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Institute of Physics, University of Belgrade

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Faculty of Mechanical Engineering, University of Belgrade

Center of Excellence for Green Technologies, Institute for Multidisciplinary Research, University of Belgrade

Faculty of Technology and Metallurgy, University of Belgrade

PROGRAMME AND THE BOOK OF ABSTRACTS

8th Conference of The Serbian Society for Ceramic Materials

June 18-20, 2025
Belgrade, Serbia
8CSCS-2025

Edited by:
Branko Matović
Jelena Maletaškić
Vladimir V. Srdić

SPECIAL THANKS TO

Република Србија
МИНИСТАРСТВО НАУКЕ,
ТЕХНОЛОШКОГ РАЗВОЈА И ИНОВАЦИЈА

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WELCOME MESSAGE

On behalf of the organizers and the organizing committee of the 8th Conference of the Serbian Society for Ceramic Materials (8CSCS-2025), it is my great pleasure to extend a warm welcome to all attendees. We are delighted to host you in Belgrade for this important gathering.

The conference is organized by the Serbian Society for Ceramic Materials, in collaboration with the Institute for Multidisciplinary Research – University of Belgrade, Institute of Physics – University of Belgrade, Center of Excellence for the Synthesis, Processing and Characterization of Materials for Use in Extreme Conditions – "CEXTREME LAB", Institute of Nuclear Sciences "Vinča" – University of Belgrade, Faculty of Mechanical Engineering – University of Belgrade, Center of Excellence for Green Technologies, and the Faculty of Technology and Metallurgy – University of Belgrade.

The primary aim of 8CSCS-2025 is to serve as a platform for academic and professional exchange in the field of ceramic materials. This conference brings together researchers, scholars, and professionals from universities, institutes, and industries across the region and beyond, encouraging the discussion of novel ideas and directions in ceramic materials research.

This year, we are proud to have received 86 abstracts from researchers representing 15 countries, reflecting the growing global interest in ceramic materials. The program features three plenary lectures, 22 invited talks, and 61 oral and poster presentations.

Covered topics include ceramic powders, characterization and processing; computing in materials science; high temperature phenomena, sintering, microstructure design and mechanical properties; ceramic composites, membranes and multimaterials; materials for environmental technology; traditional ceramics and engineering materials; advanced materials for energy-related applications; materials for sensing devices; catalytic materials; electro and magnetic ceramics.

We gratefully acknowledge the support of the Ministry of Education, Science and Technological Development of the Republic of Serbia. Special thanks go to the organizers, session chairs, presenters, exhibitors, and all participants for your contributions and enthusiastic engagement.

We hope that your time in Belgrade will be both professionally rewarding and personally enjoyable. I look forward to meeting you and engaging in fruitful discussions throughout the conference.

Branko Matović
President of the Serbian Society for Ceramic Material

PROGRAMME

PLENARY LECTURES

INVITED LECTURES

ORAL PRESENTATIONS

POSTER PRESENTATIONS

PROGRAMME

Day 1. Wednesday - June 18, 2025.

08.00 – 09.00 Registration

09.00 – 09.15 Opening ceremony and welcome addresses

09.15 – 09.30 Cocktail

Plenary lecture
Chair: Branko Matović, Jelena Maletaškić

09.30-10.00 Plenary lecture, PL-1
Samo B. Hočevar, *MODIFICATION MATERIALS FOR ELECTRO-CHEMICAL SENSORS AND BIOSENSORS*

Session 1: Materials for Sensing Devices
Chairs: Nikola Tasić, Samo B. Hočevar

10.00-10.20 Invited lecture, I-1
Nikola Tasić, *NANOSTRUCTURED MATERIALS FOR ENHANCED ELECTROCHEMICAL BIOSENSING APPLICATIONS*

10.20-10.35 Oral presentation, O-1
Aleksandar Radojković, *THE WATER VAPOR SENSING ABILITY OF RARE-EARTH-DOPED BARIUM CERATE*

Session 2: Materials for Environmental Technology
Chairs: Zorica Branković, Kristijan Vidović

10.35-10.55 Invited lecture, I-2
Ioannis Pashalidis, *LANTHANIDE ADSORPTION BY OXIDIZED BIOCHAR FIBERS*

10.55-11.15 Invited lecture, I-3
Kristijan Vidović, *BISMUTH-BASED ELECTROCHEMICAL APPRO-ACH FOR ENVIRONMENTALLY FRIENDLY DETERMINATION OF SURFACE-ACTIVE SUBSTANCES IN ATMOSPHERIC PARTICLES*

11.15-11.30 Oral presentation, O-2
Sanja Perać, *BIOPOLYMER-BASED ENCAPSULATION OF THUJA PLICATA ESSENTIAL OIL: A POTENTIAL BIOPESTICIDE AGAINST PHYTOPHTHORA PATHOGENS*

11.30-11.45 Oral presentation, O-3

Jovana Ćirković, *PREPARATION OF BIOPOLYMER BASED PESTICIDE AGAINST PHYTOPHTORA PATHOGENS*

11.45-12.00 Oral presentation, O-4

Marija Botić, *ANTHOCYANIN/BIOPOLYMERS-BASED FILMS AS pH SENSORS FOR MONITORING FOOD FRESHNESS*

12.00-12.15 Coffee break

Session 3: Electro and Magnetic Ceramics

Chairs: Slavko Bernik, Goran Branković

12.15-12.35 Invited lecture, I-4

Slavko Bernik, *EXAMINING POSSIBLE ALTERNATIVES IN DOPING THE ZnO-Cr_2O_3-BASED VARISTOR CERAMICS*

12.35-12.55 Invited lecture, I-5

Tomislav Ivek, *COLOSSAL MAGNETORESISTANCE IN OVER-DOPED $La_{1-x}Ca_xMnO_3$ THIN FILMS*

Session 4: Catalytic Materials

Chairs: Matejka Podlogar, Martina Kocijan

12.55-13.15 Invited lecture, I-6

Shotaro Tada, *FRUSTRATED LEWIS PAIR FUNCTIONALIZATION OF PRECURSOR-DERIVED CERAMICS AND ORGANIC-INORGANIC HYBRID MATERIALS FOR SMALL MOLECULE ACTIVATION*

13.15-13.35 Invited lecture, I-7

Matejka Podlogar, *ZnO NANOSTRUCTURES FOR EFFICIENT PHOTOCATALYTIC DEGRADATION OF ORGANIC CONTAMI-NANTS*

13.35-13.55 Invited lecture, I-8

Martina Kocijan, *STRUCTURAL, MORPHOLOGICAL, OPTICAL, AND PHOTOCATALYTIC PROPERTIES OF TiO_2 THIN FILMS DEPOSED BY PLASMA-ENHANCED ATOMIC LAYER DEPOSITION*

13.55-15.00 Lunch break

13.55-15.00 Poster Session 1

Day 2. Thursday - June 19, 2025

Plenary lecture
Chairs: Subramshu S. Bhattacharya, Ioannis Pashalidis

10.00-10.30 Plenary lecture, PL-2
Pavol Šajgalík, *IS SILICON NITRIDE BASED CERAMICS SUITABLE FOR THE DRUG DELIVERY?*

Session 5: Ceramic Powders, Characterization and Processing
Chairs: Pavol Šajgalík, Ondrej Hanzel

10.30-10.50 Invited lecture, I-9
Subramshu S. Bhattacharya, *SYNTHESIS AND STRUCTURE-PROPERTY CORRELATIONS IN HIGH ENTROPY OXIDES*

10.50-11.10 Invited lecture, I-10
Ravi Kumar, ESTIMATION OF SINGLE CRYSTAL ELASTIC CONSTANTS FROM POLYCRYSTALLINE CERAMIC MATERIALS – A CASE STUDY WITH AN ENTROPY STABILIZED TRANSITION METAL OXIDE

11.10-11.25 Oral presentation, O-5
Mayank Mishra, *MULTI-MODAL MECHANICAL CHARACTERIZATION OF ADDITIVELY MANUFACTURED ALUMINA CERAMICS USING MINIATURE TESTING TECHNIQUES*

11.25-11.40 Coffee break

Session 6: High Temperature Phenomena, Sintering, Microstructure Design and Mechanical Properties
Chairs: Peter Tatarko, Ravi Kumar

11.40-12.00 Invited lecture, I-11
Ondrej Hanzel, *EFFECT OF PHASE COMPOSITION AND LATTICE OXYGEN CONTENT ON THERMAL CONDUCTIVITY OF SILICON CARBIDE CERAMICS*

12.00-12.20 Invited lecture, I-12
Peter Tatarko, *NOVEL ULTRA-HIGH TEMPERATURE CERAMICS: PROCESSING AND INTEGRATION*

12.20-12.40 Invited lecture, I-13
Hakan Ünsal, *DEVELOPMENT AND ABLATION BEHAVIOR OF ULTRA-HIGH-TEMPERATURE CERAMIC MATRIX COMPOSITES*

12.40-12.55 Oral presentation, O-6

Miloš Dujović, *STABILITY AND PROPERTIES OF M_2AlC PHASES WITH COMPOSITIONALLY COMPLEX M-LAYERS*

12.55-13.10 Oral presentation, O-7

Asif Ali, *INFLUENCE OF SPARK PLASMA SINTERING ON THE STRUCTURE, MICROSTRUCTURE, AND PROPERTIES OF Nb-DOPED $BATIO_3$ PEROVSKITES*

13.10-14.10 Lunch break

13.10-14.10 Poster Session 2

Session 7: Advanced Materials for Energy-Related Applications

Chairs: Zoltán Lénčéš, M. Balasubramanian

14.10-14.30 Invited lecture, I-14

Zoltán Lénčéš, *SILICON/GRAPHITE ANODE PERFORMANCE IMPROVED BY ATOMIC LAYER DEPOSITED ZnO FILMS AND FLUOROETHYLENE CARBONATE ADDITIVE*

14.30-14.50 Invited lecture, I-15

M. Balasubramanian, *NITROGEN-DOPED Fe_3O_4-Fe_3C@RGO CATHODE FOR HIGH-PERFORMANCE LITHIUM-SULFUR BATTERIES*

14.50-15.10 Invited lecture, I-16

Jelena Vukmirović, *SOLUTION-PROCESSED PEROVSKITE THIN FILMS: FROM COMPLEX ARCHITECTURES TO EPITAXIAL LAYERS*

15.10-15.25 Oral presentation, O-8

Imrongnaro Longkumer, HIGH-ENTROPY PEROVSKITE OXIDES WITH SUBSTITUTIONS ON BOTH A AND B SITES FOR THERMOELECTRIC APPLICATIONS

15.25-15.40 Oral presentation, O-9

Emilija Nidžović, *COMPOSITIONALLY COMPLEX SPINEL-TYPE OXIDES FOR ADVANCED APPLICATIONS*

20.00-01.00 Conference Dinner at AMFORA

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Chairs: Jelena Zagorac, Dejan Zagorac

10.00-10.30 Plenary lecture, PL-3
K.C. Hari Kumar, *THERMODYNAMIC MODELLING OF THE Ta-N-O SYSTEM*

Session 8: Computing in Materials Science
Chairs: K.C. Hari Kumar, Elena Raksha

10.30-10.50 Invited lecture, I-17
Dejan Zagorac, *KOVIN ALGORITHM: BRIDGING THE GAP BETWEEN THEORY AND EXPERIMENT*

10.50-11.10 Invited lecture, I-18
Elena Raksha, *MODEL COMPOUNDS FOR CARBON-BASED SORBENT MATERIALS INVESTIGATION BY EXPERIMENTAL AND COMPUTATIONAL METHODS*

11.10-11.25 Oral presentation, O-10
Inga Zhukova, *COMPUTATIONAL AND EXPERIMENTAL INVESTIGATION OF NON-EQUIMOLAR HIGH-ENTROPY DIBORIDES: STRUCTURAL, MECHANICAL, AND THERMODYNAMIC INSIGHTS*

11.25-11.40 Oral presentation, O-11
Dušica Jovanović, *ENERGY LANDSCAPE OF NEW HYBRID ORGANIC-INORGANIC PEROVSKITES: GUANIDINIUM-BX_3 SUBSTITUTED BY B = (Be^{2+}, Ba^{2+}, Zn^{2+}, Ge^{2+}, Sn^{2+}) AND X = (I^-, F^-)*

11.40-12.00 Coffee break

Session 9: Ceramic Composites, Membranes and Multimaterials
Chairs: Claus Rebholz, Žaklina Burghard

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Žaklina Burghard, *CERAMIC MICRO-SCROLLS FOR SOFT ROBOTICS: BIOINSPIRED MAGNETIC ACTUATORS*

12.20-12.35 Oral presentation, O-12

Aleksandr Maletskii, *INFLUENCE OF NEUTRON IRRADIATION ON THE AGGREGATE- AND DISPERSION-STRENGTHENED STRUCTURE OF ZTA COMPOSITE CERAMICS*

12.35-12.50 Oral presentation, O-13

Svetlana Butulija, *PROTON-IRRADIATED DOX-LOADED MULTI-WALLED CARBON NANOTUBES: TOWARD SAFER CHEMO-THERAPEUTIC DELIVERY*

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Gianmarco Taveri, *ISOVALENT SUBSTITUTION OF OCTAHEDRAL SITES IN NaSICON COMPOUNDS: HOW ELECTROCHEMICAL PROPERTIES ARE AFFECTED*

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Chairs: Tatjana Volkov-Husović, Zvezdana Baščarević

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Claus Rebholz, *TURNING WASTE INTO VALUE: ECO-FRIENDLY THERMAL INSULATING MORTARS FROM RECYCLED RIGID FOAMS*

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Tatjana Volkov-Husović, *RECYCLING OF REFRACTORY BRICKS USED IN IRON AND STEEL INDUSTRY*

13.45-14.05 Invited lecture, I-22

Zvezdana Baščarević, *DURABILITY OF ALTERNATIVE CEMENTI-TIOUS BINDER*

14.05-14.20 Oral presentation, O-15

Antonis Kyriacou, *ENGINEERING Ni–Al REACTIVE POWDERS: EFFECT OF BALL MILLING TIME AND PARTICLE SIZE ON MATERIAL PROPERTIES*

14.20-15.20 Lunch break

15.20-16.00 Closing Ceremony

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P2. Milena Rosić, *SYNTHESIS AND CHARACTERIZATION OF $Co_{0.9}Gd_{0.1}MoO_4$ NANOPOWDERS*

P3. Tijana B. Vlašković, *FACILE SYNTHESIS AND CHARACTERIZATION OF PEROVSKITE-TYPE OXIDE $Ca_{0.9}Er_{0.1}MnO_3$*

P4. Natalija Milojković, *DESIGN OF Bi_2O_3 PROPERTIES BY BIOPOLYMER*

P5. Neda Nišić, *NOVEL MULTIDOPED SOLID IONIC CONDUCTOR BASED ON CeO_2 FOR APPLICATION AS ELECTROLYTE IN IT-SOFC DEVICES*

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P8. Tina Radošević, *APPLICATION OF FIB-SEM CHARACTERIZATION IN THE DEVELOPMENT OF PHOTOCATALYTIC MATERIALS FOR ENVIRONMENTAL REMEDIATION*

Poster Session 2: High Temperature Phenomena, Sintering, Microstructure Design and Mechanical Properties

P9. Jelena Mitrović, *THE COLD SINTERED $BaSn_{1-X}In_XO_3$ (X = 0.00, 0.05, 0.10, 0.15 AND 0.20) SAMPLES AND THEIR FUNCTIONAL PROPERTIES*

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P11. Vladimir Pavkov, *EFFECT OF SINTERING TEMPERATURE ON THE COLOUR VARIATION OF ANDESITE BASALT CERAMICS*

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P13. Jelena Bobić, *POLYCRYSTALLINE AND EPITAXIAL THIN FILMS OF $La_{1-X}Na_XMnO_3$*

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P20. Iva Toković, *DENSITY FUNCTIONAL THEORY STUDY OF LANTHANUM STRONTIUM MANGANITE*

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P25. Andrijana Vasić, *WASTE SLAG FROM LIGNITE COMBUSTION AS AN ADSORBENT FOR THE REMOVAL OF ETHYL XANTHATE FROM WASTEWATER OF THE FLOTATION PLANT FOR COPPER ORE AND PRECIOUS METALS PROCESSING IN BOR*

P26. Radmila Lišanin, *SHUNGITE AS AN ENVIRONMENTALLY RELEVANT MATERIAL AND ITS STABILITY UNDER pH VARIATIONS*

P27. Miodrag Ristović, *INDUSTRIAL WASTE AS A RESOURCE IN ASPHALT PRODUCTION AND ROAD ENGINEERING*

P28. Katarina Stefanović, *UNDERSTANDING THE IMPACT OF TECTONICS ON THE FORMATION OF ZLATOKOP ZEOLITE AS AN ECOLOGICAL RAW MATERIAL*

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P35. Milica Počuča-Nešić, *PIEZOELECTRIC NANO-BIOCOMPOSITES BASED ON CHITOSAN, GLYCINE, AND ZINC OXIDE NANOPARTICLES*

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P42. Svetlana Ilić, *INFLUENCE OF THE PRISMATIC GRAINS ON NANO-INDENTATION BEHAVIOUR OF IRON-DOPED MULLITE*

P43. Aleksandra Šaponjić, *MULLITE BASED CERAMICS OBTAINED FROM WASTE CLAY-DIATOMITE*

P44. Zvezdana Baščarević, *POSSIBILITY TO USE LOCAL PONDED ASH AS SUPPLEMENTARY CEMENTITIOUS MATERIAL*

P45. Branko Matović, COMPOSITION UNIVERSE OF CERAMIC MATERIALS: THE POTENTIAL FOR DISCOVERING NEW FUNCTIONAL CERAMICS THROUGH HIGH-THROUGHPUT ANALYSIS

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PL-1

MODIFICATION MATERIALS FOR ELECTROCHEMICAL SENSORS AND BIOSENSORS

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Nowadays, there is a growing demand for sensitive, selective, and reliable sensors and biosensors for on-site detection of numerous analytes. Applications range from environmental monitoring, food safety, industrial control, occupational health and safety, to biology, clinical diagnostics, cultural heritage preservation, and homeland security. From this point of view, electrochemistry offers unrivaled opportunities for the development of high-performing (bio)sensing platforms, utilizing various supporting electrode materials and geometries, effective electrochemical approaches, such as amperometric, (stripping) voltammetric, potentiometric, and impedimetric methodologies and their variations, and a wide range of inorganic and organic nanostructured modification materials, e.g., various types of carbon, metals and (mixed) metal oxides, polymers, and well-defined biorecognition elements. These building blocks enable enhanced sensing capabilities through the construction of different layers, providing (electro)catalytic effects, biorecognition events, enzymatic signal amplification, and the formation of immobilization, derivatization, and interference-free coatings. In combination with carefully selected architecture, linkers, and sensing schemes, a great variety of (bio)sensors can be tailored for the detection of, e.g., trace metal ions, hydrogen peroxide, glucose, insulin, antibodies, antigens, DNAs/RNAs, neurotransmitters, biomarkers, and many other important analytes.

In this talk, we will highlight our research activities at the Department of Analytical Chemistry, focusing on various aspects of developing sensitive and selective sensors for inorganic, organic, and biological analytes in liquid and gaseous samples [1-5]. We will discuss the preparation/pretreatment of the supporting electrodes, the deposition of different (electro)catalytic/biosensing layers, and protective membranes. In addition, we will show several electrochemical detection approaches that assure high sensitivity, selectivity, and reproducibility, and present application possibilities of the developed (bio)sensors in simulated or real samples.

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PL-2

IS SILICON NITRIDE BASED CERAMICS SUITABLE FOR THE DRUG DELIVERY?

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The porous silicon nitride/α-tricalcium phosphate (α-TCP) microgranules containing 50% α-TCP prepared in present study showed good in vitro simulated body fluid bioactivity with precipitation of hydroxyapatite particles. Usually used tetracalcium phosphate/monetite biocement was modified by the addition of 30

wt.% these highly porous microgranules. Granules prepared by the freeze granulation of starting mixture of silicon nitride and calcium phosphate and subsequent sintering at 1100 °C have a suitable pore structure for the foreseen use. The pore volume was almost 1000 mm^3/g with the open porosity of 77 vol%. This porosity and the biocompatible composition of silicon nitride-based granules gave a chance to fabricate a suitable composite cement for a dexamethasone (DMZ) drug release to the human body. An accelerated release of dexamethasone from composite cement was observed and the full amount of DMZ was released from the composite biocement after 10 days. The presented results are a good base to adjust the total drug release time by mixing an appropriate amount of drug infiltrated ceramic granules with the tetracalcium phosphate/monetite cement.

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PL-3

THERMODYNAMIC MODELLING OF THE Ta-N-O SYSTEM

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In this work, we report the thermodynamic modelling of the Ta-N-O system using the Calphad approach combined with ab initio calculations and experiments. The formation enthalpies of stable and certain metastable compounds of the Ta-N and Ta-N-O systems were computed using density functional theory (DFT) to serve as inputs for the Gibbs energy modelling. The DFT study has confirmed Ta_3N_5 as an equilibrium phase. Hence, this phase is included as a stable phase in the Gibbs energy modelling of the Ta-N system. Wherever feasible, we have performed phonon calculations to estimate the heat capacities of com- pounds. The heat capacities of Ta_3N_5 and TaON were measured using a differential scanning calorimeter. It is observed that θ-TaN, a high-pressure polymorph of ϵ-TaN, stabilizes at atmospheric pressure with oxygen substitution. The thermochemical data obtained in the present work are combined with carefully selected thermochemical and constitutional data from the literature to obtain the Gibbs energy descriptions of the Ta-N and Ta-N-O systems.

I-1

NANOSTRUCTURED MATERIALS FOR ENHANCED ELECTROCHEMICAL BIOSENSING APPLICATIONS

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In this work, we explore the use of selected nanomaterials in impedance-based biosensing. We highlight the application of 2D-layered MXenes flakes and $Bi_2Ru_2O_7$ pyrochlore clusters in the fabrication of sensitive and selective immunosensors for SARS-CoV-2 Spike protein detection. The integration of MXenes and pyrochlores into screen-printed electrodes enhances electroanalytical performance, achieving low detection limits and interference-free operation, even in complex biological matrices such as the nasopharyngeal fluid. Additionally, we discuss the fabrication and electroanalytical performance of a disposable glucose biosensor utilizing pyrochlore clusters and multi-walled carbon nanotubes (MWCNTs), demonstrating excellent sensitivity and reproducibility of the biosensor in the clinically-relevant range. In the agricultural domain, we present a label-free impedimetric genosensor for *Citrus bark cracking viroid* detection in hops, showcasing the significant improvements in electroanalytical performance achieved through the incorporation of $Ti_3C_2T_x$ MXenes.

Acknowledgment: This research received funding from the Slovenian Research Agency (Research Program P1-0034 and Research Project J1-50019)

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I-2

LANTHANIDE ADSORPTION BY OXIDIZED BIOCHAR FIBERS

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The application of different chemically modified biochars derived from agricultural wastes (e.g., pine needles, Luffa Cylindrica sponge and Opuntia Ficus Indica cladodes) in the adsorption of trivalent lanthanides is presented and discussed. The effect of various parameters, such as pH, initial metal concentration, temperature, ionic strength and contact time, affecting the removal efficiency (maximum adsorption capacity (q_{max}, K_d), is presented and discussed. The data evaluated from isotherm and kinetic data presented and compared with one another, as well as to corresponding data found in literature. The evaluation of the experimental data indicates a relatively fast adsorption process, which is generally described by the pseudo-second order kinetic models and a pH-dependent adsorption efficiency, which is based on the formation of inner-sphere complexes between the lanthanide ions and the surface active moieties (e.g. carboxylic groups), and the associated data are better fitted by the Langmuir isotherm model. FTIR and XPS spectroscopic data prove the formation of inner-sphere complexes, and SEM pictures reveal a homogeneous distribution of the adsorbed lanthanide onto the biochar surface. Furthermore, evaluation of the experimental data associated with the impact of temperature indicate that the adsorption is generally favoured with increasing temperature and is an endothermic ($\Delta Ho > 0$) and entropy-driven ($\Delta So > 0$) process.

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I-3

BISMUTH-BASED ELECTROCHEMICAL APPROACH FOR ENVIRONMENTALLY FRIENDLY DETERMINATION OF SURFACE-ACTIVE SUBSTANCES IN ATMOSPHERIC PARTICLES

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Accurately detecting surface-active substances (SAS) in atmospheric aerosols is essential for understanding their role in cloud formation and particle growth. Traditional methods relying on mercury electrodes, while effective, are environmentally hazardous. In this study, we present a novel, green alternative using a bismuth bulk electrode (BiBE) combined with electrochemical impedance spectroscopy (EIS) for the sensitive detection of SAS-induced surface tension (γ) changes in ultrafine atmospheric particles (Figure 1). The method exploits the near-ideal polarizability and favorable adsorption properties of bismuth to measure differential capacitance changes at the potential of zero charge. Equivalent circuit modeling with constant phase elements enables precise quantification of surface tension alterations. Our results confirm that the BiBE approach offers sensitivity comparable to the mercury-based system, with significant environmental advantages. This electrochemical methodology opens new pathways for assessing SAS and their impact on aerosol-cloud interactions while adhering to green chemistry principles.

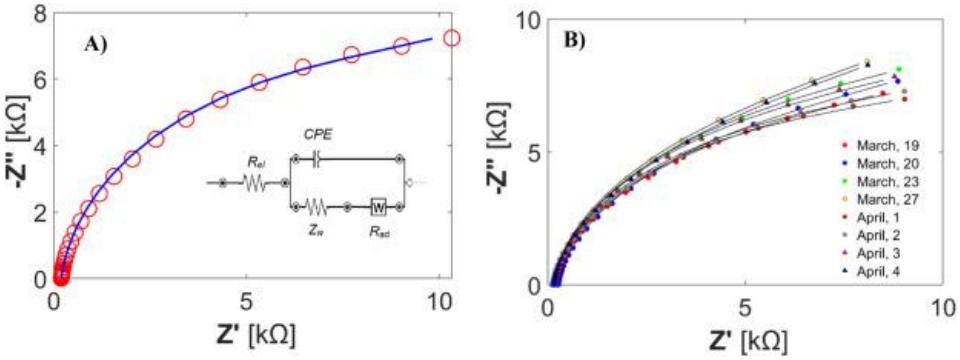

Figure 1. Nyquist plot for BiBE in: A) 0.1 M $NaClO_4$ at −0.75 V, and B) 0.1 M $NaClO_4$ and in the presence of water extracts of ultrafine mode atmospheric particles at −0.75 V. The circles are the measured impedance data, and the line shows the fit obtained from the modified FMG (Frumkin-Melik-Gaikazyan) circuit.

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I-4

EXAMINING POSSIBLE ALTERNATIVES IN DOPING THE ZnO-Cr_2O_3-BASED VARISTOR CERAMICS

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The recently discovered ZnO-Cr_2O_3-based varistor ceramic, with Cr_2O_3 as the varistor former and oxides of Ca and Co as performance enhancers, represents a significant breakthrough in the field of surge protection; it is actually the first truly environmentally friendly and sustainable varistor ceramic with such advantages that their production could significantly affect the world market for overvoltage protection. While characterized by comparable or even better current-voltage (*I-U*) characteristics, the ZnO-Cr_2O_3-based ceramics do not contain the highly volatile Bi_2O_3, expensive rare-earth elements (Pr_6O_{11}) or toxic V_2O_5 than the previously known ZnO-based varistor ceramics, their microstructure is practically single-phase, and the cost of the required varistor dopants is much lower. With the goal to keep the chemical simplicity of the novel ZnO-Cr_2O_3-based varistor ceramics and also low costs of materials, a possibility to replace oxides of Co and Ca with significantly cheaper Mn_3O_4 and more stable MgO, respectively, was examined. The results of the study, namely the influence of these alternative dopants on microstructure, phase composition and current-voltage (*I-U*) characteristics of the ZnO-Cr_2O_3-based varistor ceramics will be presented and discussed.

I-5

COLOSSAL MAGNETORESISTANCE IN OVERDOPED $La_{1-x}Ca_xMnO_3$ THIN FILMS

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Colossal magnetoresistance (CMR), the dramatic drop of resistivity under magnetic field, has long been associated with the ferromagnetic-metallic boundary in manganites. Here, we report details on an even more astonishing CMR phenomenon in the deep antiferromagnetic, charge-ordered regime of overdoped $La_{1-x}Ca_xMnO_3$ thin films (x = 0.5–0.75). By carrying out transport and magnetometry measurements from 1.5 K to 300 K in fields up to 16 T, we uncover a CMR persisting inside the charge-ordered/AFM insulating phase. Remarkably, the x = 0.58 composition exhibits a record CMR of nearly 10^{12} %, far exceeding the underdoped metallic boundary. Magnetization data reveal nanoscale phase separation into ferromagnetic and antiferromagnetic clusters: even deep in the nominally insulating state, small ferromagnetic regions act as percolative conduits when a field is applied. Detailed analysis shows that charge transport in the zero-field charge-ordered state follows spin-dependent variable-range hopping, consistent with Anderson-type localization of e_g electrons in a disordered, spin-frustrated background. Moreover, the hopping activation energy, CMR magnitude, ferromagnetic cluster fraction, and charge-ordering temperature evolve in concert across the series, highlighting the intertwined roles of spin disorder, electron-electron repulsion, and Jahn-Teller coupling in localizing carriers. These findings challenge the conventional phase diagram: colossal magnetoresistance can not only survive but thrive within an antiferromagnetic, charge-ordered matrix, opening new avenues to engineer extreme field sensitivity in oxide electronics.

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I-6

FRUSTRATED LEWIS PAIR FUNCTIONALIZATION OF PRECURSOR-DERIVED CERAMICS AND ORGANIC-INORGANIC HYBRID MATERIALS FOR SMALL MOLECULE ACTIVATION

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Small molecule activation by heterogeneous catalysts offers promising pathways for transforming small molecules, such as H_2 and CO_2, into valuable products. Recent efforts have focused on achieving high catalytic activity using earth-abundant elements, including transition metals (TMs) and main-group elements. Notably, the replacement of rare and expensive TMs in catalysts has been driven by the discovery of unique reactions mediated by main-group elements. Frustrated Lewis pairs (FLPs), consisting of a Lewis acid (LA) and a Lewis base (LB), can act as small molecule activation sites by preventing the classical LA-LB dative bond formation due to steric hindrance. FLPs exhibit a distinctive "push-pull" and/or "pull-pull" effect, efficiently enabling the activation of various small molecules and revealing unexpected catalytic properties. [1] Although molecular FLPs are widely studied, extending this concept to solid-state materials has gained significant attention in recent years. Herein, we report on the hydrogen activation capability of Si-based non-oxide ceramics (SiXN, where X = Al [2] or B [3]) synthesized via a polymer-derived ceramic (PDC) route, as well as the FLP functionalization of organic-inorganic framework synthesized by supramolecular precursors. Our findings demonstrate the potential of these materials to expand the applicability of FLP-based catalysis in heterogeneous systems.

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I-7

ZnO NANOSTRUCTURES FOR EFFICIENT PHOTOCATALYTIC DEGRADATION OF ORGANIC CONTAMINANTS

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Pollution represents a major global concern, posing a significant threat to ecosystems and public health. Among various pollutants, persistent organic contaminants and microplastics in water systems demand urgent attention. In our work, we explore photocatalysis as a promising strategy for environmental remediation, focusing on zinc oxide (ZnO) nanostructures as efficient photocatalytic materials. High abundance, low toxicity, and cost-effectiveness make ZnO a highly attractive semiconductor for photocatalytic degradation of toxic compounds in water. Its performance can be significantly enhanced by introducing intrinsic (native) defects into the ZnO crystal lattice. However, this often requires high-temperature post-processing, which can lead to grain growth and agglomeration, reducing the benefits of the original nanostructured material.

In this study, we show how defect populations evolve inherently during the recrystallization of solvothermally treated ZnO nanopowders. These defects were characterized using Raman, photoluminescence (PL), and EPR spectroscopy, while surface chemistry was evaluated by X-ray photoelectron spectroscopy (XPS). The results reveal that photocatalytic activity is primarily governed by the nature and concentration of bulk defects, rather than by surface chemical composition. This was confirmed by the degradation performance of caffeine as a model pollutant using ZnO nanorods recrystallized from ZnO nanodots. Building on this, we reviewed recent advances in the low-temperature hydrothermal synthesis of vertically aligned ZnO nanorods, with a particular focus on the evolution of structural features and self-doping phenomena occurring during post-annealing in air. By employing evolved gas analysis (EGA), along with advanced microscopic and spectroscopic techniques, we provided a comprehensive understanding of the structural and chemical changes taking place during the annealing process. We investigated how residual impurities from the synthesis influenced the electronic and optical properties of ZnO nanorods. Furthermore, we evaluated their photocatalytic performance in the degradation of caffeine, correlating structural and compositional changes with functional activity.

Our results show that ZnO nanorods possess notable photocatalytic activity, which strongly depends on synthesis conditions. These structures also exhibit

excellent stability and reusability, underlining their potential for real-world environmental applications.

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I-8

STRUCTURAL, MORPHOLOGICAL, OPTICAL, AND PHOTOCATALYTIC PROPERTIES OF TiO_2 THIN FILMS DEPOSED BY PLASMA-ENHANCED ATOMIC LAYER DEPOSITION

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Water scarcity is an increasingly pressing global issue, driven by factors such as population growth, industrialization, and the impacts of global warming. One effective solution to this problem is the treatment and reuse of wastewater, which can be repurposed for industrial processes or agricultural applications, such as irrigation or feeding livestock. This approach helps conserve valuable drinking water resources. In 2015, the United Nations General Assembly established the Sustainable Development Goals (SDGs), with Goal 6: Clean Water and Sanitation, being particularly crucial for our society [1]. One promising way to achieve this goal is by utilising advanced materials for water purification that harness solar energy as a green and sustainable light source.

Photocatalysis is an appealing process with the broad potential to use abundant solar energy for environment-related applications, such as water remediation. The fundamental challenges with photocatalysis are photon absorption and restricted charge diffusion lengths because of excitation recombination. These limitations can be addressed by suitable catalyst design, using a bottom-up approach, with precisely controlled morphology and active sites at the atomic level. Atomic layer deposition (ALD) is an efficient technique to establish thorough control of photocatalyst fabrication. Synthesizing thin films with high precision and uniformity is achievable with ALD [2]. To address the limitations of thermal ALD, which typically uses a precursor combined with water, plasma-enhanced ALD (PEALD) can be employed. PEALD utilizes a precursor in a plasma condition, which enhances reaction rates.

This method allows for lower deposition temperatures, making it suitable for film growth on heat-sensitive materials. PEALD typically achieves faster growth rates than thermal ALD due to the additional energy provided by the plasma [3].

The PEALD technique was used to synthesize thin TiO_2 films on flat silicon wafers. This study investigates how synthesis parameters, such as substrate temperature, duration of plasma pulse, and plasma power, affect the structural, morphological, optical, and photocatalytic properties of the TiO_2 films. Furthermore, it will present new findings regarding the impact of defect engineering on these properties in TiO_2 films synthesized through the PEALD growth process. To examine the surface morphology of the TiO_2 samples, scanning electron microscopy (SEM) was utilized. X-ray photoelectron spectroscopy (XPS) was employed to determine the chemical states within the films. The optical properties of the TiO_2 samples were assessed using UV-vis spectroscopy. The photocatalytic activity of the synthesized TiO_2 films was monitored in a cylindrical reactor equipped with a quartz cover. For this study, methylene blue (MB) was used as a model pollutant in an aqueous solution, which was stirred while exposed to a simulated solar spectrum (Ultra Vitalux, 300 W, Osram). Research findings show that synthesis parameters affect the structure and surface morphology of TiO_2 films, which in turn impacts photocatalytic performance in the degradation rate of MB.

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I-9

SYNTHESIS AND STRUCTURE-PROPERTY CORRELATIONS IN HIGH ENTROPY OXIDES

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High entropy oxides (HEOs) represent a novel class of ceramic materials that exhibit remarkable and often unexpected properties due to their unique compositional diversity that arises from the presence of a multiple number of cations in equimolar proportions on a given sublattice of the crystal structure. These materials have garnered significant attention for their extraordinary room-temperature lithium-ion conductivity, tunable band gaps, colossal dielectric constants, and reversible lithium storage capabilities. The ability to engineer new functionalities by tailoring elemental compositions makes HEOs highly promising for energy storage, optoelectronic applications, and as advanced functional materials.

This study explores different classes of HEOs such as rocksalt, fluorites, perovskites and spinels, involving the presence of 5 or more transition metal and/or rare earth cations. Particular attention is paid to wet chemical methods (such as reverse co-precipitation and the Pechini method) as well as gas-phase synthesis techniques, (including nebulized spray pyrolysis, NSP and flame spray pyrolysis, FSP) for their ability to synthesize high-purity nanostructured HEOs. A comprehensive analysis is conducted on the crystallographic evolution of the different classes of high entropy oxides (HEOs), with a focus on the complex interactions among multiple metal cations that drive the formation of these diverse crystal structures. This study elucidates the interdependence between synthesis conditions, composition, structure and phase stability, and emergent functional properties, offering critical insights for the rational design and optimization of next-generation HEO materials.

I-10

ESTIMATION OF SINGLE CRYSTAL ELASTIC CONSTANTS FROM POLYCRYSTALLINE CERAMIC MATERIALS – A CASE STUDY WITH AN ENTROPY STABILIZED TRANSITION METAL OXIDE

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Single crystal Elastic Constants (SECs) are fundamental to the understanding of the deformation behavior of materials and are most often used for the validation of interatomic potentials. Estimation of SECs is particularly important as single crystals find applications in semiconductor to aerospace industries. Also, SECs are vital for micromechanical modelling of various properties and for residual stress measurements using diffraction techniques. Standard methodologies for the estimation are complex and the most common techniques used to measure SECs are resonant acoustic spectroscopy (RUS) and the Brillouin scattering and in both these techniques sufficiently large single crystals are required. However, it is not easy to grow a single crystal of sufficiently large length for all materials and also of the same composition as its polycrystalline counterpart. Computational techniques, in particular first principle density functional theory (DFT) simulations are successful in estimating SECs for several inorganic compounds, but without experimental validation calculated values from DFT may be questionable. One alternate approach to estimate SECs is by *in situ* loading of polycrystalline samples in a diffractometer. Such experiments are usually carried out using synchrotron and neutron diffraction facilities which can be time consuming. Therefore in this work, we have attempted to develop an elegant methodology wherein SECs could be determined from polycrystalline samples using a commercial laboratory X-ray diffractometer. For this purpose, a universal miniature multiaxial loading fixture was custom-built that is capable of performing *in situ* experiments by integrating it with a commercial laboratory X-ray diffractometer. Proof-of-concept experiments have been carried out for various materials. In this talk, the methodology that was developed to estimate SECs from a polycrystalline entropy stabilized oxide of composition (MgCuNiZnCo)O will be discussed.

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I-11

EFFECT OF PHASE COMPOSITION AND LATTICE OXYGEN CONTENT ON THERMAL CONDUCTIVITY OF SILICON CARBIDE CERAMICS

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Fully dense (t. d. > 99 %) silicon carbide ceramics without any sintering additives were successfully prepared by combination of freeze granulation of silicon carbide powder, annealing of granulated powders and subsequent rapid hot pressing at 1900°C with dwell time from 5 to 80 minutes under a uniaxial pressure of 70 MPa in vacuum. Different ratio of alpha and beta silicon carbide has been achieved by adjusting dwell time during sintering. Thermal diffusivity, specific heat capacity, thermal conductivity, density, microstructure of additive-free SiC with various α/β contents has been investigated. The thermal diffusivity of additive-free SiC ceramics increased from 47.3 to 68.4 mm^2/s with increasing holding time and therefore increasing α-SiC content from 63 to 94 % as well as increasing grain size. Decreasing lattice oxygen content has some positive impact on thermal conductivity but according to our results α/β ratio of SiC and grain size are the main and crucial factors which can influence thermal properties of additive-free silicon carbide. The highest thermal conductivity (λ = 165 W/m.K) among the SiC ceramics sintered at temperatures ≤1900 °C was achieved for additive-free SiC sintered at 1900 °C under vacuum for 80 min. To the best of our knowledge this is the highest value of thermal conductivity for silicon carbide ceramics sintered at $T \leq 1900$ °C up to now.

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I-12

NOVEL ULTRA-HIGH TEMPERATURE CERAMICS: PROCESSING AND INTEGRATION

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This work presents the development of high-purity single phase high entropy carbides, such as (HfZrTaNbTi)C and (MoNbTaVW)C, and high entropy diboride, such as (HfZrTaNbTi)B_2 by Spark Plasma Sintering (SPS). The main aim of this study was to develop an appropriate approach to join this novel class of Ultra-High Temperature Ceramics (UHTC). The presentation will be divided into three parts. The first part will focus on wetting and joining of (HfZrTaNbTi)C and (HfZrTaNbTi)B2 with a commercially available AgCuTi alloy. The apparent shear strength of HEC and HEB joints was 176 ± 39 MPa and 116 ± 38 MPa, respectively. In all cases, the failure occurred in base materials, which fragmented into many small pieces, indicating that the shear strength of both joints was predetermined by the intrinsic properties of base materials. The second part will describe the joining of (MoNbTaVW)C with a NiTa eutectic alloy. The addition of 17.2 at.% Ta to Ni significantly reduced interfacial reactions and dissolution of HEC, while maintaining excellent wetting behaviour with the final wetting angle of ≤ 15°. Successful joining of HEC ceramics was achieved using a NiTa interlayer, demonstrating a high shear strength of 220 ± 17 MPa. The last part of the presentation will focus on the joining of (HfZrTaNbTi)C and (HfZrTaNbTi)B_2 with the high entropy alloy containing the same transition metals, i.e. HfZrTaNbTi. Microstructural and interfacial characterizations of the joint revealed a homogeneous, crack-free and well-bonded interfaces. The effect of joining temperature on the mechanical strength was evaluated, revealing the strength exceeding 350 MPa for the joints made at 1800 °C. High-temperature bending tests revealed no significant strength deterioration up to 1000 °C.

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I-13

DEVELOPMENT AND ABLATION BEHAVIOR OF ULTRA-HIGH-TEMPERATURE CERAMIC MATRIX COMPOSITES

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Ultra-High-Temperature Ceramic Matrix Composites (UHTCMCs) are promising materials for extreme environments due to their superior thermal and mechanical stability. In this study, C_f/C and C_f/SiC ceramic matrix composites (CMCs) were developed and subsequently coated with a ZrB_2-based ultra-high-temperature ceramic (UHTC) layer to enhance their ablation resistance. The coating was applied via a room-temperature deposition process and cured at 200 °C in multiple layers. The microstructural and phase composition analyses were conducted using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and X-ray diffraction (XRD), confirming uniform coating distribution and phase formation. The coated samples underwent annealing at 1400°C under an Ar atmosphere to remove organic compounds and improve thermal stability. Ablation performance was evaluated through an oxyacetylene torch test at surface temperatures of ~2300 °C for C_f/C and ~2050 °C for C_f/SiC, with real-time temperature monitoring via optical pyrometry. The results demonstrated a significant reduction in mass ablation rates, with the coated and annealed samples exhibiting up to 50% improvement in ablation resistance compared to uncoated counterparts. These findings highlight the potential of UHTC coatings for enhancing the performance of CMCs in aerospace and hypersonic applications.

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I-14

SILICON/GRAPHITE ANODE PERFORMANCE IMPROVED BY ATOMIC LAYER DEPOSITED ZnO FILMS AND FLUOROETHYLENE CARBONATE ADDITIVE

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It is widely accepted that further increase of gravimetric and volumetric energy densities of Li-ion batteries can be achieved by introducing silicon-based anodes. Even though nanoengineering technology offers several strategies to develop high-performance Si-based anodes, they are not directly compatible with the current fabrication technology.

In our contribution we report on the preparation and properties of Si-graphite-based anodes. The anodes were fabricated using ball milled Si and graphite powders, stable slurry preparation and tape casting on a copper foil. Three different slurries were prepared with the silicon/graphite ratio 20:80, 30:70 and 50:50 wt%. Carbon black and sulphonated alginate were added as conductive agent and binder, respectively.

The fabricated Si/graphite anodes were coated by ultrathin ZnO films using atomic layer deposition (ALD). Lithium hexafluorophosphate ($LiPF_6$) solution in ethylene carbonate and ethyl methyl carbonate with fluoroethylene carbonate (FEC) additive was used as electrolyte. Silicon/graphite anodes with the 20:80 wt% composition coated by ALD ZnO films and cycled in the electrolyte with 10 wt% FEC additive exhibited excellent rate capability up to c-rate of 4 and capacity retention of 80% and 60% after 100 and 500 charging/discharging cycles at c-rate 1, respectively. Differential capacity *dQ/dV* plots as a function of the cell potential during the charging/discharging cycles for the Si/Gr+ZnO anode in the electrolyte with FEC additive unveil the protective role of the ZnO coatings. The properties of the anodes with the different silicon/graphite ratios will be compared and discussed.

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I-15

NITROGEN-DOPED Fe_3O_4-Fe_3C@RGO CATHODE FOR HIGH-PERFORMANCE LITHIUM-SULFUR BATTERIES

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Lithium-sulfur (Li-S) batteries hold great potential for next-generation energy storage due to their high energy density (2600 Wh/kg) and cost-effectiveness. However, challenges, such as polysulfide shuttling, sluggish sulfur conversion, and structural instability limit their practical application. To address these issues, a nitrogen-doped Fe_3O_4-Fe_3C@RGO composite cathode with 70% sulfur loading has been developed to enhance sulfur utilization and cycle stability. The Fe_3O_4 and Fe_3C components act as strong polysulfide anchors, preventing active material loss and improving redox kinetics, while the reduced graphene oxide (RGO) matrix provides excellent conductivity and structural integrity. Electrochemical testing demonstrated a high initial capacity of 801 mAh/g at 0.5 C, with low fading rate of 0.03% per cycle, up to 150 cycles, confirming superior long-term stability. The combination of strong polysulfide confinement, efficient charge transport, and structural robustness makes this cathode a promising candidate for advanced Li-S batteries. This work presents a practical approach to overcoming key limitations in Li-S battery technology and offers valuable insights into designing stable and high-performance cathode materials.

I-16

SOLUTION-PROCESSED PEROVSKITE THIN FILMS: FROM COMPLEX ARCHITECTURES TO EPITAXIAL LAYERS

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Perovskite materials in thin film form have attracted significant attention due to their functional properties and potential applications in electronics, catalysis, energy harvesting, etc. The preparation of high-quality perovskite thin films by solution-based methods offers a cost-effective and scalable alternative to vacuum-based deposition techniques. This research focuses on the possibilities of the preparation of perovskite films: from the printed complex architectures to the ultrathin epitaxial films with solution-based techniques. $BaTiO_3$ based thin films were prepared using sol-gel method and deposited to Si substrates with spin coating and inkjet printing techniques. Spin coating technique allows fast film deposition without clear restriction of rheological properties of precursor solution suitable for fabrication of uniform thin film at large areas. On the other hand, inkjet printing demands stricter control over fluid properties such as viscosity, surface tension, and particle size distribution. These parameters were carefully optimized to enable stable printing to produce complex shaped thin films. In addition, $LaMnO_3$ based epitaxial ultrathin films were synthesized by water-based polymer assisted deposition method (PAD). Initial depositions were performed on silicon substrates by spin coating to produce polycrystalline films. Based on preliminary results, the 0.1 M solution was selected for epitaxial film growth on single-crystal $SrTiO_3$ (001) substrates. Obtained results show great potential of solution-based techniques in production of different architectures and structural forms of perovskite thin films. By precise optimization of process parameters such as precursor composition, concentration, rheology, selection of substrate and deposition method, as well as thermal treatment, it is possible to manipulate with form and structure to obtain high quality thin films.

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I-17

KOVIN ALGORITHM: BRIDGING THE GAP BETWEEN THEORY AND EXPERIMENT

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LaFSe and LaFS materials have demonstrated significant promise for a range of optoelectronic uses, including light-emitting diodes, photovoltaics, and photodetectors. High-temperature experiments have been used to create mixed LaFSe/LaFS compounds. Changes in the unit cell result from the distortion of the crystal lattice caused by the addition of sulfur to LaFSe. To rapidly build and compute models for solid solution-type compounds, a new KOVIN (Keep Original Vectors In New structure) algorithm is provided that maintains the symmetries of the mixed LaFSe/LaFS phases. This algorithm is paired with *ab initio* structure optimization [1]. Additional expected structures under extreme conditions in other lanthanoid fluoride selenides/sulfides have been introduced, and experimental and theoretical data show very good agreement. When selenium is substituted for sulfur in the LaFSe lattice, the material's electrical structure, band gap size, and gap character can all vary, among other unusual electronic characteristics. Furthermore, additional chemical systems will be presented confirming the use of the new KOVIN algorithm as a great tool for solid solution exploration [2,3].

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I-18

MODEL COMPOUNDS FOR CARBON-BASED SORBENT MATERIALS INVESTIGATION BY EXPERIMENTAL AND COMPUTATIONAL METHODS

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Carbon-based materials, namely activated carbon, expanded graphite, carbon nanotubes and graphene and related compounds, are considered as the most effective adsorbents for pollutant removal and wastewater treatment. Thermally expanded graphite (TEG) is a well-known sorbent for various eco-toxicants such as oils and oil products, organic compounds and heavy metals. Thus it is a promising component of effective sorbent materials. TEG obtained from acceptor graphite intercalation compounds [1] has an exceptional combination of interesting properties and represents a promising basis for the development of multifunctional materials. Model systems for a comprehensive study of the adsorption properties of TEG with respect to organic compounds using experimental and computational methods are discussed.

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I-19

CERAMIC MICRO-SCROLLS FOR SOFT ROBOTICS: BIOINSPIRED MAGNETIC ACTUATORS

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In this study, we present a novel scroll-like soft actuator composed of a hybrid film made of vanadium pentoxide (V_2O_5) nanofibers as the matrix with uniformly distributed Fe_3O_4 magnetic nanoparticles. The films, approximately 2 μm thick, were fabricated using a straightforward synthesis method at room temperature without the need for magnetic field alignment of the Fe_3O_4particles. Using a razor blade technique [1], these hybrid films were rolled into micro-scrolls with widths of 3 mm and lengths reaching up to 25 mm.

A key feature of these scroll-like actuators is their ability to reversibly open and close under a low magnetic field strength (6 mT), which is significantly lower than for previously reported magnetic soft actuators [2]. This enhanced sensitivity is attributed to the micrometer thickness of the hybrid ceramic film, which reduces the magnetic field required for actuation. Additionally, the bio-inspired structure of the hybrid film, with its scale-like architecture, contributes to the excellent mechanical stability of the scrolls during repeated actuation cycles. The scrolls demonstrated exceptional mechanical durability, maintaining their functionality through more than 2000 actuation cycles without any visible degradation. Furthermore, these scrolls were successfully tested as grippers capable of lifting objects up to 30 times their own weight, demonstrating their potential for practical applications in soft robotics.

This scroll-like magnetic micro-actuator, with its unique combination of flexibility, low activation field, and robust mechanical stability, presents significant potential for applications in soft robotics, artificial muscles, and microdevices. The innovative fabrication method and the outstanding performance characteristics of these magnetic micro-scrolls open new avenues for the development of advanced bio-inspired ceramic based soft actuators.

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I-20

TURNING WASTE INTO VALUE: ECO-FRIENDLY THERMAL INSULATING MORTARS FROM RECYCLED RIGID FOAMS

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Plastic waste has become a serious environmental threat, impacting both ecosystems and human health. As a result, the reuse of plastic waste for developing sustainable building materials has attracted growing interest in recent years. This study explores the use of recycled rigid polyurethane (PUR) and polystyrene (PS) foams as primary lightweight aggregates - making up more than 80% by volume - to produce premixed thermal insulating mortars intended for floor and roof applications. The binder system consists of Portland cement and hydrated natural lime, with no sand, and is enhanced with specific additives to improve mechanical, physical and thermal performance.

Results show that key properties - such as density, compressive strength and thermal conductivity - are primarily influenced by the proportion of recycled PUR or PS in the mix. The optimized mortars achieved compressive strengths of 1.0 N/mm² and 0.85 N/mm², densities of 420 kg/m³ and 340 kg/m³ and thermal conductivities of 0.07 W/mK and 0.09 W/mK for PUR- and PS-based formulations, respectively. The process was successfully scaled up, with the design and installation of a prototype production system capable of producing 1500 litres of insulating mortar per hour (equivalent to 20 bags of 75 litres each).

This research contributes valuable knowledge toward the development of sustainable construction materials - particularly relevant for countries in Europe where much of the plastic consumer waste, including PUR and PS, still ends up in landfills. There is also strong potential for the integration of additional types of plastic or composite waste, further enhancing circular economy strategies in construction. Continued development could pave the way for high-performance insulating systems that reduce environmental impact while promoting sustainable building practices on a global scale.

I-21

RECYCLING OF REFRACTORY BRICKS USED IN IRON AND STEEL INDUSTRY

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The present study will address the goals and consequences of recycling refractory materials, as well as the possible industries from which recyclable waste refractories might be gathered. When its useful life is over, the refractory material is typically recycled or dumped in industrial landfills. Refractory reuse is primarily motivated by the sustainable conservation of natural resources and environmental protection through the reduction of industrial landfills and CO_2 emissions, as well as the reduction of landfill and user costs. Refractory material recycling has the following benefits: reduced costs for raw materials and disposal; improved environmental conditions; increased product line expansion and, as a result, opportunities for product placement in previously untapped and inaccessible markets; and increased user-compliance.

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I-22

DURABILITY OF ALTERNATIVE CEMENTITIOUS BINDERS

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Over the past few decades, various alternative binders have been developed and explored, as result of growing global pressure to reduce greenhouse gas emissions and energy use related to Portland cement production. However, wider commercial adoption of the new binders is often hindered by the lack of data on their long-term properties and durability. During their lifetime, binder materials come in contact with various aggressive solutions or conditions with deteriorating effects. Durability assessment of alternative binders is complicated by wide variety of their compositions and lack of standardized procedures, as test parameters used to determine durability of Portland cement are not always suitable for the newly developed binders. In this work, an overview of the testing procedures used and the results obtained when alternative binders, such as alkali activated materials and high volume fly ash binders, were subjected to various aggressive solutions, will be given.

O-1

THE WATER VAPOR SENSING ABILITY OF RARE-EARTH-DOPED BARIUM CERATE

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The ability to conduct protons at high temperatures makes acceptor-doped perovskites suitable for humidity sensors in a high-temperature environment. In this study, the rare-earth-doped barium cerate powders were synthesized by the auto-combustion method and processed into thick porous films (60–70 % porosity) to investigate the water vapor sensing properties in the 400–700 °C temperature range. All samples showed a stable sensitivity to water vapor in the whole temperature range, expressed as impedance ratio in dry and wet argon ($|Z|_{dryAr}$ / $|Z|_{wetAr}$), and were able to detect 0.03 vol% of water vapor at 550 °C within the impedance range of 10^3 Ω at 100 Hz. The sensitivity values increased with the partial pressure of water and decreased with the temperature, whereas the maximal value of 3.41 reached the BCEu10 sample at 550 °C and $p(H_2O)$ = 4.28 kPa.

O-2

BIOPOLYMER-BASED ENCAPSULATION OF *THUJA PLICATA* ESSENTIAL OIL: A POTENTIAL BIOPESTICIDE AGAINST *PHYTOPHTHORA* PATHOGENS

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Forests are crucial national resources requiring long-term management. *Phytophthora* species, primarily attacking roots, pose a serious threat to forests, crops, and many plant species. Known as "plant destroyers", these pathogens continue to spread despite preventive measures like proper drainage, hygiene, and chemical treatments. A promising solution is the development of eco-friendly biopesticides derived from plant-based products, such as essential oils (EOs).

This study aimed to develop a new formulation that gradually releases the active components in the essential oils (EOs) from a biodegradable polymer matrix over time. The effects of three EOs from Cupressaceae family - *Chamaecyparis lawsoniana* (A. Murr.) Parl., *Thuja plicata* Donn ex D.Don and *Juniperus communis* L. - were tested against *Phytophthora* species: *P. plurivora*, *P. quercina*, and *P. ×cambivora*. The EOs were encapsulated in a biopolymer matrix containing chitosan and gelatin to form a stable water-in-oil emulsion, ensuring slow release and protection of active components for several weeks. Among the EOs, *Thuja plicata* exhibited the most effective growth inhibition of *Phytophthora* species, with concentrations of 0.1% and 0.5% (v/v) almost completely halting fungal growth over seven days. These results demonstrated the potential of *T. plicata* EO encapsulated in a sustainable biopolymer as an effective biopesticide for natural ecosystem protection.

O-3

PREPARATION OF BIOPOLYMER BASED PESTICIDE AGAINST *PHYTOPHTORA* PATHOGENS

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In this work, a new formulation that gradually released encapsulated *Thuja plicata* essential oil (TPEO) as an active component from a biopolymer matrix within a given period was obtained. Firstly, biopolymer matrix consisting of a chitosan-gelatin mixture was prepared. Afterwards, TPEO essential oil was encapsulated into the biopolymer matrix and an oil-in-water emulsion was formed. The main goal of this work was to obtain stable formulation by optimizing synthesis parameters (biopolymers ratio, amount of Tween 80 and homogenization time). FTIR spectra analysis confirmed that the addition of gelatine to the chitosan solution contributed to the forming of strong electrostatic interaction between these polymers, and also revealed hydrogen interactions between active components of TPEO (methyl thujate) and polymer chains. By optimizing biopolymers ratio and amount of Tween 80, nanoemulsion with average droplet size around 150 nm was obtained. The stability of the emulsions was confirmed by zeta potential measurements, with the value of about 30 mV, even after 14 days of ageing at room temperature.

O-4

ANTHOCYANIN/BIOPOLYMERS-BASED FILMS AS pH SENSORS FOR MONITORING FOOD FRESHNESS

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Significant food waste from fresh fruit and vegetable processing is an increasing global concern. Enzymatic or microbiological decomposition of this waste produces gaseous byproducts with varying chemical compositions and pH levels. Anthocyanins are natural pigments present in various fruits and vegetables, known for their ability to change color in response to pH variations. In this study, anthocyanins were obtained from different fruit wastes: red grape skin, blueberries, and raspberries using microwave-assisted extraction (MAE) technology. First, the fruit waste was lyophilized and the lyophilized material was then immersed in 60% (v/v) ethanol solution in water and transferred to extraction. The extraction conditions were optimized by varying several parameters: the raw material-to-solvent ratio, temperature, power, and extraction time. UV-Vis spectroscopy confirmed the presence of anthocyanin in the obtained extracts with characteristic peaks observed at wavelengths of 280 and 520 nm. Different concentrations of extracts (10%, 15% and 20% (v/v)) were incorporated into biopolymer-based matrices, containing chitosan/glycerol, in ratio 70/30 (based on the mass of chitosan), to form solutions. The prepared solutions were poured into Petri dishes, and after drying in a vacuum oven, biopolymer films were obtained. The stability of the extracts, as well as the combination of extract solutions and biopolymers, was determined by measuring zeta potential, which was in the range from -14 mV up to -20 mV for extracts and about 35 mV for extract-biopolymer combinations. To evaluate the pH-responsiveness of the films, a few drops of acidic solutions were applied to their surface. A rapid and visually detectable color change was immediately observed, indicating the films' sensitivity to pH variations. This confirmed the intended functionality of the developed materials as effective pH sensors for real-time monitoring of food freshness.

O-5

MULTI-MODAL MECHANICAL CHARACTERIZATION OF ADDITIVELY MANUFACTURED ALUMINA CERAMICS USING MINIATURE TESTING TECHNIQUES

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The mechanical characterization of additively manufactured (AM) alumina ceramics is essential for understanding their anisotropic behavior and optimizing their structural performance. This study employs uniaxial compression, four-point bending, and Vickers hardness testing, and Ball on three Balls (B3B) strength evaluation to capture the mechanical response of miniaturized AM alumina specimens. A customized miniature mechanical testing setup was developed to enable reliable testing of small-sized samples and address the limitations of conventional testing methods [1].

Computational analysis using ANSYS aided in optimizing specimen geometry to minimize stress concentrations, where design modifications reduced stress concentration factors significantly [2]. Our non-standard specimen sizes demonstrated a maximum variation of only 5% in stress-strain values compared to ASTM standard specimens, validating their reliability.

This comprehensive, multi-modal testing approach provides valuable insight into the mechanical performance of AM ceramics and supports the development of optimized ceramic components for advanced engineering applications [3,4].

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O-6

STABILITY AND PROPERTIES OF M_2AlC PHASES WITH COMPOSITIONALLY COMPLEX M-LAYERS

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This work focuses on the synthesis and stability of a class of ternary carbides known as MAX phases M_2AlC. In this work, we report on MAX phases with a chemical formula of M_2AlC where M can be Cr, Ti, Ta, V, Nb, or a combination thereof. The study focuses particularly on synthesizing M_2AlC phases with two to five different elements occupying the M-site in equiatomic ratios, starting with phase pureTi_2AlC, Cr_2AlC, V_2AlC, Nb_2AlC, and Ta_2AlC powders. This method is chosen to prevent the formation of intermediate and competing phases in the final microstructure, which can form during the synthesis of compositionally complex MAX phases from elemental powders as a result of incomplete reactions. The use of equiatomic M-element ratios is theoretically intended to maximize configurational entropy, thereby enhancing the stability of the synthesized phases. Our findings indicate that, out of the 26 compositionally complex M_2AlC phases investigated, nine were found to be phase pure; in some cases, MAX Phases were detected alongside the competing phases, while some were found to decompose under multiple processing conditions premerly to the combination of complex binary carbides. In one case, spinodal decomposition to two MAX phses with slightly different chemistries was observed. Ultimately, based on the various calculated parameters, a model was made with a goal to predict the stability of the processed compositions based on the electric structure and sizes of atoms.

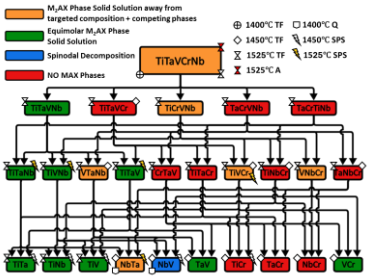

Figure 1. Schematic representation of the phase formation and stability in equimolar CCMAX phase compositions. The colors indicate the outcome of the synthesis: green represents equimolar M_2AX phase solid solutions, orange denotes M_2AX phase solid solutions that deviated from the targeted composition and included competing phases, blue indicates spinodal decomposition, and red signifies compositions where no MAX phases were detected

O-7

INFLUENCE OF SPARK PLASMA SINTERING ON THE STRUCTURE, MICROSTRUCTURE, AND PROPERTIES OF Nb-DOPED $BaTiO_3$ PEROVSKITES

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Lead-free $Ba_{0.8}Ca_{0.2}Ti_{1-x}Nb_xO_3$ perovskites (x = 0.005, 0.01, 0.03, and 0.05) were synthesized by conventional solid-state route and sintered via Spark Plasma Sintering (SPS). The X-ray diffraction patterns of the samples confirmed the formation of the single-phase cubic perovskite structures with a space group of P3mm without the detection of any secondary phase. The Raman spectroscopy further confirmed the formation of desired structures. Raman spectra also revealed that Ca^{2+} occupied the BO_6 octahedron by moving from the A- to B-site to partially occupy the Ti^{4+}- site. The SEM analysis revealed that the samples exhibited dense microstructures with the relative density greater than 97 % due to SPS sintering. FTIR spectroscopy supported the presence of characteristic metal oxide bonding and confirmed the single-phase nature. The optical band gap showed a modest increase from 3.29 to 3.30 eV as x increased from 0.005 to 0.05 (i.e. increasing Nb content). Remarkably, all samples exhibited colossal permittivity of the order of 10^5 with a low dielectric tanδ < 3 %. This clearly indicates the potential of these novel materials for the use in high-energy-density applications.

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O-8

HIGH-ENTROPY PEROVSKITE OXIDES WITH SUBSTITUTIONS ON BOTH A AND B SITES FOR THERMOELECTRIC APPLICATIONS

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The field of high entropy oxides has been fast gaining pace with applications ranging from ionic conduction, energy storage, energy conversion, etc. In high entropy perovskite oxides, these properties arise from the combination of different elements on the A site, B site or both and the associated crystal structure distortions.

In this work, the cubic $SrTiO_3$ structure with n-type thermoelectricity has been modified using the high entropy engineering approach. High entropy perovskite oxides with 3 equimolar elements on the A-site (Ba, Ca, Sr) while the amount of the 4th element La varied, and 3 equimolar transition metal elements on the B-site (Zr, Ti, Nb) have been synthesized using the solid-state method and spark plasma sintering. The effect on the thermo-electric properties have been investigated, with varying amount of La on the A site. Detailed sintering and densification studies have been carried out. Measurements of the thermal diffusivity, electrical conductivity and the Seebeck coefficient for application in thermo-electrics have been carried out.

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O-9

COMPOSITIONALLY COMPLEX SPINEL-TYPE OXIDES FOR ADVANCED APPLICATIONS

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High-entropy spinel oxides (HESOs) represent a class of complex oxides, comprising of five or more metal cations distributed within a spinel crystal structure. Their structural complexity and tunable physical properties make them promising candidates for various advanced applications. Although multiple synthesis approaches have been explored to date, the development of novel, efficacious synthesis routes continues. In this study, HESOs with eight distinct compositions were synthesized utilizing the self-propagating room temperature method. Following thermal treatment at 1000 °C, XRD confirmed the formation of single-phase spinel (*Fd-3m*) oxides. Spark plasma sintering was successfully employed for the first time to densify HESOs, leading to relative densities between 94% and 99% while preserving the spinel phase. With a holding time of only 10 minutes, process efficiency was notably enhanced. SEM/EDS revealed a dense and homogeneous microstructure with minimal porosity. The obtained materials exhibit characteristics suitable for a broad spectrum of applications, including thermal barrier coatings, microwave absorbers, solid oxide fuel cell (SOFC) cathodes, and gas sensors. This study presents a straightforward and effective route for the synthesis and densification of HESOs, contributing to the understanding of their properties.

O-10

COMPUTATIONAL AND EXPERIMENTAL INVESTIGATION OF NON-EQUIMOLAR HIGH-ENTROPY DIBORIDES: STRUCTURAL, MECHANICAL, AND THERMODYNAMIC INSIGHTS

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This work presents the design, modeling, and experimental investigation of high-entropy diboride ceramics based on $(TiZrHfNbTa)B_2$ with varying non-equimolar compositions. The study aims to understand the impact of different atomic ratios on the structural, energetic, and mechanical properties of high-entropy boride systems. Density Functional Theory (DFT) calculations were performed using VASP with structural disorder modeled via the Special Quasirandom Structures (SQS) approach. Key parameters, such as formation energy, and vacancy formation energy were evaluated to identify the most stable compositions.

Experimentally, three selected non-equimolar compositions were synthesized using boro/carbothermal reduction followed by Spark Plasma Sintering (SPS) at 1800–2000 °C [1]. Microstructural analysis was conducted using TEM and SEM, and mechanical properties—including hardness, Young's modulus, and wear resistance—were assessed via nanoindentation and tribological testing. The combined theoretical and experimental results offer insight into the structure–property relationships of high-entropy diborides and support their potential application in extreme environments.

Acknowledgement: This work was supported by the Slovak Research and Development Agency under the Contract no. APVV-21-0402 and SK-CZ-RD-21-0089. The support of project LUASK22219 is also acknowledged.

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O-11

ENERGY LANDSCAPE OF NEW HYBRID ORGANIC-INORGANIC PEROVSKITES: GUANIDINIUM-BX_3 SUBSTITUTED BY B = (Be^{2+}, Ba^{2+}, Zn^{2+}, Ge^{2+}, Sn^{2+}) AND X = (I^-, F^-)

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The development of perovskite solar cells (PSC) has attracted great attention as a "green" energy source that might even replace fossil fuels soon [1]. Conventional perovskite solar cells mostly contain toxic lead, which contributes to environmental pollution, so the solution was found to substitute lead with some non-toxic metal [2]. Our investigation of hybrid organic-inorganic perovskites aims to increase the chemical stability as well as to decrease the band gap value of crystal perovskites, which enables better conductivity and shifts the absorbance range, in order to produce the most efficient perovskite solar cells. The *ab initio* calculations of GA-BX_3, where GA is the guanidinium cation $C(NH_2)_3^+$, with several different inorganic cations and anions - specifically: B = (Be^{2+}, Ba^{2+}, Zn^{2+}, Ge^{2+}, Sn^{2+}) and X = (I^-, F^-) have been performed using Density Functional Theory (DFT), with several functionals, Local Density Approximation (LDA) and Perdew-Burke-Ernzerhof (PBE), as well as HSE06 (Heyd-Scuseria-Ernzerhof) hybrid functional. Further investigations of structural and electronic properties will provide insights into the potential applications of these new hybrid organic-inorganic perovskite structures.

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O-12

INFLUENCE OF NEUTRON IRRADIATION ON THE AGGREGATE- AND DISPERSION-STRENGTHENED STRUCTURE OF ZTA COMPOSITE CERAMICS

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Currently, numerous studies are focused on finding composite ceramic materials that can be used as structural components for the aerospace and nuclear energy industries [1–5]. Such materials must be chemically inert, radiation-resistant, and possess high physical and mechanical properties for long-term operation in various aggressive environments [4]. The structure of such structural components should be resistant to high-energy particle exposure; however, this aspect remains poorly studied for ceramic materials, particularly for ZTA (Zirconia-Toughened Alumina) composite ceramic systems with different types of microstructure.

It is known that exposure to high-energy particles and radiation alters the structural-phase state and physical properties of solids. Understanding the physical changes occurring in solids under the influence of high-energy particles and radiation requires a detailed examination of key radiation-induced effects caused by different types of irradiation.

This paper presents the results of a study on the effect of neutron irradiation on the aggregate- and dispersion-strengthened structure of composite ceramics with the composition α-Al_2O_3 + *n*% YSZ (ZrO_2 + 3 mol.% Y_2O_3) (*n* = 0, 1, 5, 10, 15 wt.%), fabricated by high hydrostatic pressure (HHP) processing of green compacts (300 and 700 MPa).

The powders for the study were synthesized using a co-precipitation method from aqueous solutions of aluminum chloride ($AlCl_3 \cdot 6H_2O$), zirconyl chloride ($ZrOCl_2 \cdot 8H_2O$), and yttrium nitrate ($Y(NO_3)_3$) at room temperature.

First, a solution of zirconyl chloride and yttrium nitrate was prepared and then mixed with an aluminum chloride solution in the required concentrations to obtain powder mixtures with the composition Al_2O_3 + *n*% YSZ (*n* = 0, 1, 5, 10, 15 wt.%). Ammonia solution was used as a precipitating agent, with the final pH of the precipitation process maintained at ≥ 8.5.

Crystallization and subsequent formation of the powder mixtures were achieved by calcining the hydroxides in air at 1000 °C with a 2-hour holding time. The resulting powders had the composition Al_2O_3 (γ+θ modifications) + *n*% YSZ, where *n* = 0, 1, 5, 10, 15 wt.% (Fig. 1).

Powders were compacted in steel dies using uniaxial pressing at 20 MPa, followed by processing via high hydrostatic pressure (HHP) at 300 and 700 MPa. The compacts were then sintered in air at 1550°C with a 2-hour dwell time. The

resulting ceramics consisted of a two-phase composite with a trigonal α-Al_2O_3 (corundum) matrix and tetragonal t-ZrO_2 filler particles.

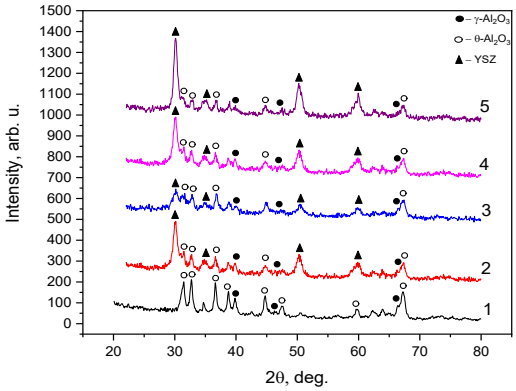

Figure 1. X-ray diffraction patterns of powder mixtures annealed at 1000 °C: 1 – γ/θ-Al_2O_3, 2 – γ/θ- Al_2O_3 + 1% YSZ, 3 – γ/θ- Al_2O_3 + 5% YSZ, 4 – γ/θ- Al_2O_3 + 10% YSZ, 5 – γ/θ- Al_2O_3 + 15% YSZ

Neutron irradiation of the synthesized α-Al_2O_3 + *n*% YSZ (*n* = 0, 1, 5, 10, 15 wt.%) ceramics was performed using the EG-5 electrostatic accelerator at the Neutron Physics Laboratory of the Joint Institute for Nuclear Research [6]. The dose of neutrons (D_n) with energy of 4.5 MeV was $2 \cdot 10^{12}$ particles/cm². Neutrons were generated using a deuterium gas target bombarded by a 2 MeV deuteron beam.

Prior to irradiation, the ceramic sample surfaces underwent grinding/polishing followed by thermal etching at 1450 °C with a 30-minute holding time to enable direct examination of the composite's surface structure immediately post-irradiation.

X-ray phase analysis revealed that neutron irradiation of the composite biphasic ceramics with the specified composition did not induce any phase transformations in either phase (α-Al_2O_3 or YSZ), regardless of the applied HHP level. The study further demonstrated that neutron irradiation did not generate macroscopic stress fields (type I stresses) on the ceramic surfaces - a phenomenon previously reported in irradiated ceramic composite systems [6]. This conclusion is supported by the unchanged lattice parameters of both phases before and after irradiation.

Analysis of the diffraction patterns indicated that at YSZ contents exceeding 5 wt.%, the diffuse background intensity in the post-irradiation diffractograms increased, suggesting enhanced defect formation within the material's structure.

However, SEM examination of the ceramic surfaces showed significant defect formation in the ZTA ceramic structure, dependent on both the applied HHP and YSZ content (Fig. 2).

SEM analysis additionally revealed a neutron irradiation-induced grain fragmentation effect in the composite ceramics with aggregate-strengthened microstructure (HHP 300 MPa), manifested through significant reduction in the

average grain size of the zirconia toughening phase within the alumina matrix. The study established that this grain refinement effect occurs exclusively in YSZ particles, while α-Al_2O_3 grains remain unaffected - a phenomenon potentially attributed to the distinct crystal lattice characteristics of α-Al_2O_3 and t-ZrO_2.

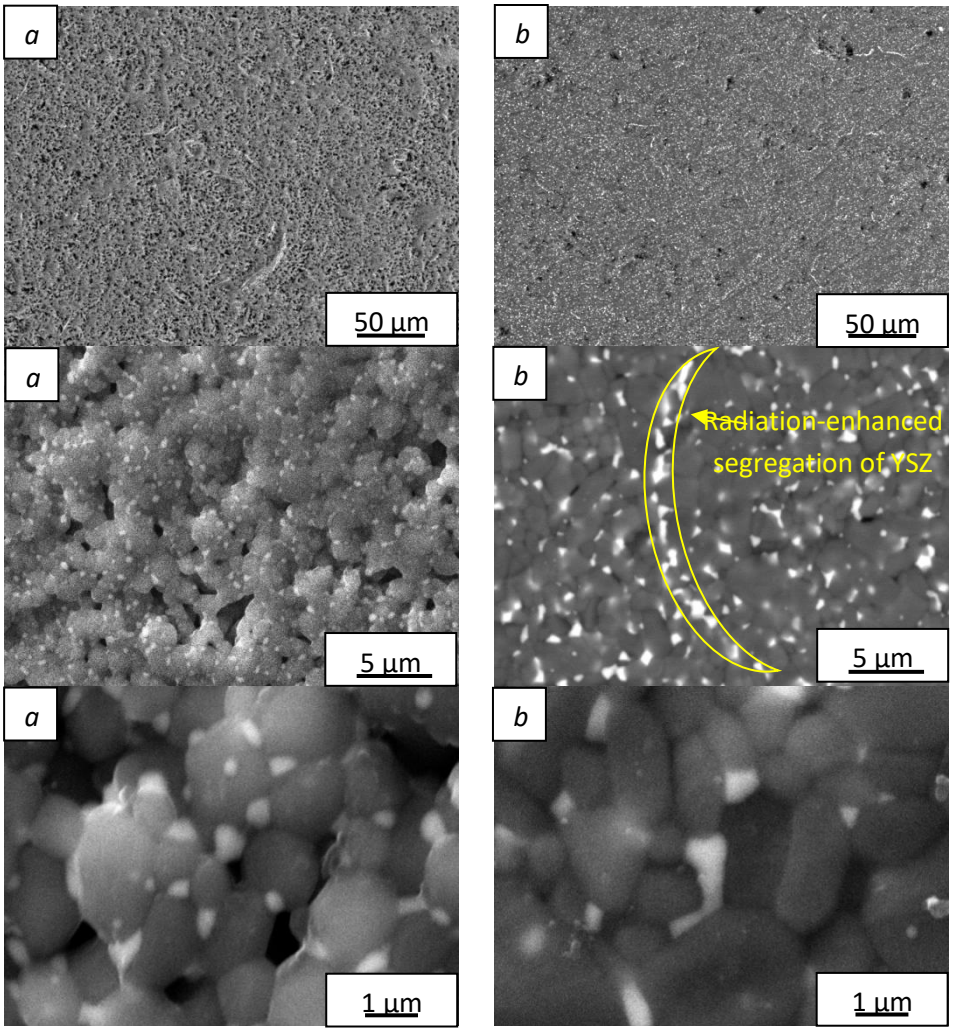

Figure 2. Surface morphology of neutron-irradiated α-Al_2O_3 + 10% YSZ ceramics processed at different HHP levels: (a) - 300 MPa, (b) - 700 MPa

In dispersion-strengthened ceramic composites (α-Al_2O_3 + *n*% YSZ, *n* = 5, 10, 15 wt.%) processed at 700 MPa HHP, neutron irradiation prompted diffusion-assisted redistribution of the dopant element, resulting in the formation of zirconia dioxide "chains" of varying lengths within the alumina matrix (Fig. 3).

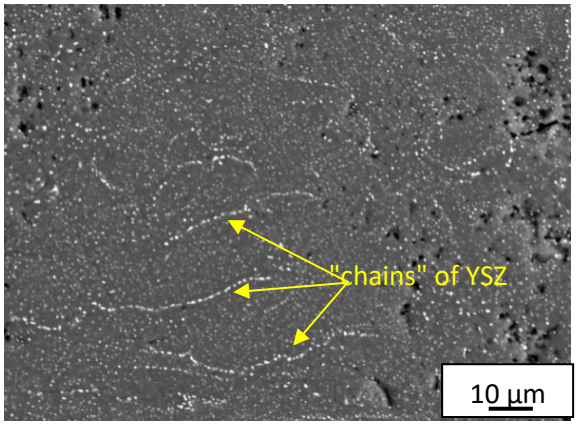

Figure 3. Surface morphology of neutron-irradiated α-Al_2O_3 + 5% YSZ ceramics processed at different HHP levels: (a) - 300 MPa, (b) - 700 MPa;

The obtained data indicate that both the aggregate-strengthened structure (HHP 300 MPa) of α-Al_2O_3 + *n*% YSZ ceramics (*n* = 0, 1 wt.%) and the dispersion-strengthened structure (HHP 700 MPa) of α-Al_2O_3 + *n*% YSZ ceramics (*n* = 5, 10, 15 wt.%) exhibit resistance to radiation-induced defect formation under neutron irradiation at a dose $D = 2\times10^{12}$ particles/cm². These research results suggest promising prospects for the application of ceramics with these specific compositions in radiation-exposed environments.

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O-13

PROTON-IRRADIATED DOX-LOADED MULTI-WALLED CARBON NANOTUBES: TOWARD SAFER CHEMOTHERAPEUTIC DELIVERY

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The clinical application of doxorubicin (DOX), a potent anticancer agent, is often restricted by its systemic toxicity. To address this limitation, multi-walled carbon nanotubes (MWCNTs) have emerged as promising nanocarriers due to their high surface area, stability, and potential for biodegradability. In this study, we explored the cytotoxic profile of DOX-encapsulated MWCNTs, both prior to and following proton irradiation at doses of 0.25, 1, and 3 Gy, using normal human fibroblast MRC-5 cells as a model system.

The surface of MWCNTs was activated through acid oxidation, leading to the formation of carboxyl (-COOH) and hydroxyl (-OH) functional groups, enhancing their dispersibility and drug-binding capabilities. Structural and chemical characterization of the resulting MWCNTs-DOX composites was conducted via X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and field-emission scanning electron microscopy (FESEM). The viability of MRC-5 cells treated with both non-irradiated and irradiated composites was assessed using the XTT assay after 24 h of exposure. Our findings indicate that MWCNT-based delivery notably mitigates the cytotoxic effects of DOX, even after exposure to proton radiation. However, radiation-induced, dose-dependent modifications in the MWCNTs' structure were observed, likely influencing functional group composition and potentially affecting composite stability and drug-carrier interactions.

These results highlight the potential of MWCNTs as protective vehicles for chemotherapeutic agents, offering a promising strategy to enhance drug safety profiles and minimize collateral damage to healthy tissues during cancer treatment.

O-14

ISOVALENT SUBSTITUTION OF OCTAHEDRAL SITES IN NaSICON COMPOUNDS: HOW ELECTROCHEMICAL PROPERTIES ARE AFFECTED

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Natrium Super Ionic CONductors (NaSICONs) are a polyanionic family of fast ionic conductors with a monoclinic crystallographic structure containing vacancies that enable the diffusion of loosely bound cations (Li^+ or Na^+) under the application of an external voltage. These materials are widely used in the field of energy storage, both as cathodic active materials in lithium-ion (LIBs) and sodium-ion batteries (SIBs) and as a solid electrolyte in all-solid-state batteries (ASSBs). Due to the limited eco-sustainability of lithium-based technology, there is a growing demand for a green transition towards sodium-based energy storage. However, sodium-based technologies still lag behind lithium counterpart in terms of performance.

Improving the ionic conductivity of the NaSICON could pave the way for an extensive adoption of the sodium technology and potentially enable the full replacement of the lithium-based counterpart, but that cannot come without a full grasp of the material. Indeed, despite long studied in the past, NaSICON still exhibits unexplained behaviors when doped especially in the octahedral site: one striking example is the 4-order-of-magnitude improvement in ionic conductivity observed in the LATP composition, when Ti is substituted with Al in a 1:1 ratio. The riddle still remained unresolved primarily due to the complexities introduced by the aliovalent substitution, which alters the ionic density as part of charge compensation mechanisms. In this work, our research group employed, for the first time, an isovalent substitution strategy to investigate the electrochemical changes in NaSICON aiming to shed light on the origins of this anomalous behavior. Possible explanations based on experimental observations and simulations are proposed and new directions for future research are outlined, contributing to a clearer and more conclusive understanding of the phenomenon.

O-15

ENGINEERING Ni–Al REACTIVE POWDERS: EFFECT OF BALL MILLING TIME AND PARTICLE SIZE ON MATERIAL PROPERTIES

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Bimetallic material systems capable of undergoing gasless self-propagating exothermic reactions (SPERs) have been widely studied due to their potential as micro- or macroscopic heat sources. Their ability to rapidly release energy on demand makes them excellent candidates for high-performance applications, including munition charges, room temperature joining of heat-sensitive components, and operations in extreme conditions. This study investigates the ball milling (mechanical activation) of nickel (Ni) and aluminum (Al) powders at a molar ratio of 1:1. By varying the low-energy ball milling duration (4–13 hours) and the starting Ni particle size (~5 μm and ~50 μm), various batches of composite particle powders were produced. The effects of these parameters on the final particle equivalent diameter (PED), specific surface area (SSA), skeletal density (SD) were examined. The PED, SSA, and SD values were determined using scanning electron microscopy, krypton (Kr) adsorption at liquid nitrogen temperature (-196 °C), and helium (He) pycnometry at room temperature, respectively. Additionally, the thermal outputs of the reactive powders were measured using differential scanning calorimetry. This work provides valuable insights into optimizing Ni-Al composite powders for enhanced performance in SPER applications.

P-1

TEXTILE DYES REMOVAL USING HYDROTHERMALLY SYNTHESIZED $LiTiO_2$

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Environmentally friendly titanium-based nanomaterials, such as layered titanates, are increasingly used in nanotechnology due to their excellent properties in the fields of metal-ion batteries, adsorption, photocatalysis, and sensors [1,2]. In order to obtain a pure $LiTiO_2$, nanoanatase powder was hydrothermally treated with 3 M LiOH solution at 120 °C for 18 h. The sample was characterized by XRPD, SEM, TG/DTA, and UV-VIS/DRS analyses. XRPD confirmed the complete transformation of the starting nanoanatase into the pure $LiTiO_2$ phase with the average crystallite size around 17 nm. According to SEM, $LiTiO_2$ nanoparticles of about 40 nm created very soft agglomerates of 2–5 μm size. The thermal stability of the obtained lithium titanate was confirmed by TG/DTA up to 400 °C. The adsorption capacity and photocatalytic activity of the $LiTiO_2$ nanopowder were tested on harmful industrial dyes. The $LiTiO_2$ nanoparticles completely adsorbed the Ethyl Violet dye within 5 min and 53.2 % of the Methylene Blue dye within 30 min. On the contrary, the same sample negligibly adsorbed the Mordant Blue 9 dye, but it photodegraded 66.2 % of this dye within 4 hours under simulated solar light. The strong adsorption power and photocatalytic activity of $LiTiO_2$ open the possibility of its multipurpose application in wastewater treatment.

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P-2

SYNTHESIS AND CHARACTERIZATION OF $Co_{0.9}Gd_{0.1}MoO_4$ NANOPOWDERS

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The glycine nitrate procedure (GNP) is recognized as the simplest and most effective method for controlling the composition and morphology during the synthesis of $Co_{0.9}Gd_{0.1}MoO_4$. This combustion process enables precise control of stoichiometry, homogeneity, and purity. In this method, metal nitrates and glycine are mixed in the correct stoichiometric ratios to produce $Co_{0.9}Gd_{0.1}MoO_4$. The samples obtained through this method were further analyzed using various characterization techniques, including Differential Thermal Analysis (DTA), X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FT-IR), Field Emission Scanning Electron Microscopy (FESEM), and nitrogen adsorption methods. The results indicated a high degree of anisotropy in the particles' shape and size, which appeared as agglomerates. Additionally, significant differences were observed in the microstructure and the formation of plate-like crystals. Notably, the color of the synthesized sample shifted from darker to lighter shades after thermal treatments. There were also marked changes in the dominant wavelength (in nanometers) and color purity between the initial sample and the sample heated to 1100 °C, primarily due to the cobalt concentration.

P-3

FACILE SYNTHESIS AND CHARACTERIZATION OF PEROVSKITE-TYPE OXIDE $Ca_{0.9}Er_{0.1}MnO_3$

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Nanostructured perovskites have attracted many researchers due to their extraordinary properties, such as piezoelectric, structural, electric, and optoelectronic properties [1]. Nanocrystalline powder with the perovskite-type oxide $Ca_{0.9}Er_{0.1}MnO_3$ was synthesized using hydrazine as a fuel and complexing agent - hydrazine nitrite procedure. Hydrazine has two free lone pairs of electrons and four exchangeable hydrogen atoms; the presence of these lone pairs allows hydrazine to coordinate with a metal ion [2]. Other chemicals used were calcium nitrate tetrahydrate $Ca(NO_3)_2{\times}4H_2O$, manganese nitrate hydrate $Mn(NO_3)_2{\times}H_2O$, and erbium nitrate pentahydrate $Er(NO_3)_3{\times}5H_2O$. Metal nitrates and hydrazine (N_2H_4) were mixed in stoichiometric ratios to obtain the perovskite crystal structure. The resulting nanopowder was calcined for 15 min at a temperature range from 800 °C to 1000 °C. The perovskite oxide $Ca_{0.9}Er_{0.1}MnO_3$ was characterized by X-ray diffraction and FTIR spectroscopy measurements.

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P-4

DESIGN OF Bi_2O_3 PROPERTIES BY BIOPOLYMER

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In the past decades, immense efforts have been made to design materials with extraordinary adsorption and photocatalytic properties. The addition of different stabilizing agents, such as environmentally friendly biopolymer chitosan, during synthesis is a novel effective approach to significantly improve properties of a material [1]. Bismuth(III) oxide is considered as an excellent candidate for water remediation, especially for photocatalytic applications due to the suitable band gap and high oxidation ability [2]. The aim of this work was to investigate the influence of chitosan as a stabilizing agent on the properties of hydrothermally synthesized Bi_2O_3.

For that purpose, $Bi(NO_3)_3 \cdot 5H_2O$ was initially dissolved in 5 mol/dm^3 HNO_3 solution, which was followed by the dropwise addition of 10 mol/dm^3 NaOH solution until pH was set to 12. Then, chitosan solution in diluted acetic acid was added and the suspension was left overnight. The resulting yellow suspension was hydrothermally treated at 120 °C for 12 h, rinsed with water and ethanol, then finally dried at 100 °C for 1 h. For a comparison, the same synthetic procedure without chitosan addition was applied to prepare the pristine Bi_2O_3. Obtained powders were characterized by XRPD, FTIR, FESEM, and EDS methods while their adsorption and photocatalytic properties were tested on toxic dyes, anionic Reactive Orange 16 (RO16) and cationic Ethyl Violet (EV).

Monoclinic α-Bi_2O_3 was obtained in the case of both samples, with negligible differences in unit cell parameters and crystallites within the range of 50−65 nm. The pristine Bi_2O_3 demonstrated low adsorption capacity towards RO16 (only 5 % of the dye was adsorbed after 1 h in the dark), but very high photocatalytic activity by degrading 95 % of this dye after 3 h under simulated solar light. On the other hand, chitosan-influenced Bi_2O_3 exhibited an extraordinary adsorption capacity by adsorbing 99 % of the RO16 within 15 min in the dark. However, both samples did not show any activity towards cationic EV dye, indicating that their surface was probably positively charged. This photocatalysis-adsorption switching revealed that the properties of a semiconductor can be tailored by the addition of biopolymer chitosan during hydrothermal synthesis.

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P-5

NOVEL MULTIDOPED SOLID IONIC CONDUCTOR BASED ON CeO_2 FOR APPLICATION AS ELECTROLYTE IN IT-SOFC DEVICES

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With progress in modern technologies, conventional methods for ceramics production are facing technical limits, therefore, some innovative synthesis procedures are needed to develop high-performance and eco-friendly materials with applications in different industries [1]. Cerium (IV) oxide (CeO_2) based ceramic materials are proven to possess several advantages over other similar heat-resistant materials, for that reason, they are considered very attractive among researchers nowadays [2]. Consequently, the application of ceria-based electrolytes in solid oxide fuel cells (SOFCs) has grown significantly, as the technology aims to deliver excellent energy outputs within an intermediate temperature range (500–800 °C), enabled by the notably high ionic conductivity of ceria at these lower temperatures [3,4]. In this study, the synthesis of CeO_2-based multidoped nanopowder by application of a time-effective, low-energy consumption, yet very simple Self-Propagation Room Temperature (SPRT) method is presented. Nanopowder of CeO_2 was doped with rare earth oxides in order to obtain a highly efficient electrolyte for IT-SOFC fuel cells. Initially, obtained nanopowder oxide, with composition $Ce_{0.8}Nd_{0.05}Sm_{0.05}Gd_{0.05}Dy_{0.01}Y_{0.02}Yb_{0.02}O_{2-\delta}$, was submitted to XRPD analysis and single phase solid solutions of fluorite structure were confirmed. Then, the sample was sintered in an air atmosphere for 2 h at 1550 °C, which induced a densification process. A rather low density value of 86 % of the theoretical value was achieved. SEM micrograph showed a highly ordered microstructure. Ionic conductivity of the sintered sample, recorded by complex impedance method, amounted to 1.03×10^{-2} $\Omega^{-1}cm^{-1}$ at 700 °C. Finally, the investigated ceramic material shows potential for

application as an electrolyte for IT-SOFC technology, though further optimization is necessary.

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P-6

ION-DOPED MESOPOROUS BIOACTIVE GLASS PARTICLES AS CIPROFLOXACIN DRUG DELIVERY VEHICLES

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In recent years, sol-gel derived mesoporous bioactive glass particles (MBGs) have gained significant attention due to their highly tunable surface properties, which allow for high surface area and large pore volume, key features for applications in regenerative medicine and drug delivery systems. The incorporation of therapeutic ions presents a promising strategy to stimulate specific biological responses and promote tissue regeneration. Additionally, the presence of dopants can influence the mesoporosity, hence affecting drug delivery performance. This study aimed to investigate the influence of binary and multi-ion doping on the surface properties and drug delivery capacity of MBGs.

A modified microemulsion-assisted sol-gel synthesis method was utilized to prepare the particles co-doped with Sr and Mg ions (denoted as SrMg-MBGs) and multi-doped with Sr,Mg,Cu,Zn ions (referred to mMBGs). The obtained particles were subsequently analyzed for their morphological and surface characteristics, and their capacity for ciprofloxacin drug loading and release. Brunauer-Emmett-Teller (BET) analysis revealed that binary doping only slightly increased volume of mesopores (V_{meso}) and micropores (V_{micro}), while multi-doping significantly increased V_{micro} and specific surface area (SSA). High-Resolution Transmission

Electron Microscopy (HR-TEM) revealed that doping significantly influences pore size and morphology. Additionally, synthesis parameters of MBGs were found to influence particle size and porosity, leading to marked increase in SSA. UV-Vis spectroscopy analysis were employed to determine drug loading capacity and release behavior, and it was found that ion-doping had a significant impact on drug loading capacity. Overall, this study highlights the potential of doped MBGNs as drug delivery systems, and underscores the need for further research into their application in targeted therapeutics.

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P-7

NOVEL Ca-Sr-Ba HYDROXYAPATITE: FROM NANOEMULSION TO DENSE BIOCERAMIC

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Hydroxyapatite (HA) is widely recognized as a promising bioceramic material for bone replacement, due to its excellent biocompatibility and chemical similarity to natural bone. However, its inherent brittleness and limited mechanical performance often restrict its broader application. Ionic substitution at the calcium sites has emerged as a powerful strategy to tailor the structural and functional properties of HA. In this study, a novel ternary-substituted hydroxyapatite with the nominal composition $(Ca,Sr,Ba)_5(PO_4)_3(OH)$ was successfully synthesized using the Ouzo nanoemulsification method at room temperature, followed by calcination at 700 °C for 3 h. X-ray diffraction confirmed the formation of a pure apatite phase,

with no secondary phases detected. The calcined powders were consolidated via spark plasma sintering, achieving theoretical density without decomposition. Microstructural analysis revealed a dense and uniform grain morphology. Assessment of mechanical properties revealed improved hardness and comparable Young's modulus relative to traditional HA. Simulated body fluid test showed that apatite precipitation occurs within 24 h. The results suggest that Sr^{2+} and Ba^{2+} co-substitution not only stabilizes the apatite phase but also enhances its sinterability and mechanical properties, while maintaining bioactivity. The ternary-substituted hydroxyapatite developed in this study shows great potential for applications in bone regeneration and implants.

P-8

APPLICATION OF FIB-SEM CHARACTERIZATION IN THE DEVELOPMENT OF PHOTOCATALYTIC MATERIALS FOR ENVIRONMENTAL REMEDIATION

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Microplastic fibers released from synthetic textiles during washing remain in various parts of the environment and pose a significant threat to aquatic ecosystems. Photocatalytic materials offer a promising solution for environmental remediation by degrading these pollutants, and focused ion beam (FIB) techniques provide valuable support in characterizing microplastic fibers and photocatalysts involved in this process. FIB is a powerful and increasingly widespread technique used for site-specific deposition, milling, cutting, imaging, and sample preparation at the micro- and nanoscale. It operates using a finely focused beam of ions, typically gallium. A typical FIB instrument features a dual- beam system that integrates both scanning electron microscope (SEM) and FIB columns, allowing complementary imaging and processing of the same region of interest. FIB systems can operate at low ion currents for high-resolution imaging or at higher currents for precise material removal, making them ideal for applications such as cross-sectioning, defect analysis and lamella preparation for transmission electron microscopy (TEM).

In this study, we show how FIB techniques support the development of photocatalysts for environmental remediation and enable precise cross-sectional observation of microplastic fibers to assess degradation effects. In one case, a TiO_2 nano-powder was too thick for TEM analysis. Using FIB, we thinned the crystals to enable detailed investigation of morphology, structure, polytypes, phases, and

stacking faults. In a second case, FIB was used to analyse photocatalytic films on substrates. In addition to cross-section analysis, FIB lamellae were prepared from hydrothermally grown TiO_2 on a titanium substrate and from ZnO nanorod arrays grown on a glass substrate. FIB enabled the precise preparation of site- specific regions for high-resolution TEM, offering valuable insights into the crystal growth and film formation processes. While nanorods are often detached and observed via TEM, this approach typically produces randomly oriented fragments that complicate structural interpretation. To overcome this, we used FIB to extract well defined sections. The empty spaces between the nanorods were filled with electron- and ion-deposited platinum to stabilize the structure during milling and lift-out. Once thinned, the lamella enabled detailed TEM analysis. This allowed us to trace the growth mechanism of the TiO_2 and ZnO film. Finally, we analyzed plastic microfibers exposed to photocatalytic degradation. After treatment, SEM images showed increased surface roughness. Furthermore, FIB prepared cross-sections of pristine and degraded fibers revealed clear internal structural damage, confirming the effects of photocatalytic degradation.

P-9

THE COLD SINTERED $BaSn_{1-x}In_xO_3$ (x = 0.00, 0.05, 0.10, 0.15 and 0.20) SAMPLES AND THEIR FUNCTIONAL PROPERTIES

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Since conventional sintering methods are characterized by high temperatures and long sintering times, recent research is focused on finding an appropriate sintering method that would enable the production of dense ceramics with significant energy savings. The cold sintering (CS) technique is characterized by the addition of the liquid phase as the transient solvent which allows a densification process at temperatures below 300 °C in a short sintering time. In the case of conventional sintering of the barium stannate ($BaSnO_3$, BSO) ceramics, doping with In^{3+} can promote the sintering process at lower temperatures.

The aim of this work was to investigate the cold sintering technique for the preparation of dense indium-doped $BaSnO_3$ ceramics with the composition $BaSn_{1-x}In_xO_3$, BSIO (x = 0.00, 0.05, 0.10, 0.15 and 0.20).

BSIO ceramic samples with a density above 89 % were obtained at 300 °C for 3 h with a heating rate of 2 °C/min at 670 MPa using 10 wt% of KOH/NaOH hydroxide mixture as the transient liquid phase. XRD analysis revealed that all samples have cubic $BaSnO_3$ phase as a dominant phase, and $BaCO_3$ and SnO_2 as a secondary phases. FESEM analysis confirmed the dense microstructure of all BSIO ceramic samples. The undoped sample showed the highest conductivity of 6.84×10^{-4} S/cm in wet Ar at 650 °C, while doping with In decreased the conductivity of ceramics. The water vapor sensing properties of the sample with 5 mol% at 650 °C in the 10^5–10^6 Hz frequency range showed the maximum response value ~1.2.

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P-10

OPTIMIZING COLD SINTERING CONDITIONS FOR DENSE YTTRIUM MANGANITE CERAMICS

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Hexagonal yttrium manganite ($YMnO_3$) is a multiferroic material exhibiting both ferroelectric and antiferromagnetic properties. This coexistence allows for the possibility of magnetoelectric coupling, where magnetization can potentially be controlled by an electric field, and electric polarization can be influenced by a magnetic field. However, the application of this ceramic material is limited by the appearance of microstructural defects, such as microcracks and inter- and intragranular pores, which appear during the cooling phase following high sintering temperature.

Cold sintering is a relatively novel sintering technique that allows densification of ceramics at significantly lower temperatures (usually below 300 °C), using a transient liquid phase, typically water or another solvent, under uniaxial pressure.

The presented results show the influence of different conditions of the cold sintering method on the densification and microstructure of $YMnO_3$ ceramics. Yttrium manganite powders were synthesized using the sol-gel, polymerization complex method from citrate precursors, and then calcinated at 900 °C for 10 h. After that, the powders were used for cold sintering under different conditions, where the rates of heating and applying pressure, duration of the process, and liquid phase amount were varied. The structural properties of $YMnO_3$ sintered samples were examined by XRD analysis while scanning electron microscopy (SEM) was used to assess their microstructural properties.

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P-11

EFFECT OF SINTERING TEMPERATURE ON THE COLOUR VARIATION OF ANDESITE BASALT CERAMICS

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This study examines the effect of sintering temperature in the air on the colour variation of ceramics produced from andesite basalt aggregate. Research has shown that a slight variation in sintering temperature by 10 °C, within the range of 1040 to 1080 °C, while maintaining a constant sintering duration of 60 min, results in noticeable colour variations in the sintered ceramic samples. After sintering and prior to analysis, the sintered samples were prepared using a standard method that included wet grinding with silicon carbide sandpaper of grit sizes P240, P400, P800, and P1200, followed by polishing with 1 μm diamond paste on a laboratory grinding and polishing device (Beta Grinder/Polisher, Buehler). Besides visual assessment, colour variations can be measured using colour classification systems, such as the CIELAB colour space, which is standardised by the International Commission on Illumination (*Commission Internationale de l'Éclairage - CIE*). The CIELAB system defines colour based on three parameters: L^* representing lightness, a^* indicating red-green intensity and b^* denoting yellow-blue intensity. The sintered samples were analysed using a spectrophotometer (Shimadzu UV-2600) to measure diffuse reflectance in the 380–720 nm range, with a step size of 1 nm. Due to its outstanding physical properties and distinctive reddish-brown colouration, the polished sintered ceramic, processed at 1060 °C for 60 min, is highly suitable for producing of floor and wall tiles in the construction industry.

P-12

A CHRONOPOTENTIOMETRIC EXAMINATION OF Co-DOPED HETEROPOLY ACID AND ITS BRONZE

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To synthesize a new electrode material, the heteropoly salt was heated to 650 °C [1]. This salt was obtained by doping $H_3PW_{12}O_{40}\times 29H_2O$ (heteropoly acid) by $CoCl_2$ [2]. Chronopotentiometry in a 6 M aqueous $LiNO_3$ solution was used to examine heteropoly salt and its bronze to simulate a battery. The heteropoly salt collapsed during the charge process; however, its corresponding bronze was stable over the charging and discharging. The bronze was examined using three rates of 1000, 2000 and 3000 mA/g. The capacity obtained for the lowest rate of 1000 mA/g was ~28 mAh/g, while its stabilization was achieved after the tenth cycle yielding a capacity of ~13 mAh/g. Taking into account the high current densities applied, this material has a potential for a higher capacity under the application of lower current densities.

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P-13

POLYCRYSTALLINE AND EPITAXIAL THIN FILMS OF $La_{1-x}Na_xMnO_3$

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The renewed interest on doped-manganites came from the observation of a high magnetoresistive effect, designed as "colossal" (CMR), which triggered the attention of the scientific community both for fundamental research and for applicative possibilities [1]. The research efforts during last 10 years have pointed out the role played in the manganites by the different oxidation states, 3+ and 4+, of the manganese ions [2]. The so-called double exchange transfer via oxygen anions, is responsible for the appearance of ferromagnetism, metallic conductivity, and colossal magnetoresistance.

Polycrystalline and epitaxial thin films of $La_{1-x}Na_xMnO_3$ (x = 0; 0.05; 0.10; 0.15; 0.30) were prepared by spin coating technique on various substrates (Si, Si/Pt and $SrTiO_3$ (100)) from acetate solution. XRD analysis showed a slight shift in the peaks` positions towards high 2θ, revealing the incorporation of Na ions ($x \leq 0.10$) in the structure of $LaMnO_3$. FE-SEM, AFM, and Raman spectroscopy analyzed the films' structure. The structure and morphology of the films were examined and correlated with sheet resistance and magnetic properties, considering the type and thickness of the films.

Acknowledgement: financial support of project program of the Science Fund of the Republic of Serbia (Grant no. 7383, Project - PROMTEH).

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P-14

UNVEILING THE ENERGY LANDSCAPE OF $Cr_3Si_3N_8$ THROUGH A MULTI-METHODOLOGICAL APPROACH

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A multi-methodological approach, combining Global optimization, Data mining, and the Primitive Cell for Atom Exchange (PCAE) method, was used to investigate the $Cr_3Si_3N_8$ compound. Global optimization generated multiple structural candidates which were refined using *ab initio* calculations, yielding eight distinct phases. Unlike the previously investigated Cr_2SiN_4 and $CrSi_2N_4$ [1,2], where data mining identified multiple candidates along with the global minimum, this $Cr_3Si_3N_8$ yielded only a single structure - the Li_2ZnTiO-type.This structure ranked lowest with the GGA-PBE functional but showed slight improvement with DFT-LDA calculations. The PCAE method also identified one additional candidate, bringing the total to ten promising structures, with the global search directly identifying the global minimum. Additionally, to examine the behavior of these phases under high-pressure conditions, values for bulk modulus, volume, total energy, and Gibbs free energy were calculated at pressures up to 10 GPa. Due to the lack of experimental data, two functionals were used to ensure the qualitative validity of the results. These findings provide a comprehensive understanding of the $Cr_3Si_3N_8$ compound and suggest that the identified structure may serve as a promising candidate for future experimental studies and applications.

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P-15

MODELING OF MULTICOMPONENT RARE EARTH COMPOUNDS: ENERGY LANDSCAPE EXPLORATION, STRUCTURE PREDICTION, AND ELECTRONIC PROPERTIES CALCULATION

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The discovery and characterization of new rare earth compounds and their modifications are important for advancing applications in electronics, energy storage, catalysis, biomedical technologies, and many other fields. Modern approaches to their identification increasingly integrate theoretical predictions with experimental efforts, enabling the discovery of novel phases and calculation of their electronic, magnetic, and other properties without relying solely on experimental methods.

In this work, we conduct a comprehensive theoretical investigation of three rare earth compound systems – lanthanum oxyiodide (LaOI) [1], holmium fluoride selenide (HoFSe), and lanthanum fluoride sulfide (LaFS) – by exploring their energy landscapes using global optimization techniques. For each system, periodic simulation cells containing varying numbers of formula units (e.g., 1, 2, 3, 4, 6, 8, 12, and 16) were subjected to simulated annealing with empirical potentials under different pressures (from 0 to 100 GPa), which yielded more than a million candidate structures per system. These candidates were subsequently classified based on ground state energy, frequency of occurrence, and symmetry. Complementary to this approach, data mining and machine learning methods were employed, enhancing the identification and categorization of promising candidate structures.

The most promising candidates were subjected to local optimization using density functional theory (DFT) with different exchange-correlation functionals (notably GGA-PBE and HSE06) as implemented in CRYSTAL17, Quantum ESPRESSO, and VASP software packages. Energy vs. volume (E(V)) curves were computed and detailed structural and crystallographic analysis was performed for the most energetically favorable modifications. In order to investigate the thermodynamic stability of these structures, the enthalpy vs. pressure (H(p)) curves

were computed, and finally, the electronic properties (band gap and band structure) were calculated for the selected structures using DFT calculations.

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P-16

EXPLORING THE STRUCTURAL DIVERSITY AND ENERGY LANDSCAPE OF $CrSi_2N_4$

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The energy landscape of $CrSi_2N_4$ was explored using Global optimization, Data mining, and the Primitive Cell for Atom Exchange method (PCAE), generating ten promising structural candidates [1]. Similar to the previously investigated Cr_2SiN_4 system [2], data mining identified the global minimum ($TiMn_2O_4$ structure type) with the lowest energy, confirmed using both, the GGA-PBE and LDA-PZ functionals. Seven other favorable modifications were found through global optimization, and one each through data mining and the PCAE. Decomposition into CrN, Si_3N_4, and N_2 was also analyzed, revealing that the global minimum phase remains stable at low temperatures. Due to the absence of experimental data, two functionals were employed to validate the energy rankings and structural predictions, demonstrating strong agreement. These results suggest the identified candidates are likely (meta)stable phases of $CrSi_2N_4$, offering promising targets for future experimental synthesis and further studies on their properties and applications.

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P-17

THEORETICAL INSIGHT INTO STRUCTURAL AND MECHANICAL FEATURES OF $Hf_{0.5}Ta_{0.5}C$

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Tantalum carbide (TaC) and hafnium carbide (HfC), as well as mixed hafnium tantalum carbides, are of great recent scientific and industrial interest due to their structural features, and thermal, elastic, and mechanical properties. In order to identify the possible crystal structure candidates in the $Hf_{0.5}Ta_{0.5}C$ system that are (meta)stable for different pressures, a global search was performed on the energy landscape of the system. The structure candidates obtained were further locally optimized on the DFT level, and the relaxed structures were crystallographically analyzed and compared. As a result, the experimentally observed rock salt phase was found as a global minimum, and an additional dozen feasible modifications of $Hf_{0.5}Ta_{0.5}C$ were predicted. Besides the experimentally observed NaCl-type structure, various distorted versions of this structure type were found, as well as modifications exhibiting the NiAs-, ortho-, and 5-5-type of structure. Furthermore, mechanical properties including bulk, shear, Young's moduli, elastic constants, and the Vicker´s hardness were computed for all promising predicted structure candidates. We believe that the present results will help in understanding the structure-property relationship in mixed HfC/TaC systems.

P-18

ENERGY LANDSCAPE OF GLUTAMINE (L) ON Au / Ag / Cu DOPED TiO_2 SURFACES AND POTENTIAL BIOMEDICAL APPLICATIONS

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A better understanding of the molecular inorganic-organic interactions in biological environments is of key importance for understanding physiological processes, and the safe application of medical implants, medicaments, drug delivery systems, etc. In this study, Glutamine (L) was selected as the model molecule for the investigation of inorganic-organic interactions due to its important role in cancer metabolism - it serves as an alternative to glucose for fueling the tricarboxylic acid (TCA) cycle in cancer cells, with many tumor cells relying on extracellular glutamine for survival [1,2], while one of the inorganic materials that show antitumor properties is titanium dioxide, and Au / Ag / Cu doped TiO_2 particles showed toxic effects on several cancer cell lines. To simulate the interactions between nanoparticles and an amino acid molecule in a vacuum, we constructed systems with different glutamine conformations onto 2D slab surfaces of anatase TiO_2, oriented along the (001) and (101) planes, both in their pristine form and doped with Au, Ag, or Cu. *Ab initio* calculations were performed using Density Functional Theory (DFT) with the LDA and GGA-PBE functionals, employing two different computational codes-CRYSTAL17 and Quantum Espresso [3]. To optimize the search for low-energy configurations of molecule on ceramic-type surfaces, we implemented an iterative approach that alternated between doped and undoped surfaces, which proved to be highly efficient for identifying stable structures in inorganic–organic systems of this nature. We observed 3 different types of molecule adsorption on the surfaces - the physical interaction, chemical interaction, and breaking up of a molecule/separation of H atoms from a molecule, with significant deformations. The presented results can contribute to general investigations of biomolecules on metal-oxide surfaces, as well as to the potential design of new anticancer materials and drug delivery systems, nanoscale

therapeutics, environmental remediation, catalytic, and corrosion-resistant materials [3].

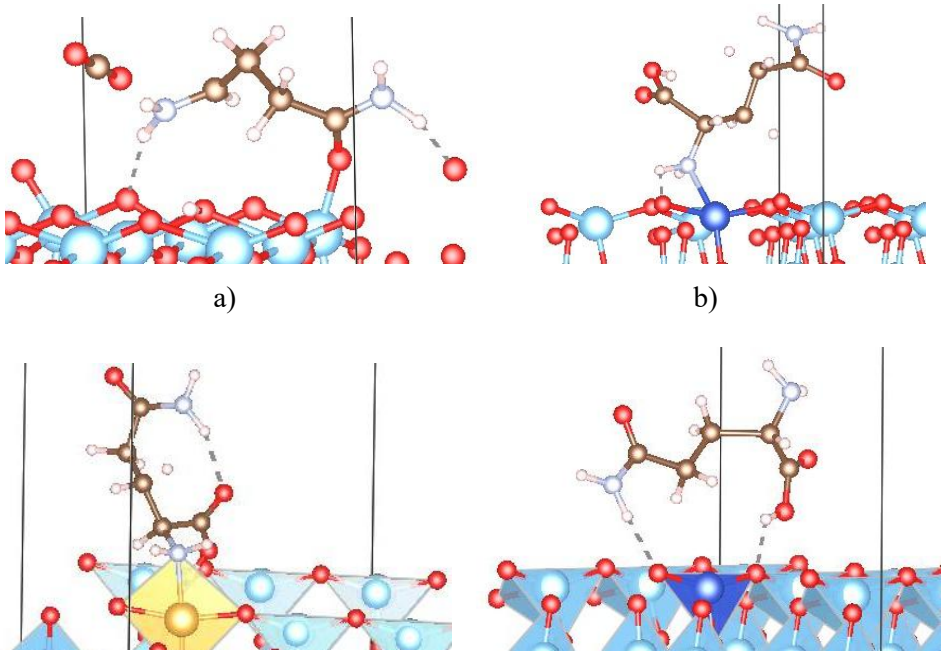

Figure 1. Presentation of dominant interactions in this study between (metal atoms in) the various undoped and doped anatase slab surfaces (a (001), and b–d (101) surface orientation) and molecule's: a) amino, amide, and carboxyl groups, with specific denaturation of carboxyl group-linear chain; b) direct interaction with dopant atom and separation of hydrogen atoms of the molecule; c) round-like shape deformation of molecule and separation of hydrogen atoms, and d) heart-shaped deformation of the molecule, with carboxyl and amide group interactions (visualized by Vesta program) [3].

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P-19

SILVER-DOPED BISMUTH FERRITE: ENHANCED MAGNETIZATION AND THEORETICAL PREDICTIONS OF NOVEL PEROVSKITE PHASES

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In this study, we present the hydrothermal synthesis of ultrafine nanopowders of pure $BiFeO_3$ (BFO) and Ag-doped $Bi_{1-x}Ag_xFeO_3$ (x = 0.01, 0.02). X-ray diffraction confirms that all obtained samples crystallize in the *R3c* space group. To further investigate structural stability, bond valence calculations (BVCs) were employed, predicting several viable perovskite structures and shedding light on the structural transformations induced by Ag incorporation. Magnetization studies indicate that while the Néel temperature remains unchanged at T = 630 K across all compositions, silver doping leads to an increase in both magnetization magnitude and irreversibility, indicative of weak ferromagnetic behavior. Density functional theory (DFT) calculations support this experimental observation, suggesting that Ag substitution perturbs magnetic interactions between Fe atoms, thereby enhancing magnetization. Additionally, electronic and magnetic properties were studied for all phases predicted by the BVCs study. DFT predicted half-metallicity in the γ phase of BFO, which may be of great interest for further study and potential applications.

P-20

DENSITY FUNCTIONAL THEORY STUDY OF LANTHANUM STRONTIUM MANGANITE

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Lanthanum strontium manganite ($La_{1-x}Sr_xMnO_3$, LSMO) is extensively researched as a perovskite oxide due to its compelling combination of structural, electronic, and magnetic characteristics, which are greatly influenced by the concentration of Sr doping. Replacing La^{3+} with Sr^{2+} introduces hole carriers into the Mn 3*d*–O 2*p* hybridized bands, resulting in significant changes to the material's electronic structure and magnetic interactions. These changes permit phenomena like colossal magnetoresistance and adjustable metal-insulator transitions, rendering LSMO an attractive prospect for spintronic and magnetic sensor technologies. In this research, density functional theory (DFT) is utilized to methodically explore the effects of A-site doping in LSMO at varying levels of Sr concentration. Applying the plane-wave pseudopotential method within the generalized gradient approximation (GGA) framework, and incorporating Hubbard U corrections to account for the strongly correlated Mn 3*d* electrons, the variations in lattice parameters, electronic band structure, density of states (DOS), and magnetic ordering were evaluated. Research offers a comprehensive understanding of how electronic and magnetic properties evolve with doping in LSMO, providing insights into the core mechanisms influencing its behavior.

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P-21

SYNTHESIS AND CHARACTERIZATION OF CARBON CRYOGEL/MULTI-WALLED CARBON NANO TUBES COMPOSITE

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In this study we investigated the possibility to incorporate multi-walled carbon nano tubes (MWCNTs) into the carbon cryogel matrix in order to enhance the structural, textural, and adsorptive properties of the carbon cryogels. Composites with different weight percentage of MWCNTs (1, 3 and 5%) were synthesized by sol-gel method, followed by freeze-drying and carbonization. The obtained materials were characterized using nitrogen adsorption-desorption measurements and field emission scanning electron microscopy. Also, point of zero charge (PZC) was determined. The application of composite in water purification processes will be investigated in batch adsorption experiments.

P-22

ADSORPTION OF As^{3+} CATION IN A BATCH SYSTEM BY BENTONITE AT pH 3.5 IN SHORT TIME INTERVALS

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Due to its large specific surface area, bentonite is known as a good metal cations adsorbent. The adsorption capacity, in addition to the mineral itself, also depends on the nature of the metal cation, its charge, and ionic radius. Apart from these well-known factors, it can also largely depend on various physicochemical parameters such as pH value. In this regard, the results of the adsorption of As^{3+} cations in a batch system using bentonite clay at pH 3.5 for a total duration of 2 h are presented. The results of this adsorption were compared with the adsorption results of other natural materials such as granular activated carbon (GAC) and zeolite. The amount of adsorbed As^{3+} cations was determined by inductively coupled plasma optical emission spectroscopy (ICP-OES). The obtained results show that the concentration of As^{3+} cations in the solution decreases over a time, which confirms their adsorption by bentonite. This trend is also observed with the samples used for comparison. During the observed time, the majority of the adsorption process for bentonite and GAC occurs within the first 45 min. Unlike them, zeolite achieves significant adsorption (19.5%) within the first 10 min. After 1 h, bentonite adsorbed 4% of As^{3+} while GAC and zeolite adsorbed 10% and 25%, respectively. At the and of adsorption experiment materials have adsorbed 6.5%, 14 % and 26.5%. The study demonstrated that bentonite exhibits the lowest adsorption capacity at pH 3.5. In this case, its low efficiency is attributed to its chemical instability in acidic conditions, resulting in the formation of $H_2AsO_4^-$ anions in an aqueous oxidative (oxygen-rich) environment. Bentonite is not a suitable choice for the adsorption of As^{3+} cations from solutions that are acidic to this extent.

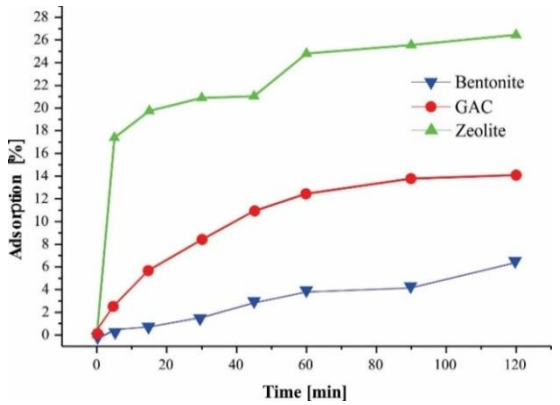

Figure 1. Adsorption of As^{3+} cations by natural materials

P-23

DEVELOPMENT OF A BIOPOLYMER-BASED BIOPESTICIDE WITH *AILANTHUS ALTISSIMA* EXTRACT FOR SUSTAINABLE CONTROL OF *LYMANTRIA DISPAR* IN FOREST ECOSYSTEMS

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This work presents the development of a novel biopesticide formulation based on natural biopolymers (chitosan and gelatin) and plant extract from the invasive species *Ailanthus altissima*. The use of this extract is economically and environmentally justified, as it supports sustainability by utilizing a widespread weed. A key challenge with plant-based biopesticides is the instability of active compounds when exposed to environmental factors. This was overcome by incorporating the extract into a chitosan-gelatin biopolymer matrix, both of which are GRAS (*Generally Recognized as Safe*)-certified by the FDA (*Food and Drug Administration*). The resulting formulation enables controlled release and prolonged activity of the bioactive compounds. Laboratory testing against the spongy moth (*Lymantria dispar* L.) showed improved efficacy compared to the pure extract. Since *A. altissima* extract is not commercially available and such a formulation has not been previously tested for spongy moth control, this approach offers an innovative, non-toxic, and eco-friendly alternative with great potential for forest pest management.

P-24

FUNCTIONALIZED ACTIVATED CARBON SPHERES FOR ENHANCED WATER DECONTAMINATION

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The presence of emerging pollutants in aquatic environments is increasing rapidly, posing serious threats to ecological systems. This study targets several such contaminants, including organic dyes (Crystal Violet, Methylene Blue), heavy metals (uranium and thorium at elevated concentrations) and pharmaceutical compounds (paracetamol and tetracycline), by employing activated carbons, known for their porous structure and high specific surface area [1].

Key parameters affecting the adsorption of these pollutants, using oxidized activated carbon spheres (~400 μm in diameter) and powders (<50 μm) derived from them, were investigated. The activated carbon spheres were functionalized through oxidation in 8M nitric acid (HNO_3), introducing carboxyl groups onto their surface [2]. These oxidized spheres were characterized using a range of analytical techniques, including Gas Sorption Analysis, Fourier Transform Infrared Spectroscopy (FTIR), X-ray Photoelectron Spectroscopy (XPS) and Scanning Electron Microscopy (SEM). Experiments were conducted to examine the effects of contact time, temperature and various aquatic environments (deionized water, seawater and groundwater) on adsorption performance. Pollutant concentrations for organic dyes and pharmaceutical compounds ranged from 1–200 ppm, using 25 mL of solution and 10 mg of adsorbent material (S_{BET} = 1308 m²/g) per experiment [3]. For heavy metal adsorption, solutions with concentrations between 10^{-3} and 10^{-5} mol/L were tested using 10 mL of solution and 20 mg of either spheres or powders.

Across all trials, the powders consistently demonstrated high adsorption efficiency - reaching up to 95% within the first 30 minutes in contact time experiments. In contrast, the adsorption plateau for the spheres ranged from 3 to 7 days, depending on the pollutant. These findings underscore the importance of external surface area in adsorption performance and highlight the potential of modified activated carbon materials for effective water purification.

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P-25

WASTE SLAG FROM LIGNITE COMBUSTION AS AN ADSORBENT FOR THE REMOVAL OF ETHYL XANTHATE FROM WASTEWATER OF THE FLOTATION PLANT FOR COPPER ORE AND PRECIOUS METALS PROCESSING IN BOR

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The waste slag generated from lignite combustion at Valjevo heating plant and Kostolac thermal power plant represents a serious ecological hazard, therefore, it is crucial to find its new utility value and return it into the reuse streams in accordance with circular economy concepts. This study examines two types of waste slags as potential adsorbents for removal of ethyl-xanthate from industrial wastewater [1–3]. Samples of wastewater were obtained from the Bor copper mine flotation tailings. Quantity of 10 mg waste slag was added to 50 cm^3 of wastewater sample for each of the waste slag types. Adsorption was observed during a period of 24 h at 25 °C at pH 10. As a reference sample, an aqueous solution of ethyl – xanthate was used, at a fixed concentration of 21 mg/dm^3 for both types of waste slag as adsorbents. The obtained results showed that both waste slags are suitable for ethyl - xanthate removal from copper mine tailings. Given their respective removal efficacies of 75 % (slag from Valjevo) and 81.5% (slag from Kostolac) during 24 h, it was concluded that waste slag from Kostolac power plant was a more efficient adsorbent for ethyl – xanthate removal from flotation tailings. It was noted, that both types of waste slag were efficient adsorbents for ethyl – xanthate removal where 250 g of waste slag succeeded in purifying about 1000 liters of mine wastewater. Therefore, we suggest both types of waste slag are suitable materials for ethyl – xanthate removal.

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P-26

SHUNGITE AS AN ENVIRONMENTALLY RELEVANT MATERIAL AND ITS STABILITY UNDER pH VARIATIONS

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Shungite, a naturally occurring carbon-rich material, was evaluated for its stability and surface charge behavior under varying pH and ionic strength conditions to assess its potential for environmental applications. It originates from Precambrian metamorphosed sedimentary rocks, primarily near the village of Shunga in the Trans-Onega region of Karelia, Russia [1]. The sample used in this study was obtained from the Zazhoginskoe deposit near the village of Tolvuja, the largest industrial source of shungite. Shungite has been explored for various applications, including its use as a rubber filler, water treatment adsorbent, composite component, binder, radiation shield, photocatalyst, and Li-ion battery anode material [2]. Due to its low dispersity and predominantly closed porosity, raw shungite is a relatively poor adsorbent. However, its surface, characterized by both hydrophilic/hydrophobic and acidic/basic functional groups, makes it amenable to physical and chemical modification to enhance its performance [3]. Shungite demonstrated notable stability in neutral to mildly acidic environments, suggesting its potential for use in water treatment and environmental remediation. However, substantial pH shifts in highly acidic or basic media revealed its reactivity, which could be either advantageous or limiting, depending on the application. The point of zero charge (pHpzc), determined using 0.1–0.001 M KNO_3, was identified as a key parameter influencing adsorption behavior. The pH_{pzc} of the shungite was found to be 6.46. The results indicated that for initial pH values lower than 7, the surface of shungite has a positive charge; for initial pH values between 7 and 9, the surface is neutrally charged; and for pH values higher than 9, the surface possesses a negative charge. As ionic strength decreased, pH values shifted toward neutrality, providing insights into shungite's surface interactions under variable environmental conditions. A short plateau length indicates weak buffering properties of the tested material. These findings underscore the importance of further stability testing and support the case for surface modification to enhance shungite's performance.

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P-27

INDUSTRIAL WASTE AS A RESOURCE IN ASPHALT PRODUCTION AND ROAD ENGINEERING

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The growing accumulation of industrial waste poses serious environmental and economic challenges. Among these materials, waste enamel - a byproduct of the ceramics and metal coating industries - offers significant potential for reuse. A potential solution is its integration into construction materials, particularly asphalt mixtures [1, 2]. The potential application of industrial waste enamel as a replacement for conventional filler in asphalt mixtures was evaluated through a series of mechanical tests. Two asphalt mixtures were designed - one using standard stone dust and another incorporating waste enamel as a filler. Both mixtures were subjected to volumetric and mechanical testing, including bulk density, stability and flow at 60 °C, void content, stiffness modulus, and Marshall characteristics, following SRPS EN standards [3]. The obtained results show that the asphalt mixture with waste enamel exhibited similar or slightly improved mechanical properties compared to the reference mixture. This suggests that waste enamel can be used as a viable alternative to traditional fillers in asphalt production, offering potential economic and environmental benefits through the utilization of industrial byproducts. Further research should explore variations in enamel content and long-term performance to optimize its implementation in road construction.

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P-28

UNDERSTANDING THE IMPACT OF TECTONICS ON THE FORMATION OF ZLATOKOP ZEOLITE AS AN ECOLOGICAL RAW MATERIAL

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Zeolites, due to their characteristics, are among the most useful ecological raw materials, widely employed as adsorbents and ion exchangers. They also play an important role in industries such as oil refining, water treatment, and electrochemical sensing of heavy metal ions [1,2]. Their mineralogical composition significantly influences their quality and suitability for various applications. However, the mechanisms underlying the formation of zeolites, as well as the connection between their formation process and mineralogical composition, remain incompletely understood. This paper provides a possible explanation for the conditions of zeolite formation, using the Zlatokop deposit as an example. The Zlatokop deposit is one of the most significant deposits of natural zeolites in Serbia, characterized by zeolitic tuffs of Miocene age, which are incorporated into the lacustrine series of marls [3]. The aim of this research was to achieve a better understanding of the conditions in which the deposit was formed, based on field kinematic analysis utilizing fault-slip inversion to derive paleostress regimes and study the deformation phases that control the formation of the Vranje Basin and volcaniclastics associated with andesitic magmatism. Additionally, this research includes X-ray powder diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR) analyses of zeolite samples, through which the connection between zeolite quality and formation processes can be elucidated. Considering the wide range of applications for zeolites, particularly for environmental purposes, it is essential to understand all the factors influencing their properties that make them highly suitable for diverse applications.

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P-29

ACTIVATED CARBON FROM BLACK ALDER CONE-LIKE FLOWERS FOR MICROCYSTIN-LR REMOVAL

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Cyanobacterial blooms pose a significant threat to water quality, particularly through the release of harmful toxins known as cyanotoxins. Among them, microcystins (MCs), especially microcystin-LR (MC-LR), are the most toxic and frequently detected variants. Due to the harmful nature of MC-LR, the International Agency for Research on Cancer (IARC) has classified this cyanotoxin as carcinogenic to humans [1]. There is growing interest in low-cost, sustainable adsorbents derived from natural materials for its removal. Activated carbon is well-known as an effective adsorbent for microcystins [2]. Activated carbon synthesized from the cone-like flowers of Alnus glutinosa (black alder) (A_AC) has been investigated for its efficiency in removing MC-LR from aqueous solutions. Previous research has already demonstrated this material's high efficacy in experiments targeting cyanobacteria removal [3]. In the present study, A_AC achieved over 90% removal efficiency of MC-LR under optimized conditions. The results confirmed its high adsorption capacity and effective performance, indicating that black alder-derived activated carbon is a promising material for the simultaneous removal of cyanotoxins and cyanobacteria. This study highlights the potential of lignocellulosic biowaste as an environmentally friendly and cost-effective solution for mitigating the impacts of cyanobacterial blooms in freshwater systems.

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P-30

ELECTROCHEMICAL SYNTHESIS OF NANOTUBULAR TiO_2 ON Ti-6Al-4V IN DEEP EUTECTIC SOLVENT: FLUORIDE-FREE AND FLUORIDE-ASSISTED APPROACHES

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This study presents a novel approach for the formation of nanotubular TiO_2 layers on Ti-6Al-4V substrates via anodic oxidation in a deep eutectic solvent (DES) based on Ethaline. The electrochemical process was conducted both without and with small additions of NH_4F to investigate the influence of fluoride ions on the nanotube formation. Remarkably, our results demonstrate that a well-defined nanotubular structure can be obtained even in the absence of fluoride additives, a phenomenon not commonly observed in conventional anodization processes. The etching mechanism in pure DES led to the formation of a microstructured porous layer embedded with nanotubular architecture, whereas the addition of NH_4F significantly intensified the etching process, promoting the growth of more defined nanotubular features (Fig. 1).

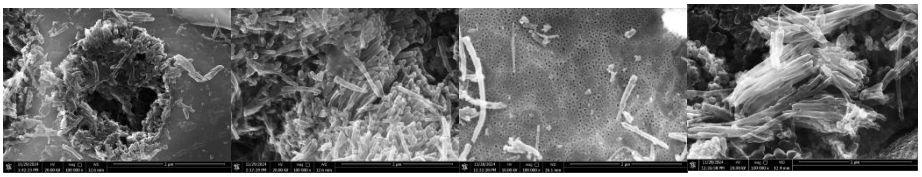

Figure 1. SEM images of nanotubular TiO_2 on Ti-6Al-4V surfaces after processing in DES

The synthesized TiO_2 layers were characterized in terms of their morphology, composition, and functional properties. Corrosion resistance tests revealed that the obtained TiO_2 layers provided superior protection compared to the naturally occurring oxide layer on Ti-6Al-4V, indicating the potential for biomedical and other applications where enhanced durability is required. Furthermore, the nanotubular TiO_2 structures exhibited enhanced photocatalytic and electrocatalytic activity, which could be beneficial for applications in energy conversion and environmental remediation. This study highlights the feasibility of using DES as an alternative and environmentally friendly electrolyte for the synthesis of functional TiO_2 layers, paving the way for fluoride-free anodization techniques in surface engineering.

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PHOTOCATALYTIC PERFORMANCE OF RARE EARTH-DOPED $BiVO_4$

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Rare earth-doped bismuth vanadate ($BiVO_4$) has emerged as a promising material for various optoelectronic and photocatalytic applications due to its unique structural, optical, and electronic properties. The doping of rare earth elements into $BiVO_4$ modifies its electronic structure, which can lead to enhanced photocatalytic efficiency. This research explores the effects of La, Ce, Eu, and Gd doping on the structure and photocatalytic performance of $BiVO_4$. Synthesis, characterization, and performance metrics of rare earth-doped $BiVO_4$ are presented in the study. The influence of doping concentration and rare earth ion type on the material's properties and performance is discussed. Additionally, the challenges and future prospects for improving the efficiency and stability of rare earth-doped $BiVO_4$ are highlighted.

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ELECTROCATALYTIC PERFORMANCE AND STRUCTURAL FEATURES OF A Pd-DECORATED MULTIPHASE COMPOSITE ELECTRODE

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This study investigates the one-step synthesis and characterization of a palladium (Pd)-decorated multiphase composite ($TiN/Ti_{1.886}O_3/MgTiO_3/Mg_2TiO_4$), denoted as Pd@MPC. X-ray diffraction (XRD) analysis confirms the presence of TiN, a highly conductive ceramic, which enhances the electron conductivity of the composite, while the inclusion of magnesium titanium oxides ($MgTiO_3$ and Mg_2TiO_4) provides structural robustness and improved corrosion resistance. These properties make Pd@MPC a promising electrode material for electrochemical sensors, where long-term stability and reliable performance are essential. XRD results further indicate that Pd nanoparticles do not significantly alter the bulk structure of the composite but rather enhance its surface properties, thereby preserving structural integrity while improving catalytic activity.

Scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX) analyses corroborate the XRD findings. The observed granular morphology suggests a high surface area, crucial for electrocatalytic performance, while the smooth surface of the Pd-decorated composite indicates a uniform distribution of Pd nanoparticles. This uniformity plays a key role in enhancing electrochemical detection of pesticides such as dicamba (DIC) and 2,4-D by facilitating electron transfer kinetics, increasing the number of active catalytic sites, and improving overall electrochemical response. EDX analysis confirms the successful incorporation of Pd, with a relatively high content (8.1%), further reinforcing its catalytic efficiency in oxidation reactions.

Electrochemical performance was evaluated using the Pd@MPC/GC electrode in a $K_4[Fe(CN)_6]$ redox system, demonstrating superior electrocatalytic activity compared to a commercial glassy carbon electrode. The composite was tested as a voltametric sensor for determination of DIC and 2,4 D pesticides. Oxidation peaks for DIC and 2,4-D were observed at +0.9 V and +1.3 V vs. SCE, respectively. The results highlight the strong influence of pH on signal-to-noise ratio, with optimal analytical performance achieved at pH 2.0 and a detection limit of 3.03 ng/mL.

These findings confirm that Pd@MPC is a highly promising material for high-performance electrochemical sensors, offering a unique combination of structural stability, conductivity, and catalytic activity.

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ELECTROSPUN SnO_2 NANOFIBERS FOR ADVANCED GAS SENSING: FROM MORPHOLOGICAL DESIGN TO FUNCTIONAL PERFORMANCE

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This work focuses on the fabrication of tin dioxide (SnO_2) nanofibers using an electrospinning approach, aimed at producing nanostructured materials with potential gas-sensing applications. To enable the synthesis, an ethanol

(EtOH)/dimethylformamide (DMF) solvent system was employed as the medium for precursor formulation. A polyvinylpyrrolidone (PVP) solution was prepared by dissolving PVP in the EtOH/DMF mixture under magnetic stirring, while, in parallel, tin(II) chloride dihydrate ($SnCl_2 \cdot 2H_2O$) was dissolved in a separate portion of the same solvent system. The PVP solution was then added dropwise into the $SnCl_2$ solution under continuous stirring, followed by thermal treatment in an oil bath at 45 °C for 2 h and cooling overnight. Electrospinning was performed under optimized conditions: an applied voltage of 20 kV, a needle-to-collector distance of 18 cm, a flow rate of 0.7 mL/h, and a collector rotation speed of 1000 rpm, using aluminum foil as the substrate. Nanofibers were collected over multiple electrospinning cycles, and after each cycle, the fiber-coated foils were dried to remove residual solvent. The dried nanofibers were then carefully removed and subjected to a specific thermal treatment regime, which included a final calcination step at 550 °C for 1 h to induce complete crystallization.

The structural and morphological properties of the resulting SnO_2 nanofibers were characterized using X-ray diffraction (XRD), Brunauer-Emmett-Teller (BET) surface area analysis, scanning electron microscopy (SEM), and field emission scanning electron microscopy (FESEM). Thick films were fabricated by screen-printing a paste composed of calcined nanofibers dispersed in terpineol onto Al_2O_3 substrates pre-patterned with interdigitated electrodes and integrated microheaters. The printed films were subsequently heated at 160 °C for 1 h to remove the organic binder and improve adhesion between the sensing layer and the substrate.

The sensors were then evaluated for NO_2 detection using a dynamic gas-sensing measurement system, in which the NO_2 concentration was precisely regulated via mass flow controllers, with a total flow rate maintained at 100 mL/min. The sensing response was assessed across different NO_2 concentrations and operating temperatures. The unique nanofibrous architecture and high surface area significantly enhanced sensing performance, revealing pronounced sensitivity and clear temperature dependence, thereby highlighting the material's strong potential for gas sensor applications.

The sensor processed from SnO_2 nanofibers, with a specific surface area of 75 m^2/g, a pore radius of 4.5 nm, and an average crystallite size of 15 nm, exhibited a superior sensor response (S = 367%) toward 20 ppm of NO_2 at an operating temperature of 300 °C, suggesting it could be operative even at sub-ppm NO_2 concentrations.

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FLEXIBLE AND BIODEGRADABLE PRESSURE SENSORS BASED ON CHITOSAN-GLYCINE REINFORCED WITH MXENE

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As the demand for sustainable and eco-friendly electronics grows, biodegradable materials are receiving increasing attention for their potential in flexible sensing applications. This study focuses on the development of film composites based on chitosan (CH) and glycine (Gly), synthesized through a simple solution-casting method. Chitosan was first dissolved in a 1% v/v aqueous acetic acid solution, followed by the incorporation of glycine at varying weight ratios (CH:Gly = 1:0.2, 1:0.6, and 1:0.8). The thin films were characterized using optical imaging, atomic force microscopy (AFM), and X-ray diffraction (XRD) to assess their morphology and phase composition. Local mechanical and piezoelectric properties were evaluated through AFM-based techniques, including AM-FM viscoelastic mapping, PFM DARTSS, and PFM lateral DARTSS. These analyses confirmed that the CH:Gly compositions of 1:0.6 and 1:0.8 were suitable for use in pressure sensor applications, with potential for further modification.

The resulting solution was cast and dried in a desiccator for 48 h, producing uniform, free-standing films. Additionally, free-standing films from CH:Gly = 1:0.6 and 1:0.8 compositions were further modified by incorporating low concentrations of $Ti_3C_2T_x$ (MXene) sheets (5 and 25 μg/ml). While MXene is not a piezoelectric material itself, it offers unique properties such as a large specific surface area, high conductivity, excellent hydrophilicity, and adjustable surface functional groups. These characteristics make MXene an ideal candidate for enhancing the performance of flexible pressure sensors. Specifically, MXene was used as a

nucleating agent to induce the β-phase polarity and enhance the piezoelectric output during compression by promoting electron transfer.

Square samples (2.3 cm × 2.3 cm) were fabricated and equipped with copper electrodes (2 cm × 2 cm) on both sides, connected via wires and encapsulated in Kapton for mechanical and thermal protection. The electrical output of the films was measured using a custom-built laboratory apparatus under mechanical stress induced by finger taps. To ensure a more uniform distribution of mechanical stress, additional tests were performed using a Quartz Impulse Hammer (KISTLER, Italy) with a 2 cm rubber end. The CH-0.6Gly-25MXene film demonstrated strong and reproducible responses in both finger tapping and hammer impact tests, with a sensitivity of 40 mV/N.

These results underscore the promising potential of CH-Gly-MXene composites as high-performance, flexible, biodegradable pressure sensors. They offer an optimal combination of high sensitivity, mechanical robustness, and environmental sustainability.

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PIEZOELECTRIC NANO-BIOCOMPOSITES BASED ON CHITOSAN, GLYCINE, AND ZINC OXIDE NANOPARTICLES

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Pressure sensors based on materials converting mechanical stress into electrical signals are widely used in fields ranging from industrial automation to medical diagnostics and wearable electronics. These materials offer a unique combination of self-powered operation, high sensitivity, rapid response, mechanical flexibility, and long-term durability. However, rising consumer expectations for sustainability, coupled with stricter environmental regulations, have driven growing demand for economical, biodegradable, and environmentally friendly alternatives. Biopolymers offer a promising solution, combining eco-friendliness, non-toxicity, biodegradability, and biocompatibility. Still, they often suffer from limited piezoelectric and mechanical performance, which presents a key challenge for their broader application in pressure sensing devices.

From this perspective, this study focuses on the development and investigation of novel, natural biopolymer composites based on chitosan (Ch), zinc oxide nanoparticles (ZnO), and glycine (Gly). To fabricate thin-film sensors, solutions with varying weight ratios of Ch, ZnO, and Gly were cast into glass Petri dishes and dried. The resulting films were characterized using optical imaging, atomic force microscopy (AFM), and X-ray diffraction (XRD) to assess their morphology and phase composition. Square samples were then cut from the films, equipped with copper electrodes, connected via wires, and encapsulated in Kapton. The electrical output of the films was measured using a custom-built laboratory setup under mechanical stress applied by finger taps. To ensure more consistent pressure distribution, additional tests were conducted using a Quartz Impulse Hammer (KISTLER, Italy) with a 2 cm rubber tip.

The results indicate that modifying chitosan with zinc oxide nanoparticles enhances its piezoelectric performance, highlighting the potential of the developed composite for use in pressure sensing technologies.

P-36

SYNTHESIS OF SnO_2 NANOFIBERS BY ELECTROSPINNING METHOD AND STUDY OF ITS ETHANOL AND ACETONE SENSING PROPERTIES

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Gas sensors are crucial in multiple aspects of daily life, such as environmental and food quality monitoring, human and industrial safety, and illness detection. Among semiconducting metal oxides, SnO_2 has been extensively investigated for gas-sensing applications owing to its wide bandgap, non-stoichiometric nature, excellent electronic mobility, and stability. To tailor its gas sensing functionalities, numerous approaches regarding its synthesis into useful nanostructured morphologies have been explored. For this purpose, electrospinning proved to be one of the most simple, versatile and low-cost method for producing nanofibers with high surface area-to-volume ratio and interconnectivity of nanoparticles.

For the preparation of the electrospinning solution, a dimethylformamide DMF/ethanol (weight % = 40:60) solvent system was used. Separately, tin(II) chloride dihydrate ($SnCl_2 \cdot 2H_2O$) and polyvinylpyrrolidone (PVP) were dissolved in this solvent system. Finally, both solutions were mixed and stirred further to obtain a clear and transparent solution for electrospinning. Optimal conditions for electrospinning were: applied voltage of 20 kV, a needle-to-collector distance of 18 cm, a flow rate of 0.7 mL/h, and a collector rotation speed of 1000 rpm, using aluminum foil as the substrate. Nanofibers were collected over multiple electrospinning cycles, and after each cycle, the fiber-coated foils were dried to remove residual solvent. The dried nanofibers were calcined at 550 °C for 1 h to induce complete crystallization.

TGA of nanofibers indicates complete decomposition of the organics at 550 °C and their XRD analysis confirms the formation of pure tin oxide. The specific surface area of the as spun nanofibers was 75 m^2/g with pore radius of 4.5 nm. FESEM study shows cylindrical fibers with diameter in the range of 20–50 nm with aspect ratio >1000.

The sensing films were prepared by screen-printing a paste composed of calcined nanofibers dispersed in terpineol onto Al_2O_3 substrates pre-patterned with interdigitated electrodes and integrated microheaters. The printed films were subsequently heated at 160 °C for 1 h to remove the organic binder and improve adhesion between the sensing layer and the substrate.

The gas sensors were tested using a dynamic gas sensing measurement system. Ethanol and acetone sensing of the nanofibers showed a good and desirable sensing behavior such as high sensitivity, fast response and recovery times.

P-37

STUDY OF MASS TRANSFER MECHANISMS AT THE INITIAL STAGE OF SINTERING AND THEIR INFLUENCE ON THE STRUCTURE OF ALUMINA-ZIRCONIA COMPOSITE CERAMICS

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Currently, several methods and actively developing new approaches are aimed at optimizing the technology for producing Al_2O_3 ceramics, as well as modernizing the structure, physical, and mechanical properties of corundum ceramics [1–3]. One way to enhance the properties of Al_2O_3 is to create composite ceramics based on it. In particular, ZTA ceramics (zirconia-toughened alumina) have found wide application [3,4]. Since understanding the processes and controlling all stages of ceramic production are essential for improving the properties of aluminum oxide-based materials, the primary task in their manufacturing is the optimization of conditions and methods for obtaining nanopowders, their compaction, and consolidation during sintering. The microstructure of the sintered material depends on the characteristics of the initial powder, the microstructure of the green compact, as well as the mass transfer processes during sintering [5]. The initial sintering stage is particularly critical when using nanopowders, as their high specific surface area leads to consolidation processes that differ from those observed during the sintering of micron-sized powders.

Alloying additives significantly influence the kinetics of the initial stage of aluminum oxide sintering, leading to a change in sintering mechanisms at this stage by transitioning from grain boundary diffusion (GBD) to volumetric diffusion (VD). The transition from grain boundary diffusion to volumetric diffusion leads to an increase in the rate of compaction of nanopowders and a decrease in the activation energy of sintering [5–7]. Researchers typically focus on examining the influence of one factor, the additive, without considering the effect of compaction pressure.

This paper presents the results of a study on the influence of the mass transfer mechanism on the initial sintering stage of a metastable mixture of nanopowders with the composition γ/θ-Al_2O_3 + *n*% (ZrO_2 + 3 mol.% Y_2O_3) (YSZ) (*n* = 0, 1, 5, 10, 15 wt.%) on the structure of a ceramic composite α- Al_2O_3 + *n*% YSZ (*n* = 0, 1, 5, 10, 15 wt.%). The study examines the effects of the YSZ alloying impurity concentration and the processing of powders under high hydrostatic pressure (HHP) (300, 500, 700 MPa).

The powders for the study were obtained by the method of co-precipitation from solutions of aluminum chloride ($AlCl_3 \times 6H_2O$), zirconium oxychloride ($ZrOCl_2 \times 8H_2O$), and yttrium nitrate ($Y(NO_3)_3$) at room temperature. Ammonia

solution was used as the precipitant, and the precipitation pH at the end of the synthesis was ≥ 8.5. The crystallization and subsequent formation of nanoparticles were carried out by calcining the hydroxides in air at a temperature of 1000 °C for 2 h. The obtained powders had a composition of Al_2O_3 (γ/θ modifications) + *n*% YSZ, where *n* = 0, 1, 5, 10, 15 wt%. For the investigation of the ZTA ceramic composite structure, powders of the composition Al_2O_3 (γ/θ modifications) + *n*% YSZ (*n* = 0, 1, 5, 10, 15 wt%) were compacted under high hydrostatic pressure at 300, 500, and 700 MPa, after which the compacts were sintered in air at 1550 °C for 2 h with a heating rate of 5°C/min.

To study the kinetics of the initial stage sintering, the powders were compacted into beams with dimensions of 6×6×40 mm in steel molds using uniaxial pressing at 20 MPa, followed by processing under high hydrostatic pressure (HHP) at 300, 500, and 700 MPa. The behavior of nanopowders at the initial sintering stage was studied using dilatometry at a constant heating rate of 5 °C/min, within a temperature range of 20 °C to 1500 °C. It was determined that the sintering of compacts in the indicated composite system occurs in two stages: compaction of metastable phases γ/θ-Al_2O_3 (Stage I) and compaction of the stable α-Al_2O_3 phase (Stage II), with an inhibition of the compaction process between them (Fig. 1).

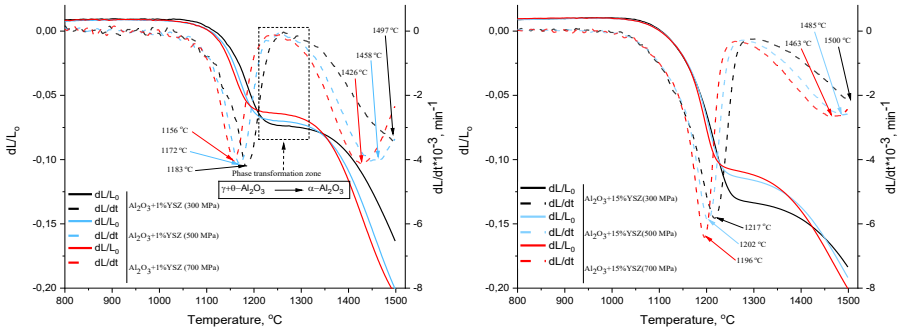

Figure 1. Temperature dependences of shrinkage and shrinkage rate in γ/θ-Al_2O_3+1%YSZ (a) and γ/θ-Al_2O_3+15%YSZ (b) samples with different values of HHP

A study of the mechanisms and activation energies of sintering in γ/θ-Al_2O_3 + *n*% YSZ systems (*n* = 0, 1, 5, 10, 15 wt.%) revealed that an increase in the dopant concentration and pressure leads to a decrease in the activation energy of the initial sintering stage. The prevailing sintering mechanism in these systems is volumetric diffusion within corundum grains. Additionally, the work established that for γ/θ-Al_2O_3 + ≥5 wt.% YSZ systems, the optimal compaction pressure is HHP ≥ 500 MPa, which corresponds to the transition of the sintering mechanism from grain-boundary diffusion to volumetric diffusion.

Analysis of the composite ceramics' structure showed that, depending on the magnitude of mechanical processing and the concentration of the alloying impurity, two types of structures are achieved: aggregate-hardened and dispersion-hardened. For HHP ≥ 500 MPa and YSZ ≥ 5 wt.%, a dispersion-hardened structure is obtained.

This structure is characterized by a bimodal distribution of Al_2O_3 grain sizes and a transition from grain boundary diffusion to volumetric diffusion with $n = ½$.

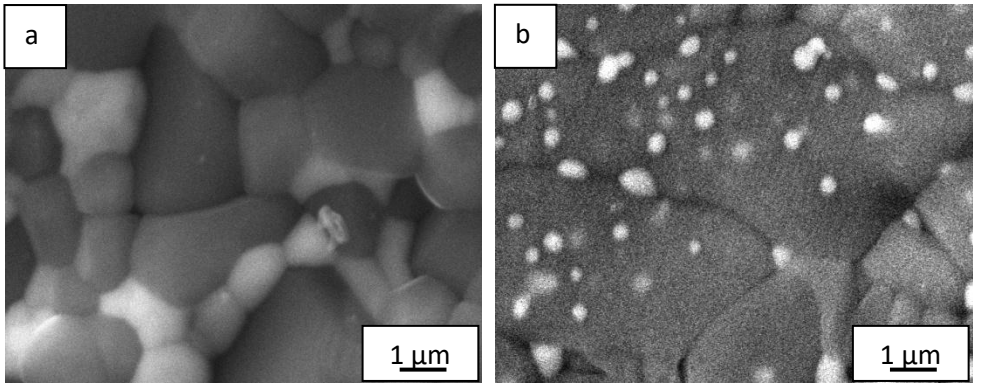

Figure 2. Surface structure of ceramic samples α-Al_2O_3 + 10% YSZ, sintered at 1550°C, depending on the magnitude of HHP processing: a) 300, b) 700 MPa (a – aggregate-hardened structure, b – dispersion-hardened structure)

It has been established that systems with YSZ < 5 wt.% exhibit an aggregate-hardened structure and tend to sinter via the volumetric diffusion mechanism with $n = ½$, regardless of the magnitude of HHP.

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P-38

HIGHLY POROUS SILICON NITRIDE–BASED COMPOSITE AS DRUG DELIVERY CARRIER?

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We modified tetracalcium phosphate/monetite biocement with addition of 30 wt% highly porous microgranules prepared from silicon nitride/α-tricalcium phosphate. The volume ratio for composite microgranules of Si_3N_4 and α-TCP was 1:1. In vitro simulated body fluid (SBF) test showed good bioactivity (precipitation of hydroxyapatite layer). The idea for addition of amount of microranules to biocement was to have a drug carrier which will be able unleash continuously medicament. Our granules were prepared from mixture of silicon nitride and calcium phosphate by free granulation and then sintered at 1100 °C. The pore volume was almost 1000 mm^3/g, the open porosity of 77 vol%. The biocompatible composition and porosity of silicon nitride–based microgranules gave a chance to fabricate a suitable ceramic-cement composite for dexamethasone (DMZ), drug release into the human body. An accelerated release of dexamethasone from composite cement was observed. The full amount of DMZ was released from the composite after 10 days. The presented results are a good base to adjust the total drug release time by the mixing of an appropriate amount of infiltrated ceramic granules with the tetracalcium phosphate/monetite cement.

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P-39

INDUCED MODIFICATIONS IN STRUCTURAL, MICROSTRUCTURAL, AND FERROELECTRIC PROPERTIES OF BISMUTH FERRITE CERAMICS DOPED WITH LANTHANUM AND EUROPIUM

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The series of ten ceramic samples with the composition $Bi_{1-x}La_xFeO_3$ (x = 0.05; 0.10; 0.15), $Bi_{1-y}Eu_yFeO_3$ (y = 0.05; 0.10; 0.15) and $Bi_{1-(x+y)}La_xEu_yFeO_3$ ($x = y$ = 0; 0.025; 0.05; 0.075), obtained by sintering at 835 °C of the as-prepared powders synthesized via the hydro-evaporation method, were examined in this work. The influence of their structural and microstructural properties on the ferroelectric behavior of bismuth ferrite was investigated, considering the specificities of both dopant ions (La^{3+}, Eu^{3+}). XRD analysis revealed that lanthanum and europium doped bismuth ferrite ceramics had the rhombohedral (*R*3*c*) structure as the dominant one, while the samples doped with 15 mol% of dopant ions contained the orthorhombic phases as well. The partial substitution of Bi^{3+} ions with 10 mol% of La^{3+} or Eu^{3+} and 15 mol% of La^{3+} ions generated significantly enhanced ferroelectric responses (the large remnant polarizations and high coercive fields) and an almost square form of the hysteresis curves in comparison with undoped and the other doped samples. The bismuth ferrite ceramic sample doped with 15 mol% of La^{3+} ions exhibited the highest remnant electric polarization (P_r = 24 °C/cm^2 in electric field equal to 160 kV/cm), nearly saturated hysteresis curves in high electric fields, and the lowest leakage currents, which are consequences of its unique structural and microstructural properties. The samples doped with 15 mol% europium and co-doped with 7.5 mol% lanthanum and 7.5 mol% europium exhibited a poor ferroelectric response due to the non-polar orthorhombic structures. The leakage current densities of La and Eu-doped bismuth ferrite samples were reduced due to the decrease in the concentration of oxygen vacancies, which were the primary cause of the electric conductivity in the undoped bismuth ferrite ceramics. The decrease in the grain size of the doped samples also affected the reduction of their leakage currents.

P-40

ASSESSMENT OF ALKALI ACTIVATED BINDERS BASED ON FLY ASH FOR IMMOBILIZATION OF CESIUM

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The management of radioactive waste is a major challenge in the nuclear industry in order to protect human health and the environment. Radioactive waste has primarily been immobilized in Portland cement-based binders. However, for nuclides that are difficult to immobilize, such as cesium (Cs^+), researchers have been studying alternative matrices for immobilization, such as alkali-activated binders. This study investigated the immobilization of Cs in binders based on alkali-activated fly ash (AAFA). The effectiveness of Cs immobilization was assessed by the leaching behavior of Cs according to the ANSI/ANS-16.1-2003 standard test, depending on the concentration of added Cs. The Cs leaching rate for the sample with 5 % Cs was higher than for the sample with 2 % Cs, probably due to a higher percentage of Cs^+ ions physically encapsulated within the pores of the gel that formed as the main product of alkali activation reaction of FA. It was also determined that the addition of Cs, had no statistically significant effect on the compressive strength of the AAFA mortars. Based on the calculated leachability indexes of Cs (~ 10), which significantly exceeded the minimum required value of 6, it was concluded that AAFA binders can be utilized as a highly efficient matrix for immobilizing cesium up to 5 % concentration.

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P-41

COMPARISON OF FTIR SPECTRA OF BENTONITE CLAY WITH SPECTRA OF ITS BASIC ACTIVATION BY ULTRASOUND

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In order to improve the physicochemical properties of clay (most often by increasing the specific surface area), its activation is carried out. Fourier-transform infrared spectroscopy (FTIR) is one of the methods that can be used to monitor the effect of activation. Since acid activation is expensive due to the high costs of washing out the residual acid in the clay, the long activation time, and the high price of the acid, there is a need for cheaper activation methods. One such method is base activation. Activation was performed by dispersing 5 g of clay in 100 mL of 1 M NaOH solution. After that, the resulting suspension was exposed to ultrasonic waves for 5 min. The suspension was then strained and washed.

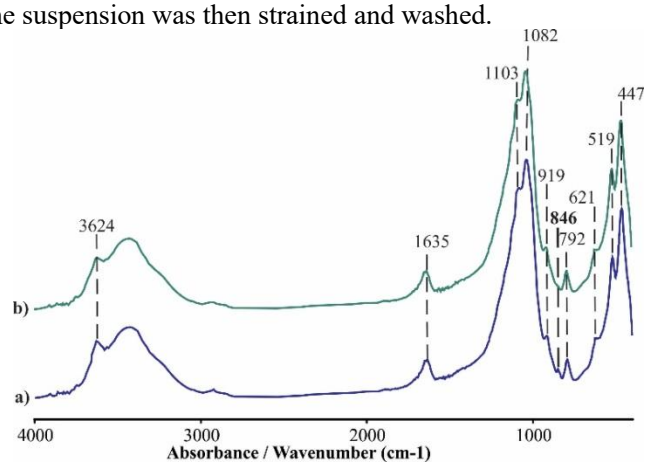

Figure 1. FTIR spectra before activation (a) and after clay activation (b)

Figure 1 shows the FTIR spectrum of unmodified bentonite clay (a) and modified clay (b). Based on the types of vibrations, four parts of the bentonite spectrum can be distinguished. The first part consists of the OH vibrations of surface moisture (a broad band at about 3400 cm^{-1}) and the OH bands in montmorillonite (a peak at 3624 cm^{-1}). The second part, which is in the range of 950 to 1200 cm^{-1}, corresponds to the Si-O-Si and Si-O-M valence vibrations (where M is most often Al, Mg, and Fe), with characteristic peaks at 1083 cm^{-1} and 1039 cm^{-1} for montmorillonite. The third part, located at about 600–950 cm^{-1}, originates from the valence vibrations of OH groups in silicate minerals. The fourth part, below 600 cm^{-1}, is attributed to the Si-O-Si and Si-O-Al valence vibrations. The peak at around 1637 cm^{-1} is attributed to the valence and deformation vibrations of physically bound water molecules.

Of particular interest is the comparison of the spectra in the 600–950 cm^{-1} region between clay samples activated with a base and untreated clay samples. In this region, three peaks are observed. The first peak, at 846 cm^{-1}, corresponds to the Al-O-Mg bond in clay. The second and third peaks, at 792 and 621 cm^{-1}, originate from quartz and cristobalite, respectively. The peak corresponding to Al-O-Mg at 846 cm^{-1} disappears upon base activation of the clay. The disappearance of this peak is attributed to the decomposition of magnesium within the octahedral sheet during base activation [1].

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P-42

INFLUENCE OF THE PRISMATIC GRAINS ON NANO-INDENTATION BEHAVIOUR OF IRON-DOPED MULLITE

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Prepared by the standard sol-gel procedure, sintered at 1550 °C for 4 h, and tested in terms of microhardness, the mullite samples doped with iron have improved hardness. This phenomenon is likely to be related to the characteristic microstructure revealing the regularly shaped prismatic 3D grains. In this regard, the nanoindentation tests were employed to investigate micromechanics of iron-doped

sintered mullite material using the diamond Berkovich indenter in load-controlled nanoindentation tests with applied loads of 50, 300 and 2000 μN. Also, structural and microstructural characterization was performed using XRD (X-ray diffraction) and SEM-EDS (scanning electron microscope with energy dispersive X-ray spectrometry), while SPM (scanning probe microscopy) was used for topographical analysis. XRD and SEM analysis showed that undoped sintered mullite contains phases such as mullite (93.3%) and corundum (6.7%) with almost uniform grain size. On the other hand, adding 9 wt.% of Fe_2O_3 to the starting solution decreases the corundum content in the sintered sample below 1%, and prismatic 3D grains occur surrounded by elongated ones. These changes in iron-doped mullite microstructural features led to the improvement of its hardness and plasticity. Moreover, nanoindentation results indicated that the prismatic 3D grains possess much higher elastic modulus than the elongated ones, probably due to the higher iron content. Also, elongated grains exhibited lower hardness values than prismatic grains, ascribing it to iron deficiency and their grain size.

P-43

MULLITE BASED CERAMICS OBTAINED FROM WASTE CLAY-DIATOMITE

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Mullite based ceramics have been fabricated using waste clay-diatomite from raw diatomite powder as Si and Al-nitrate as Al precursors with fibrous particles, nest like morphology. The hard mullite ceramics prepared by mold pressing (50 MPa) without additives obtained high compressive strength (up to 160 MPa at 1500 °C). The diatomite-nitrate samples were sintered at three temperatures (1300, 1400, and 1500 °C) for 1 h. XRPD of the sintered samples showed that the crystalline mineral phases mainly comprise mullite, cristobalite, and corundum. Field emission scanning electron microscopy (FESEM) images confirmed that the rod shape morphology of mullite particles, with 5 μm in length and 500 nm in diameter (aspect ratio 1:10). The mechanical stability of samples sintered at different temperatures evaluated by compressive testing showed good mechanical stability enabling the raw diatomaceous earth suitable for the production of various types of construction, and thermal insulating ceramic materials.

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P-44

POSSIBILITY TO USE LOCAL PONDED ASH AS SUPPLEMENTARY CEMENTITIOUS MATERIAL

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Production of Portland cement, the main binder material used in construction, contributes to ~5% of global CO_2 emissions. In order to reduce the negative environmental impact of cement production, cement producers and users adopted various strategies, mostly based on more extensive use of supplementary cementitious materials (SCMs) and reduction of cement clinker content in cements. This resulted in shortage of CEM I in markets and raised reasonable concerns about future availability of traditionally used SCMs, such as fly ash. On the other hand, more than 400 ha of arable land in Serbia are taken by landfills where fly ash produced by the local thermal power plants is already being disposed.

The aim of this work is development of sustainable low carbon footprint binder with low cement clinker content, in which a portion of CEM II is substituted by ponded fly ash (PA). Two PA samples from "Nikola Tesla" power plant were used: one recently disposed (sample from the active landfill, PAA), and the PA sample taken from the closed, passive, landfill (sample PAP). Mechanical activation was used as a method to improve properties of the PA samples and increase their content in the binder. It was found that up to 20 wt.% of mechanically activated PAA could be used as the cement substitute while maintaining excellent mechanical properties of the used CEM II, thus providing 52.5 MPa 28-days compressive strength. At the same time, binder samples that contained up to 30 wt.% of mechanically activated PAP showed good mechanical properties, and developed compressive strength higher than 42.5 MPa after 28 days of curing.

P-45

COMPOSITION UNIVERSE OF CERAMIC MATERIALS: THE POTENTIAL FOR DISCOVERING NEW FUNCTIONAL CERAMICS THROUGH HIGH-THROUGHPUT ANALYSIS

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A vast number of possible ceramic compounds remains unexplored, despite intensive research in the field of materials science. Through combinatorial analysis with repetition, it is shown that even with a limited number of chemical elements (e.g., 60) and high compositional precision (steps of 0.1%), it is theoretically possible to form around 10^100 different materials - a number that exceeds the number of atoms in the known universe. When the space is limited to oxides with 20 elements and 1% compositional steps, the number of potential unique compositions still reaches the order of 10^19. However, experimentally, we only know a small fraction of this space, indicating the vast potential for discovering new functional ceramics, including spinel and perovskite structures. A systematic search of this "compositional universe", with the aid of high-throughput computational and experimental methods, represents the key to finding the next generation of materials for energy, electronics, and catalysis.

P-46

EFFECTS OF CHEMICAL CORROSION ON BASALT BASED GLASS-CERAMIC COMPOSITES

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A basalt-derived glass-ceramic was developed using the volume crystallization method to assess its chemical durability in aggressive environments. The material was synthesized by melting natural basalt rock, followed by controlled crystallization to form a dense, homogenous microstructure. Chemical resistance was evaluated by immersing samples in aqueous solutions at pH 3, 7, and 12 for exposure times of 2, 6, 12, 20, and 30 h. Elemental leaching was quantified using inductively coupled plasma (ICP) analysis.

Across all pH conditions, leaching levels remained extremely low or below detection limits, indicating exceptional chemical stability. At both acidic (pH 3) and neutral (pH 7) conditions, no significant changes in elemental concentrations were observed over time. While elevated sodium levels were detected at pH 12, this was attributed to external contamination from sodium-based laboratory glassware, rather than degradation of the sample itself. These results demonstrate the high resistance of the basalt glass-ceramic to chemical attack, highlighting its potential for applications in chemically aggressive or long-term service environments.

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The properties of carbon derived from biowaste were investigated to develop environmentally and economically viable electrochemical sensors. Biowaste carbon was obtained by carbonizing almond shells at 800 °C in an inert nitrogen atmosphere. Two batches were prepared: the first contained only almond shells, while the second was enriched with a Bi_2O_3 composite doped with 5% mass of Sm to enhance the electrochemical properties of the material. The structural and morphological characteristics were analyzed using X-ray diffraction (XRD), Diffuse Reflectance Infrared Fourier Spectroscopy (FTIR-DRIFT), and field emission scanning electron microscopy (FE-SEM). Electrochemical properties were examined by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). A three-electrode system was used, consisting of a carbon paste electrode (CPE) as the working electrode, an Ag/AgCl reference electrode, and a Pt-wire counter electrode. Two different pastes for CPE were prepared: bare almond carbon (BAC) and Bi_2O_3-Sm-doped almond carbon (AC/Bi_2O_3-Sm) from the second batch. XRD patterns confirmed the amorphous nature of carbon in both samples, with low-intensity peaks corresponding to Sm-doped Bi_2O_3 [1,2]. DRIFT spectroscopy further verified the presence of characteristic functional groups, including O-H (hydroxyl group), C-O (phenol group), C=O (carboxylic group), and C=C (alkene group) [3]. FE-SEM analysis revealed an uneven, porous carbon structure. EIS analysis showed a lower charge transfer resistance for the AC/Bi_2O_3-Sm, correlating with more defined and intense CV peaks, indicating enhanced electron transfer kinetics [4]. The findings demonstrate that carbon derived from almond shells biowaste is a sustainable and eco-friendly option for use in carbon paste electrodes, showcasing good electrochemical characteristics. Future research efforts will concentrate on developing sensors and assessing their performance.

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