based counterparts. Fe-based soft magnetic alloys are an important class of ferromagnetic materials for high-performance inductive components, and can match the wide bandgap-based devices in electronic communication, power electronic transmission, sensors and transformers, especially in terms of their higher temperature operation, as well as their potentially higher radiation tolerance.
Master alloy of chemical compositions $Fe_{72}Al_5Ga_2P_{11}C_6B_4$ was prepared by arc-melting in Ti-gettered argon atmosphere. Elemental EDS microanalyses confirmed the presence and homogeneous distributions of all constituent elements of the alloy. The ribbons produced by a single-roller technique in air exhibit as-cast ‘‘XRD-amorphous’’ state. The DSC trace exhibit glass-transition region followed by an exothermal crystallization process (at a heating rate of 40 K/min the glass transition and crystallization onsets are T_g = 736 K, T_x = 802 K, respectively). The difference between the onset of crystallization and the onset of the glass transition defines the supercooled liquid region $T_x \approx 66$ K, that is the metastable temperature interval where a substance remains a highly viscous, disordered liquid. The sample annealed at 673 K still remains amorphous XRD-halo, in contrast to the sample annealed at 773 K which features emerging of several iron-metalloid compounds.
The phenomenon of magnetoimpedance (MI) effect, which represents a large change in total impedance when an external magnetic field H_{ex} is applied, is of particular interest in advanced sensorics, due to the high-performance requirements of diverse emerging magnetic sensor devices. After material optimization, a significant increase in MI response up to value $\Delta Z/Z \approx$ 55%, as well as a sensitivity of about 6%/kA/m (for $H_{ex} \approx$ 3–4 kA/m), were recorded in still amorphous samples at driving frequencies of 2–3 MHz, revealing their perspective to match the wide bandgap-based devices.
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P21

Processing-Structure Relationships in Estane-Coated Nitramine Containing Nanoceramic Additives

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This study investigates the influence of graphite, graphene, and tungsten disulfide (WS_2) particulate additives on the behavior of Estane as a phlegmatizer for the surface coating of octogen, HMX, explosive particles. Octogen phlegmatized with Estane was selected as a standardized polymer bonded explosive, PBX. The selected additives possess layered crystal structures, lubricating properties, high thermal stability, and potential to improve energy dissipation under mechanical stimuli, what makes them attractive functional modifiers for the selected granulated PBX. Their incorporation is expected to affect Estane-based suspensions rheological behavior, as well as particle-binder interactions between the nitramine explosive and the Estane. Also, it is expected to reduce interparticle friction.
PBX formulations were prepared by aqueous suspension coating: a reference HMX/Estane system and modified systems containing selected additives dispersed in the polymer solution. Estane was dissolved in methyl ethyl ketone, in which the graphite, graphene, and WS_2 were ultrasonically dispersed prior to processing. Rheological measurements were performed using an MCR 302 rheometer under controlled shear rate and temperature conditions to monitor viscosity changes during solvent evaporation.
The resulting PBX granules were characterized by bulk density, microscopic analysis, FTIR spectroscopy, differential scanning calorimetry (DSC), and sensitivity to impact and friction. The results demonstrate that the investigated additives significantly influence processing behavior and granulated PBX characteristics, offering potential routes for improved safety and manufacturing control.

P22

Synthesis, Characterization and Quality Assessment of Ceramic Coatings for Use in Modern Casting Processes

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Cordierite ceramics have the necessary specific properties that make them interesting for use in modern casting coatings. The paper presents the results of the synthesis of three cordierite ceramic masses: based on pure oxides (K1), based on talc (K2) and based on sepiolite (K3), which correscpond to the composition $2MgO{\cdot}3SiO_2{\cdot}nH_2O$. The characterization of cordierite masses was carried out by X-ray structural tests in order to monitor the evolution of the phase composition and by electron microscopy in order to monitor the evolution of microstructural components. The behavior of cordierite during heating was performed by DTA analysis. In

order to determine the distribution of the refractory filler in the coating suspension, specially prepared preparations were observed under a polarizing microscope. Coatings were made from the obtained cordierite masses. The results of testing the effect of the use of cordierite in the composition of the coating on structural and mechanical properties show that an evenly applied coating of thinner layers (0,2mm) gives a smooth surface of the casting, while thicker coating layers affect a slight decrease in mechanical properties, due to reduced permeability of the coating. For a realistic assessment of the quality of cordierite synthesized in this way, comparative studies were performed with a commercial ceramic mass based on zircon (C). The ultimate goal of this research is to examine the possibility of using cordierite ceramics in foundry and to define the technological parameters of the production of refractory coatings for use in the Lost Foam process.

Key words: cordierite ceramics, structural properties, mechanical properties, ceramic coatings, refractory filler

P23

Short-Time Mechanical Activation as an Energy-Efficient Route for Tailoring the Sintering Behavior and Electrical Properties of $Ba_{0.5}Sr_{0.5}TiO_3$ Ceramics

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$Ba_{0.5}Sr_{0.5}TiO_3$ (BST) ceramics are attractive materials for electronic and energy-related applications due to their tunable dielectric properties. This study investigates the effect of short-time dry mechanical activation on the processing, sintering behavior, microstructure, and electrical properties of BST ceramics. Stoichiometric mixtures of $BaCO_3$, $SrCO_3$, and TiO_2 powders were mechanically activated for 0–8 h in a planetary ball mill, calcined at 900 °C, pressed into pellets, and sintered at 1200–1300 °C. Dilatometric analysis was used to evaluate densification behavior, while XRD, FTIR, SEM/EDS, and electrical measurements were employed for structural and functional characterization. The results showed that mechanical activation enhanced powder reactivity, promoted densification, and reduced the required sintering temperature. The sample activated for 6 h exhibited the most homogeneous microstructure and the best dielectric performance. These findings confirm that controlled short-time mechanical activation is an effective and energy-efficient method for tailoring the structure and electrical properties of BST ceramics.

Keywords: BST; Mechanical activation; Sintering; Microstructure; Dielectric properties.

P24

Comparative Pore Structure Analysis of a Macroporous Clay Filter: MATLAB Digital Image Processing vs. Optical Microscopy

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A comparative analysis of pore-structure characterization in a macroporous clay-based filter for industrial wastewater was conducted using MATLAB-based image processing and conventional optical microscopy. The filter was fabricated from clay obtained from the Kolubara mining basin in Serbia. A porous clay-based material was produced at low forming pressure and low sintering temperature in air, with boric acid as the pore-forming agent. Sample images were analyzed using an automated adaptive thresholding algorithm to segment and quantify pore-size distribution, porosity, and morphological parameters. The results derived from MATLAB analysis were validated against a reference value of 133.5 μm, representing the maximum pore diameter determined experimentally via the first bubble-point method. Over 5,000 individual pores were detected, with a median pore diameter of approximately 15 μm. The largest detected pore diameter of 127 μm demonstrated almost 95% agreement with the reference value. Morphological analysis indicated that pores in this filter are predominantly irregular and elongated, with large pores exhibiting similar irregularity to small pores. Automated MATLAB-based image analysis offers a rapid, reproducible, and quantitative approach to pore characterization that is consistent with conventional methods.

P25

Structural Characteristics of Zn–Ni LTA Zeolite Synthesized by Thermally Induced Phase Transformation

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Thermally induced phase transformation of ion-exchanged zeolites represents an effective solid-state route for the synthesis of high-performance ceramic materials with controlled phase composition and improved structural stability. Data on thermally induced transformations of Zn–Ni exchanged LTA-type zeolites are presented in this paper. The thermally induced phase transformation of Zn–Ni exchanged zeolites was investigated in the temperature range from 700 to 1300 °C. Framework collapse occurs, leading to amorphous intermediate products after heating between 600 and 650 °C. Prolonged heating of the intermediate phase above 1100 °C results in the formation of disordered anorthite and spinel phases. The unit cell parameters of Zn–Ni anorthite-type phases in the temperature range between 700 and 1300 °C were determined in the space group C-1. Phase transformations in the investigated temperature range were monitored by thermal analysis and X-ray powder diffraction (XRPD).
Keywords: Ion exchange of zeolite; Thermal treatment; X-ray powder diffraction analysis.

P26
Up-Conversion Luminescent $MgGd_2Zr_2O_8:Yb^{3+}$, Tm^{3+} nanophosphors for biological thermal sensing

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This study aimed to thoroughly investigate a novel up-conversion luminescent material, $MgGd_2Zr_2O_8:Yb^{3+}$, Tm^{3+}. Nanoparticles doped with various dopant concentrations of Yb^{3+} (2, 4, and 6 at%) and Tm^{3+} (1 and 0.5 at%) were synthesized *via* the sol-gel method and underwent structural, morphological, and optical characterization. X-Ray Powder Diffraction (XRPD) analysis, complemented by Rietveld structural refinement, revealed the crystalline nature of the samples and a fluorite-type structure with $Fm\bar{3}m$ space group. Transmission electron microscopy (TEM) and HR-TEM analysis showed that the clusters of agglomerated particles (up to 200 nm) consist of fine crystallites with diameters below 10 nm. Energy dispersive spectroscopy (EDS) confirmed uniform elemental distribution, while Selected Area Electron Diffraction (SAED) verified the polycrystalline nature of the material. UV-Vis spectroscopy exhibited characteristic transitions of Gd^{3+}, Yb^{3+}, and Tm^{3+} ions. Photoluminescence (PL) measurements recorded at room temperature with an excitation wavelength of 978 nm observed emission transitions characteristic of Tm^{3+} ions, with the highest emission intensity achieved for the 4 at% Yb^{3+} and 0.5 at% Tm^{3+} sample. The time-resolved photoluminescence measurement exhibited a well-defined mono-exponential decay with a value of 206.7 μs. Furthermore, temperature-dependent luminescence was investigated in the 270–380 K range using the luminescence intensity ratio (LIR) method, based on transitions at 477 and 489 nm, yielding a maximum relative sensitivity of 0.5927 $\%K^{-1}$ at 270 K.

P27
Space charge Relaxation of Sintered $BaFe_{12}O_{19}$ and $BaFe_{12}O_{19}$/PVDF Composite in the Low Frequency Region

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Barium hexaferrite $BaFe_{12}O_{19}$ was prepared of mixture of $BaCO_3$ powder and Fe_2O_3 powder (molar ratio 1:6) using solid-state reaction at 1000 °C/4h in air. The obtained composition was milled in the planetary ball mill and agate mill to achieve particle size around 0.5 μm. The prepared powder was characterized by using XRD and SEM techniques. After that the submicron powder was pressed at 0.2 GPa to form thin discs, and sintered for 2 hours at different temperatures in the range of 1050 °C to 1275 °C. The produced $BaFe_{12}O_{19}$ discs were also characterized by XRD and SEM. The sintered disk samples were covered on both sides with Ag silver epoxy to form electrodes for electrical measurements on a chemical impedance

analyzer, Hioki IM 3590, in the range of from 0.1 Hz to 100 Hz. After that a submicron powder of barium hexaferrite $BaFe_{12}O_{19}$ was mixed with polyvinylidene fluoride (PVDF) in the ratio of 70 : 30 wt. and processed into thin sheets of 0.3 mm thickness using a calendering process. The sheets were cut in the small pieces and also characterized by XRD and SEM. After that the sheet samples were covered with Ag epoxy electrodes. The electrical measurements were done on the same chemical impedance analyzer. The obtained results of the sintered $BaFe_{12}O_{19}$ and $BaFe_{12}O_{19}$/PVDF composite in the low frequency region were compared. They candidate $BaFe_{12}O_{19}$ / PVDF as a material for potential application in supercapacitors and multilayer capacitors for low-frequency conductive noise suppression.

Keywords: barium hexaferrite, intergranular capacitance, colossal dielectric permittivity

P28

Different Materials Influence on the Fruit Wine Aging Process

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Winemaking is a complex process that involves various steps in order to obtain a high-quality end product. One of the most important steps is the maturation of the wine, which is very important for the quality of the wine. During this process, various compounds are formed and the materials used to make the vessel in which the wine matures can be very important. This study gives an overview of the use of wooden, glass and inox vessels for the maturation of fruit wine and their influence on the phenolic profile of the wine. Fruit wines were produced from blackberries using the microvinification process. Selected pure wine yeast cultures were used for controlled fermentation. Microvinification was carried out with and without the addition of sugar before the start of fermentation. At the end of production, the wines were transferred to wooden, glass and stainless steel containers for maturation. The addition of sugar before the start of fermentation increased the alcohol content and improved the extraction of phenolic compounds. Wine matured in wood had the highest content of total phenolic compounds and gallic acid. Wine stored in stainless steel and glass had lower levels of phenolic compounds compared to wood. During maturation in wood, the wine comes into contact with oxygen and some natural compounds are extracted from the wood into the wine, which could increase the phenolic content. The lowest content in wines aged in glass vessels could be due to the decomposition of some photo labile compounds. This study underlines the importance of the material used for wine aging and its influence on the quality of the final product.

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P29

Catalitic Effect of Fe-Doped Phosphate Tungsten Bronze on Briggs-Rausher Reaction Dynamics

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Phosphate tungsten bronzes (PWBs) continue to draw significant interest due to their remarkable chemical, electrical, optical, and mechanical properties [1]. In this study, synthesized 12-tungstophosphoric acid (PWA) underwent ionic exchange with Fe^{3+} ions, resulting in the formation of the FePWA salt. Thermal analysis (TGA/DTA) was then performed on FePWA to determine the phase transition temperature, marking the collapse of the Keggin anion. This collapse occurs at approximately 600°C, leading to the formation of iron-doped phosphate tungsten bronzes (FePWB). Its behavior was investigated for the first time in the Briggs-Rauscher (BR) oscillatory reaction. This reaction is well-know as a highly sensitive chemical system for detecting various analytes, as well as their catalytic activity. The modifications in oscillatory dynamics were induced by the addition of Fe-doped bronze into oscillatory reaction. The results obtained indicate that an increasing mass of FePWB significantly shortens the BR oscillatory time, pointing out that FePWB is a good catalyzer of BR oscillatory reaction.

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P30
Synthesis-Dependent Structure and Morphology of $CoFe_2O_4$ Nanoparticles

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Cobalt ferrite ($CoFe_2O_4$) nanoparticles were synthesized via three aqueous routes, hydrothermal synthesis (CoFe(HT)), conventional coprecipitation (CoFe(COP)), and ultrasonically-assisted coprecipitation (CoFe(COP+US)), and characterized to establish relationships between synthesis conditions, crystal structure, and particle morphology. X-ray powder diffraction confirmed phase-pure inverse spinel $CoFe_2O_4$ in all samples, with Williamson–Hall crystallite sizes of approximately 9, 13, and 86 Å, respectively, demonstrating that acoustic cavitation significantly promotes crystallization under mild conditions. Fourier transform infrared spectroscopy corroborated the spinel phase through characteristic metal–oxygen stretching bands and revealed synthesis-dependent differences in surface hydroxyl content consistent with varying crystallinity. Scanning electron microscopy showed micrometre-scale aggregates in all samples, ranging from heterogeneous plate-like structures (CoFe(HT)) to finer, homogeneous rounded aggregates (CoFe(COP+US)). Transmission electron microscopy provided complementary local structural information at the individual particle level. Small-angle neutron scattering (SANS) offered statistically bulk-representative nanoscale morphological data: Guinier–Porod modelling revealed elongated rod-like particles for CoFe(HT) and spherical particles for both coprecipitated samples, with radii of gyration of 43–46 Å. All samples exhibit surface fractal behavior (d_s = 2.2–2.5), with ultrasound assistance measurably reducing surface roughness. Temperature-dependent SANS (25–60 °C) confirmed full structural stability, supporting potential suitability for biomedical applications including MRI contrast enhancement and magnetic hyperthermia.
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P31

Influence of Separator Type and Electrolyte Content on the Electrochemical Performance of Li–S Cells

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Lithium–sulphur batteries represent a promising energy storage technology due to their high theoretical energy density and low-cost active materials. In this work, the influence of electrolyte-to-sulphur (E/S) ratio and separator type on the electrochemical behaviour of Li–S cells was investigated. Sulphur cathodes containing 60 wt.% sulphur were prepared and assembled into laboratory cells using two separator types: glass fibre GF/A and polymeric Celgard® 2325. Electrochemical characterization was carried out using cyclic voltammetry and galvanostatic cycling at different current loads. Cells with various E/S ratios ranging from 5 to 55 µl mg^{-1} were compared in terms of discharge capacity and cycling stability. The results demonstrated a significant dependence of electrochemical performance on both separator structure and electrolyte amount. Glass fibre separators exhibited improved electrolyte retention and more stable cycling behaviour, while lower electrolyte contents led to increased polarization and reduced sulphur utilization. The study highlights the importance of optimizing internal cell parameters for the development of high-capacity lithium–sulphur batteries with improved long-term stability.

P32

Catalytic Oxidative Degradation of Binary Dye Mixtures Using Co-Supported Pseudo-Boehmite as Peroxymonosulfate Activator

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The catalytic oxidative degradation of binary dye mixtures is essential because industrial wastewater rarely contains a single dye, but rather complex dye mixtures. In this study, a Co-supported commercial pseudo-boehmite catalyst was tested as a peroxymonosulfate activator for the degradation of binary dye mixtures containing a combination of the yellow dye, Tartrazine (Tz), and individual blue dyes: Remazol Brilliant Blue R (RB), Methylene Blue (MB), and Basic Blue 41 (BB). The influence of coexisting dyes on their degradation efficiency was investigated by comparing binary and single dye systems using UV–Vis spectral monitoring. Different degradation behaviours were observed depending on the combination of dyes. Specifically, for RB and MB mixtures with Tz, the degradation efficiency of RB and MB in the binary dye mixture is almost the same as for a single dye system. In contrast, Tz degradation is much slower in the mixture. On the other hand, for the BB and Tz combination, Tz degradation efficiency in the binary dye mixture is almost the same as for a single dye system, while BB degradation efficiency is lower. Despite the observed complex behaviour,

this research demonstrates that the investigated catalyst can be effectively used for the treatment of wastewater containing multiple organic pollutants.

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P33
Bio-Based Carbon Material for Enhanced Li–S Battery Performance

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Lithium–sulfur (Li–S) batteries are considered promising next-generation energy storage systems due to their high theoretical energy density and the low cost and abundance of sulfur. Nevertheless, their practical application is hindered by the low electrical conductivity of sulfur and the shuttle effect associated with lithium polysulfide migration. Biomass-derived carbon materials have recently attracted significant attention as sustainable and low-cost additives for Li–S batteries because of their porous structure, high surface area, and ability to improve electrical conductivity and sulfur confinement. In this study, Li–S battery cathodes incorporating biomass-derived carbon were prepared. The electrochemical performance of the electrodes was evaluated using electrochemical impedance spectroscopy, cyclic voltammetry, and galvanostatic charge–discharge measurements. Cycling experiments were carried out within a potential window of 1.8–2.8 V. The prepared electrodes delivered an initial discharge capacity of approximately 742 mAh g^{-1} at a current rate of 0.1 C. The first results indicate that biomass-derived carbon materials represent a promising and sustainable additive for improving the electrochemical performance of Li–S batteries.

P34

Efficient electrochemical H_2O_2 production through two-electron oxygen reduction on a La-MOF/MXene Catalyst

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This research aimed to investigate the electrocatalytic performance of a novel La-MOF/MXene composite catalyst for the selective two-electron oxygen reduction reaction ($2e^-$ ORR) toward hydrogen peroxide production. The composite material was synthesized by integrating a lanthanum-based metal-organic framework (La-MOF) with conductive MXene nanosheets in order to enhance catalytic activity and electron-transfer efficiency. Electrochemical characterization of the prepared catalyst was performed using cyclic voltammetry, linear sweep voltammetry, chronoamperometry, and Koutecky-Levich analysis. The obtained results demonstrated significantly improved electrocatalytic activity of La-MOF/MXene composite compared to the individual components, including a more positive onset potential, lower Tafel slope, and higher diffusion-limited current density. The electrochemical analysis confirmed a dominant two-electron transfer mechanism, indicating efficient and selective hydrogen peroxide generation. Furthermore, the catalyst showed good long-term electrochemical stability. The study concludes that the synergistic interaction between La-MOF active sites and the conductive MXene structure contributes to enhanced reaction kinetics and improved catalytic efficiency, making the composite a promising candidate for sustainable electrochemical hydrogen peroxide production. These findings highlight the potential of MXene-based hybrid materials for the development of next-generation electrocatalysts in energy conversion and environmental applications.

P35

NiO/CuO/MXene and NiO/Fe_3O_4/MXene composites for efficient oxygen reduction reaction

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The aim of this study was to evaluate the electrocatalytic performance of NiO/TMO/MXene (M = Cu, Fe) ternary composites toward the oxygen reduction reaction (ORR) in alkaline media. The composites were synthesized by a uniform hydrothermal treatment at 180 °C for 6 h in the presence of polyvinylpyrrolidone, enabling the formation of well-defined phase-pure ternary structures, as confirmed by morphological analysis. The electrochemical activity of the prepared materials was systematically investigated and compared with that of pristine MXene to assess the effect of transition metal oxide incorporation. The results demonstrated that the introduction of CuO and Fe_3O_4 significantly enhanced the intrinsic ORR activity, indicating strong synergistic interactions between NiO, TMO, and the MXene conductive matrix. Among the studied samples, NiO/CuO/MXene exhibited superior ORR performance, with improved reaction kinetics and enhanced charge transfer characteristics, while NiO/Fe_3O_4/MXene also showed notable catalytic activity. The enhanced performance is attributed to the increased availability of active sites and improved electrical conductivity within the composite structure. The study concludes that NiO/TMO/MXene composites based on earth-abundant materials represent promising and cost-effective electrocatalysts for efficient oxygen reduction applications.

P36

Corrosion Behavior of Pure and Fe-Doped Amorphous and Crystallized Ni-P Alloys

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Ni-P alloys have been used in various industries, including automotive, aerospace, air craft, electrical, medical, pharmaceutical, marine, military, chemical, petroleum, etc. Beside the chemical composition and related properties, the microstructure and proneness to microstructural transformations of such alloys determine their practical applicability. Nevertheless, corrosion characteristics could be decisive factors affecting their usability in wet or marine environments.

Pure and Fe-doped amorphous and composite alloys were synthesized by chemical reduction route, followed by subsequent thermal treatment for some of the samples. Microstructural characterization of the obtained alloys was performed using XRD and electron microscopy methods. Corrosion behavior of the prepared alloy samples was studied in NaCl, NaOH and HCl solutions with different concentrations, applying electrochemical methods. The processes of formation of corrosion-protective surface layers as well as the metal dissolution exhibited the effects of both intrinsic and external factors, being strongly influenced by the alloy composition and microstructure.

P37

$Ti_3C_2T_x$/Sulfur Composites as Potential Electrode Materials of Aqueous Monovalent Cation–Sulfur Batteries

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MXenes have emerged as a new class of 2D materials obtained by selective etching and delamination of their 3D precursors, named MAX phase. Due to their various favorable properties, MXenes have shown great potential for application in different fields, including electronics, optoelectronics, biomedicine and healthcare, water desalination and purification, tribology, chemical catalysis and electrocatalysis, and particularly in energy conversion and storage.
Rechargeable monovalent cation–sulfur batteries have been attracting scientific attention as potential candidates to substitute current Li-ion batteries, due to their high theoretical capacity, natural abundance, lower environmental risks and low cost of sulfur, but still face many challenges. In this work, $Ti_3C_2T_x$ MXene-based material was obtained by selective delamination of Ti_3AlC_2 MAX phase via molten chloride salt etching route, and subsequent melt-diffusion treatment of the $Ti_3C_2T_x$ mixture with sulfur. The $Ti_3C_2T_x$/sulfur composite thus prepared was microstructurally characterized, and then examined as a potential electrode material for rechargeable aqueous monovalent cation–sulfur batteries applying electrochemical methods. The study was performed in lithium and sodium-based aqueous electrolytes. The obtained results pave the way for further work on this topics and future development of this kind of batteries.

P38

Chemiresistive H_2 Gas Sensor Based on TiO_2 Nanoparticles

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Recently, hydrogen has gained increasing importance due to its potential as a clean and sustainable energy carrier. Considering hydrogen's flammability and the fact that its molecules diffuse easily, reliable detection of H_2 gas is crucial. Chemiresistive gas sensors, which detect reducing or oxidizing gases by measuring changes in the resistance of metal oxide semiconductors (MOS), provide a dependable and cost-effective method for H_2 detection. It has been shown that using nanoparticles as a thin layer of gas-sensing material increases sensitivity and fast response in chemiresistive sensors. These structures can achieve a high surface-to-volume ratio and facilitate the diffusion of the target gas. In our research, we proposed an inventive fabrication method for chemiresistive H_2 sensors based on interdigital electrodes and a thin layer of TiO_2 nanoparticles. Interdigital electrodes were fabricated from Pt on a sapphire substrate. TiO_2 nanoparticles were dispersed in ethanol (8% wt), and the drop-cast method was used to apply a thin layer on the interdigital electrodes. The thin TiO_2 layer was characterized using XRD, SEM, and AFM. After annealing at 400°C, H_2 gas sensing measurement at 150 °C was performed, demonstrating that the fabricated sensor exhibits high sensitivity to H_2 in the concentration range from 300 to 10000 ppm. This investigation showed that the proposed method can be used to fabricate highly sensitive H_2 gas sensors.
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P39

Highly Sensitive Graphene/Elastomer-Based Sensors for Biomechanical Vibration Monitoring: Throat Cleaning and Coughing

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The remarkable properties of graphene—such as high tensile strength, flexibility, unique optical features, exceptional electrical and thermal conductivity, and biocompatibility—make it useful across various domains, including medicine, electronics, photonics, energy storage,

and environmental sciences. Starting from electrochemically exfoliated graphene in N-methyl-2-pyrrolidone (NMP), we used the Langmuir-Blodgett method to deposit a thin, conductive graphene film onto a poly(dimethylsiloxane) (PDMS) substrate. PDMS is a biocompatible, transparent, and flexible elastomer, frequently employed in flexible sensor development. This approach resulted in a flexible sensor designed to monitor throat vibrations. The graphene layer was characterized using Raman spectroscopy, XPS, and AFM. Electrical contacts to the sensor were made by sputtering a thin titanium layer. Copper wires were connected to the sensor with silver paste to interface it with electrical equipment, enabling the tracking of changes in electrical resistance as the throat vibrated during cleaning and coughing. This study shows that a flexible sensor with LPE graphene on a PDMS substrate featuring sputtered electrical contacts yields a stable and precise electrical signal in response to vibration of the human throat and that this type of sensor can be used for biomechanical vibration monitoring.

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P40
Investigation of Thermal Stability of Polyurethane/TiO_2 Nanocomposites

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Polyurethane composites (PUCs) were fabricated using a polyurethane network (PUN) based on poly(ε-caprolactone) (PCL) and 2 wt.% of unmodified or surface-modified TiO_2 nanoparticles (NPs). For the surface modification of TiO_2 nanoparticles, amphiphilic gallic acid ester with a C12 long alkyl chain was used. Thermal stability of PUN and PUCs was tested in air and nitrogen atmosphere.
Thermal degradation of prepared PUN and PUCs took place as a two-step process. According to the obtained results, thermal stability of PUC prepared with modified TiO_2 NPs was higher, due to the better dispersion of NPs, compared to the PUC prepared with unmodified NPs. Besides that, investigation of DTG curves showed that modified TiO_2 NPs were mostly embedded in soft segments, leading to the delay in thermal degradation of PCL and simultaneously improving the overall thermal stability. This study clearly confirms the positive impact of both types of TiO_2 NPs on thermal stability of PUCs.

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P41

Influence of Organic Precursors on the Formation of Carbon-Hybrid Smectites and Their Catalytic Activity in PMS Activation

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The main goal of this study was to investigate the influence of different organic precursors on the formation of carbon-hybrid phases in Al-pillared smectite materials and to evaluate their effect on the catalytic activity toward azo dye degradation. Four Co-supported hybrid Al-carbon-smectite catalysts were synthesized by simultaneous intercalation of inorganic Al-Keggin cations and different organic surfactants, namely hexadecyltrimethylammonium ($HDTMA^+$), dodecyltrimethylammonium ($DTMA^+$), benzyltrimethylammonium ($BTMA^+$), and tetramethylammonium (TMA^+), into the 2 μm smectite fraction. After impregnation with Co^{2+} ions (5 wt.%) and thermal treatment in Ar atmosphere at 400 °C, the obtained catalysts were denoted as Co-Al/H-S, Co-Al/D-S, Co-Al/B-S, and Co-Al/T-S, where H, D, B, and T correspond to $HDTMA^+$, $DTMA^+$, $BTMA^+$, and TMA^+, respectively. Structural and surface characterization was performed using FTIR and XPS analyses. The catalytic performance was evaluated by activating potassium peroxymonosulfate (PMS) to degrade the azo dye AO10, with degradation monitored by UV–Vis spectroscopy at λ_{max} = 478 nm. After 4 h, degradation efficiencies of 94.4%, 97.9%, 88.6%, and 81.4% were achieved for Co-Al/H-S, Co-Al/D-S, Co-Al/B-S, and Co-Al/T-S, respectively. The results indicate that the nature of the organic precursor significantly affects the formation of the carbon-hybrid phase and consequently the catalytic activity.

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A Novel 3D-Printed Hydroxyapatite Based Bone Graft for the Regeneration of Critical-Sized Long Bone Defects

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Critical-sized bone defects represent significant challenge in orthopedic surgery. The use of 3D printing technology in bone grafting provides a promising solution by producing personalized

grafts that imitate the natural bone structure and shape. The aim of this study was to reconstruct long-segment bone defects in the rabbit radius using a 3D-printed graft composed of hydroxyapatite (HAP) and poly(lactide-co-glycolide) (PLGA), and to evaluate its potential to support bone healing without the use of exogenous biological agents such as stem cells or growth factors.
Prior to 3D printing, six rabbits were subjected to computed tomography scanning in order to create patient-specific 3D models of the radius. Custom-designed HAP/PLGA grafts were 3D printed and implanted into segmental defects corresponding to one-third of the radius length in each rabbit, created by osteotomy. Graft integration, osteointegration, and overall bone regeneration were assessed over a 12-week observation period through histological and histomorphometric analyses.
Significant bone regeneration was observed in the defect areas, demonstrating that the implanted grafts promoted effective bone healing. Histological examination revealed substantial new bone formation and vascularization with minimal inflammatory response. These results suggest that the 3D-printed HAP/PLGA-based graft has strong potential as a viable approach for reconstructing large bone defects.

P43
Effect of Ho^{3+} Doping on the Structural, Photoluminescence and Dielectric Properties of $BaTiO_3$ Ceramics

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Ho^{3+}-doped $BaTiO_3$ ceramics with a perovskite ABO_3 structure were systematically studied to determine the effect of Ho^{3+} incorporation on their structural, microstructural, optical, vibrational, and dielectric characteristics. The ceramics were prepared using the conventional solid-state synthesis route and sintered at 1380 °C. Phase composition and microstructural evolution were examined by X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS). Raman spectroscopy, Fourier-transform infrared spectroscopy (FTIR), and photoluminescence measurements were used to analyze lattice vibrations and optical behavior. Far-infrared FTIR reflectivity measurements enabled detailed analysis of changes in the vibrational spectrum caused by Ho^{3+} incorporation into the $BaTiO_3$ lattice.
SEM observations showed abnormal grain growth in samples with low Ho^{3+} concentrations, where grain sizes reached 20–40 μm. Increasing dopant concentration inhibited grain growth and promoted the formation of a finer and more uniform microstructure. EDS elemental mapping confirmed homogeneous distribution of Ho^{3+} ions within the ceramics. According to XRD analysis, Ho^{3+} ions increasingly occupied Ti lattice sites at concentrations of 0.5 wt.% and above. The introduction of Ho^{3+} ions into the lattice induced additional structural disorder, resulting in the appearance of new vibrational modes and a slight red shift of characteristic bands.

Electrical characterization revealed that dielectric properties strongly depended on Ho^{3+} concentration. The ceramic containing 0.01 wt.% Ho^{3+} showed the highest dielectric permittivity (εr = 2160 at room temperature). In contrast, higher dopant concentrations produced lower temperature sensitivity of permittivity and a reduction of the Curie constant, suggesting progressive stabilization and modification of the ferroelectric behavior of $BaTiO_3$ ceramics.

P44

Influence of Processing Parameters on Structure and Morphology of $BaZrO_3$-based Nanoparticles

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$BaZrO_3$-based powders have attracted considerable attention due to their excellent thermal stability, chemical resistance, and structural stability, making them promising materials for dielectric ceramics, proton-conducting systems and advanced functional applications. In this study, the influence of composition, milling time speed on the structural and morphological properties of $BaZrO_3$-based powders was investigated. Commercial $BaZrO_3$ powder and modified systems processed under various high-energy ball milling conditions were analyzed in order to evaluate the effects of mechanical activation on phase composition, crystallinity, particle refinement and microstructural evolution. The powders were characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and field-emission scanning electron microscopy (FESEM). Morphological analysis revealed a strong dependence of particle morphology and agglomeration behavior on the applied milling conditions. Increasing milling speed and prolonging milling duration promoted fragmentation of larger particles and the formation of finer submicron structures. However, excessive milling conditions also led to partial agglomeration and localized neck formation caused by increased surface energy and repeated particle collisions during high-energy processing. The obtained results demonstrate that the combined effects of composition, milling time and milling speed play a critical role in controlling the crystallite size, structural disorder and morphology of $BaZrO_3$-based powders.

P45

The Potential ZnO-MgO Composites Prepared by the Sol-Gel Method for Photocatalytic Degradation and Electrochemical Sensing ff Dyes

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ZnO–MgO composites are heterostructured metal-oxide materials that exhibit enhanced photocatalytic and electrochemical performance due to improved charge separation and increased surface active sites. The synergistic interaction between ZnO and MgO promotes efficient electron–hole separation while providing additional adsorption sites for pollutant molecules, thereby enhancing efficiency in the degradation of organic contaminants.
The sol–gel method is widely used for synthesing ZnO–MgO composites due to its simplicity, low processing temperature, and good control over particle size and composition. In this research ZnO-MgO composite with a molar ratio Zn:Mg = 1:1 was synthesized by sol-gel method. The efficiency of this composite for degradation of the Rhodamine B as a represenative of cationic dye and Methyl Orange as representative of anionic dye is investigated. The same composite is used as a modifier of a carbon paste electrode and investigated for the electrochemical detection of the same dyes.
The results obtained are promising, showing potential for further analysis, such as the influence of the Zn-Mg ratio and/or calcination temperature on the efficiency of the investigated applications.

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P46

Monte Carlo Simulations of K^+ Ions in Dimethoxy Ethane Gas

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Dimethoxy-containing compounds, such as dimethoxy ethane (DXE), can be produced from dimethyl ether by using dielectric barrier discharge (DBD) plasmas containing water vapor at atmospheric pressure. As clear and colorless liquid at room temperature and atmospheric pressure, DXE is used as a precursor in production of ceramics or as a sole compound to make other chemicals such as those used in lithium batteries production, superconductor production and nanoparticles synthesis.
In this work we present most probable reactions of alkali metal ion K^+ with dimethoxy ethane (DXE) molecule. Appropriate gas phase enthalpies of formation for the products were used to calculate scattering cross section as a function of kinetic energy. Three body association reaction of ion with DXE is studied and compared to experimental results. A Monte Carlo method is applied to accurately calculate transport parameters for the hydrodynamic regime.

Calculated cross sections were used to obtain mean energy, characteristic energy, reduced mobility, longitudinal diffusion coefficients and rate coefficients are given as a function of low and moderate reduced electric fields E/N (E-electric field strength, N-gas number density).

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P47
Development of a ZnO/SnO_2-Based Electrochemical Sensor for Ceftriaxone Detection

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Ceftriaxone (CTX) is a third-generation cephalosporin antibiotic widely used to treat bacterial infections. Its residues can enter the environment through wastewater, potentially affecting aquatic ecosystems. Therefore, reliable methods for its detection and monitoring are needed. Among variety of analytical techniques useful for detection of pharmaceutics, electrochemical sensors offer high sensitivity, selectivity, rapid response, as well as portability. Besides, their performance can be further improved by electrode modification using different materials such as noble metals, metal oxides, polymers, and carbon-based compounds.

With the aim of developing an electrochemical sensor for CTX detection, ZnO/SnO_2 composites were prepared by a mechanochemical processing of commercially available ZnO and SnO_2 powders in a weight ratio 9:1. Planetary ball mill (Across International PQ-NO4) with stainless steel vessels (100 ml) and balls (∅ 5 mm) was used, while the balls to powder weight ratio was adjusted to 10:1. To modify amount of point defects in the ZnO/SnO_2 composite, prepared powder was calcined at 400 and 700 °C. Physicochemical properties of as-prepared and calcined powders were characterized using X-ray powder diffraction (XRD), photoluminescence (PL) spectroscopy, and field-emission scanning electron microscopy (FESEM).

Cyclic voltammetry (CV), differential pulse voltammetry (DPV), square-wave voltammetry (SWV), and chronoamperometry (CA) were employed for CTX quantification using modified carbon screen-printed electrodes (C-SPEs). The modifying ink was prepared using ZnO/SnO_2 composite, carbon black, Nafion, ethanol, and distilled water. Electrochemical measurements were performed in 25 mL of phosphate buffer (0.1 M, pH 3.0) with successive 10 μL additions of an aqueous CTX solution (75 mg/3 mL), up to a total added volume of 200 μL.

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detection by ZnO-modified electrochemical sensors: From computational modeling via electrochemical testing to real system application – WaPoDe.

P48

Biomass ash: The Next Generation of cement substitutes in road construction

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The construction and maintenance of road infrastructure require significant quantities of cement-based materials, whose production is associated with substantial environmental impacts and CO_2 emissions. At the same time, the increasing use of biomass for energy production generates significant quantities of ash that require appropriate management. Wood biomass ash and agricultural biomass ash therefore represent potentially valuable secondary materials for road construction. This study investigates the potential application of wood biomass ash and agricultural biomass ash as partial replacements for cement in soil stabilization and pavement construction. Their suitability is assessed for the stabilization of soils used in road subgrade and embankment construction, as well as for the production of stabilized load-bearing pavement layers. The evaluation focuses on key engineering properties, including strength and compaction characteristics, with particular emphasis on their suitability for practical road construction applications. Particular attention is given to the utilization of locally available biomass residues. The use of biomass ash as a cement-replacement material has the potential to reduce cement consumption, valorize industrial and agricultural residues, and contribute to more sustainable road construction in accordance with circular economy principles. The findings provide a basis for further development and practical implementation of biomass ash-based stabilization technologies.

Exhibitions

Author: DA Valentina Savić

The ceramic installation **"Condensation"** explores the materialization of water in its transitional states—between fluidity, condensation, and solid form. Initially conceptualized for a wellness environment where water serves as a primary element of renewal and tranquility, the artworks translate the dynamic movement of sea currents, droplets, and organic layering into permanent porcelain structures. The work investigates the boundary between fluid organic processes and structural ceramic permanence.

Valentina Savić is a visual artist and ceramicist holding a Ph.D. at Faculty of Applied Arts in Belgrade. She is a member of the International Academy of Ceramics (IAC). Her artistic practice explores porcelain sculpture, installation, and material transformation, often combining traditional ceramic techniques with contemporary concepts.

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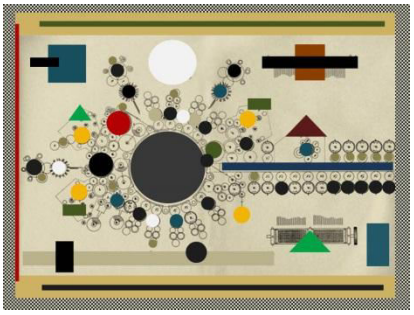
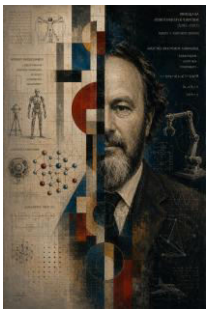
Author: Lana Tikveša

This composition consists of two ceramic forms that are based on oversized and transformed teapot shapes, but at the same time develop through associative links with organic forms from the world of fish, birds and lizards. The inspiring starting point is the imaginary and hidden life of the tropical jungle - a space of intense vegetation, unusual organisms, hidden movements and sounds, as well as the mysterious atmosphere of the tropical night, in which familiar forms are transformed and take on an ambivalent mysterious character.

The sculptures were created as part of the "**Wild at Heart**" cycle, realized in the period from 2010 to 2020, and represent the beginning of research that will be further developed in the "**Summer of the Salamander**" cycle. They are made of fireclay clay using the manual construction technique. The specificity of their art-technological process is reflected in the layered treatment of the surface: the basis is a coating composed of several oxides and ceramic dyes, over which the decor is transferred by the monotype process. The decor is previously formed by pouring porcelain engobes on a textile or paper base, which achieves spontaneous complex, organic structures and textures that further emphasize the hybrid and imaginative character of sculptural forms.

Connected Networks - digital art exhibition

Authors: Prof. Dr. Vladimir Pavlović, Dr. Darko Kosanović

The goal of the exhibition of digital prints and AI-generated art is to pay homage to some of our great scientists — past and present — by transforming their discoveries into visual narratives. The exhibition bridges the language of science with the sensory power of art. It celebrates those whose visionary work continues to shape our world, reminding us that creativity and knowledge are two sides of the same human quest.