8TH INTERNATIONAL CONFERENCE ON EMERGING TECHNOLOGIES IN MATERIALS ENGINEERING

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8th EmergeMAT CONFERENCE

The 8th **EMERGEMAT Conference** focuses on bringing scientists, engineers, industry representatives and other stakeholders interested in developing new methods, concepts and materials using new and emerging technologies, such as: additive manufacturing, high pressure/high temperature processes and substitution of critical materials for energy, environmental protection and regenerative medicine.

These topics are more and more relevant considering the importance of non-ferrous metals and materials for the European Green Deal, the de-carbonation of Industrial Processes, and the new Horizon Europe Programme.

The 2025 edition is organized as a mixt event with 4 sections:

- ***Materials for Energy*** (Materials for improved metal ion batteries: advanced materials for metal ion-based batteries, electrochemical methods and new characterization methods; Materials for fuel cells, methods for synthesis, sintering and characterization; New piezoelectric and thermoelectric materials for energy harvesting; Novel materials for thermal energy storage);
- ***Critical Raw Materials*** (New materials and processes for sustainable replacement of critical raw materials for extreme conditions; Multicomponent materials with high entropy-high entropy alloys, high entropy ceramics; Additive manufacturing of novel metallic, ceramic, composite and hybrid materials for energy and biomedical applications; Circularity of advanced materials, new processes for their re-use and re-design);
- ***New Materials for Environmental Protection*** (Materials for industrial waste water purification; Materials for CO_2 adsorption; New materials for sensors and advanced detection).
- ***Materials Modelling and Simulation*** (Multi-scalar modelling of advanced materials; Process modelling).

We continue to encourage the participation of young researchers. Their many interesting contributions are included in the ***Young Scientists Award Competition***.

This year edition is accompanied by **3 workshops**, related to the field:

- PHOTOSTRUCT – „Structuri fotocatalitice pe baza de TiO_2 dopat functionalizat cu oxid de grafenă obținute prin fabricarea aditivă pentru decontaminarea avansată a apelor uzate industriale și din domeniul militar”
- AHEAD – „Antimicrobial high-entropy alloys and coatings with enhanced physical and mechanical properties designed by machine-learning assisted methods for mitigation of microbiologically influenced corrosion”
- M2DESCO – „Computational multi-models enabled design of safe & sustainable multi-component high-entropy coatings”

and 1 Products/models exhibition

Acknowledgement
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European Technology Platform on Sustainable Mineral Resources

8th INTERNATIONAL CONFERENCE PROGRAMME
Emerging Technologies in Materials Engineering – EmergeMAT

Day 1 (06.10.2025)	
8.30-09.00	**REGISTRATION AND COFFEE**
09:00-09:10	**WELCOME AND OPENING OF THE CONFERENCE SPONSORS PRESENTATIONS**
09:20-09:30	**IMNR IN THE CONTEXT OF CRITICAL RAW MATERIALS ACT AND INDUSTRIAL GREEN DEAL** **General Director of IMNR- Roxana -Mioara Piticescu (Romania)**
09:30-09:45	**TEHNOLOGII EMERGENTE ÎN ECONOMIA CIRCULARĂ PENTRU INGINERIA MATERIALELOR: DE LA PROIECTARE LA VALORIFICAREA RESURSELOR CRITICE** **Simina Lakatos- Institute for Research in Circular Economy and Environment "Ernest Lupan" (IRCEM)**
09:45-10:00	**THE IMPACT OF PLASMA TREATMENT ON THE PRINTABILITY OF COMMERCIAL-GRADE POLYMERS USED IN ADDITIVE MANUFACTURING** **Andrei Vasile Nastuta (Grigore T. Popa University of Medicine and Pharmacy Iasi, Romania)**
SECTION 1: MATERIALS FOR ENERGY **Chairs: Adrian Mihail Motoc (IMNR)& Valentin Dumitru Drăguț (IMNR)**	
10:00:10:15	**PHENOXAZINE-BASED POLYMERS WITH NIR ELECTROCHROMISM AND ENERGY STORAGE CAPABILITY USED IN PROTOTYPE DEVICES Constantin Catalin Paul("Petru Poni" Institute of Macromolecular Chemistry)**
10:15-10:30	**SUPERCRITICAL WATER AS A REACTION MEDIUM FOR ADVANCED MATERIALS DEVELOPMENT Florentina Maxim (Institute of Physical Chemistry-Ilie Murgulescu of the Romanian Academy)**
10:30-10:45	**THE EXPERIMENTAL INVESTIGATION OF THE COMPOSITE COMPOUND OF PYRAZOLE, PYRAN, AND FURAN: BOND COORDINATION, ADSORPTION, AND CORROSION MITIGATION Fatine el Farhani (Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco)**
10:45-11:00	**CHARACTERIZATION OF THE MICROSTRUCTURE AND STABILITY OF PT-MODIFIED NI-BASED SUPERALLOY FOR AEROSPACE APPLICATIONS Łukasz Rakoczy (AGH University of Krakow, Faculty of Metals Engineering and Industrial Computer Science, Poland)**
11:00-11:15	**SOURCING AND APPLICATIONS OF MATERIALS WITH PHASE CHANGE Bârdan Marius Vasile (Gheorghe Asachi Tehnical University Iasi)**
11:15-11:30	**ALUMINOTHERMIC FUELS Coman Tudor Adrian (Doctoral School SIM-UNSTPB)**
11:30-11:45	**COFFEE BREAK**

SECTION 2: CRITICAL RAW MATERIALS **Chairs: Mădălina Laura Cursaru (IMNR) & Ioan Albert Tudor (IMNR)**	
11:45-12:00	**INSIGHTS INTO THERMODYNAMIC PROPERTIES OF SOME ENTROPY-STABILIZED OXIDES** **Speranta Tanasescu (Institute of Physical Chemistry - Ilie Murgulescu of the Romanian Academy)**
12:00-12:15	**STUDY OF DRUG RELEASE KINETICS OF DOXORUBICIN/CIPROFLOXACIN FROM Mn2 DOPED CAP SCAFFOLDS DERIVED FROM AVIAN EGGSHELL IN OSTEOSARCOMA TREATMENT** **Siddhartha Dan (Dr. B.R. Ambedkar National Institute of Technology, Jalandhar, India)**
12:15-12:30	**REDUCED GRAPHENE OXIDE AS PLATFORM FOR ELECTROCHEMICAL AND PHOTOTHERMAL ON-DEMAND INSULIN DELIVERY** **Teodorescu Florina ('Ilie Murgulescu' Institute of Physical Chemistry of the Romanian Academy)**
12:30-12:45	**SUSTAINABLE CATALYSTS FOR DRM AND RWGS REACTIONS BASED ON ACTIVE METAL CONTAINED IN THE LEACHATE SOLUTIONS OF SPENT DIESEL AUTOCATALYSTS** **Alessio Varotto (Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)Italy**
12:45-13:00	**DEVELOPMENT OF BIOCORROSION RESISTANT COATINGS BASED ON HIGH ENTROPY ALLOYS (HEA)** **Madalina Cursaru-National R&D Institute for Non-Ferrous and Rare Metals**
SECTION 3: NEW MATERIALS FOR ENVIRONMENTAL PROTECTION **Chairs: Ana Maria Mocioiu (IMNR)& Cristian Simion (INCDFM)**	
13:00-13:15	**TiO2-BASED HETEROSTRUCTURES FOR SENSING APPLICATIONS** **Cornelia Bandas (National Institute for Research and Development in Electrochemistry and Condensed Matter, Timisoara)**
13:15-13:30	**ENHANCED PHOTOCATALYTIC PERFORMANCE OF ELECTROSPUN RARE EARTH-DOPED ZnO NANOSTRUCTURES** **Petronela Pascariu ("Petru Poni" Institute of Macromolecular Chemistry,Iasi)**
13:30-14:00	**LUNCH**
14:00-14:15	**THE IMPACT OF THE INTERDIGITAL ELECTRODES ON THE NO2 SENSITIVITY AT ROOM TEMPERATURE** **Cristian Simion (National Institute of Materials Physics Magurele)**
14:15-14:30	**ELECTROCHEMICAL AND PHARMACOLOGICAL ANALYSIS OF CU-COUMARIN COMPLEX** **Rakesh Choure (Dept. of Chemistry, Government SSP College Waraseon,India)**
14:30-15:30	**IMPROVEMENT OF HYDROGELS PROPERTIES BY ADDITION OF GRAPHENE OXIDE** **Ioana Ion (National Institute for R&D in Electrical Engineering ICPE-CA)**
15:30-16:30	**POSTER PRESENTATION** **YOUNG SCIENTISTS AWARD COMPETITION: BEST POSTERS AWARDS**
16:30-17:30	**BILATERAL MEETINGS / PANELL SESIONS** **EXIBITION**
Day 2 (07.102025)	

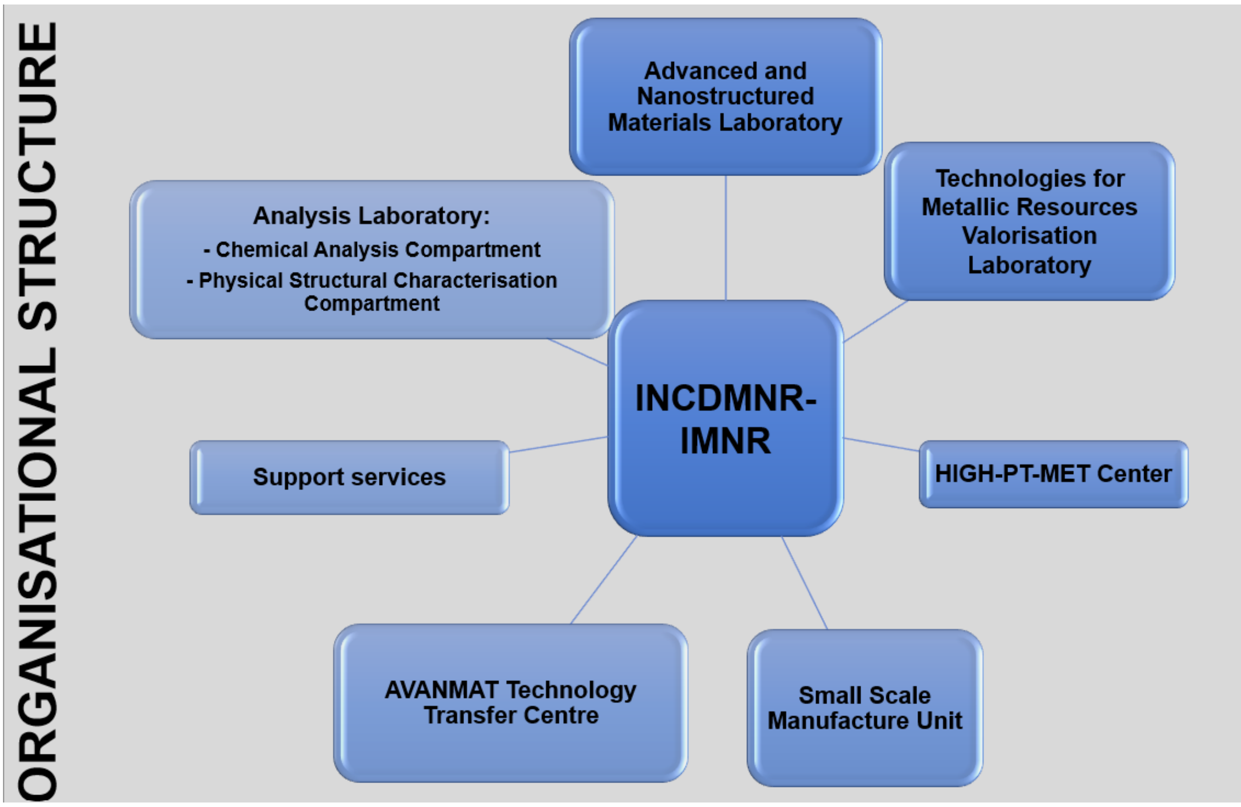
08:30-09:00	**COFFEE AND REGISTRATION OF PARTICIPANTS*** *Note: Online access is available from 08:45. Participants are encouraged to log in as early as possible.*
09:00-09:20	**STRATEGIC ALIGNMENT OF SUSTAINABLE METALLURGY AND MATERIALS SUBSTITUTION: THE ETP SMR SRIA 2023 ROADMAP FOR CRITICAL RAW MATERIALS Katarina Öquist (EPIROC)**
SECTION 3: NEW MATERIALS FOR ENVIRONMENTAL PROTECTION **Chairs: Ana Maria Mocioiu (IMNR)& Cristian Simion (INCDFM)**	
09:20-09:35	**FROM FRUIT WASTE TO FUNCTIONAL MATERIALS: APPLE POMACE-DERIVED CARBONS FOR METHANE AND CO_2 MITIGATION** **João Pedro Correia (Department of Materials and Ceramic Engineering, CICECO, University of Aveiro, Portugal)**
09:35-09:55	**PROMISING MATERIALS FOR POLLUTANT REMOVAL Maftei Andreea Elena (Institute of Interdisciplinary Research, Alexandru Ioan Cuza University of Iași)**
09:55-10:10	**CORROSION INHIBITION OF B66 BRONZE IN 3% NACL USING A 1,2,4-TRIAZOLE DERIVATIVE: COMBINED EXPERIMENTAL AND THEORETICAL INVESTIGATIONS Malak Rehioui (Laboratory of Organic Chemistry, Catalysis and Environment, Chemistry Department, Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco)**
10:10-10:25	**HIGH-PERFORMANCE CORROSION INHIBITION OF CARBON STEEL IN 1.0 M HCL USING AN ECO-FRIENDLY CO-APATITE PHOSPHATE COMPOUND Nouhaila Ferraa (Organic Chemistry, Catalysis and Environment Laboratory, Faculty of Science, Ibn Tofail University, Marocco)**
10:25-10:40	**ECO-FRIENDLY PAPER COATINGS VIA VALORIZATION OF POTATO, ONION, AND GARLIC PROCESSING WASTE Mariana Vallejo (CICECO – Aveiro Institute of Materials University of Aveiro, Portugal)**
10:40-10:55	**HYDROTHERMAL SYNTHESIS OF REO- CNTS-DOPED TIO2 NANOSTRUCTURED POWDERS FOR 3D PRINTING APPLICATIONS IN PHOTOCATALYSIS Radu Robert Piticescu (National Research and Development Institute for Non – Ferrous and Rare Metals, Romania)**
10:55-11:10	**COFFE BREAK**
SECTION 4: MATERIALS MODELING AND SIMULATION **Chairs: Radu Robert Piticescu(IMNR) & Viorel Chihaia (ICF)**	
11 :10-11 :25	**SURFACTANTS FOR STABLE NANO-COLLOIDS : AN EXPERIMENTAL APPROACH Elena Ionela Cherehes (Technical University Gheorghe Asachi Iasi,Institute of Macromolecular Chemistry Petru Poni, Iasi)**
11:25-11:40	**THE PULSATORY LIPOSOME FUNCTIONS AS A PERCEPTRON Diana R. Constantin ((Astronomical Institute of the Romanian Academy, Romania))**
11:40-11:55	**QUANTUM SPECTRAL-MODEL AND THE HYDROGEN I SPECTRUM Diana R. Constantin (Astronomical Institute of the Romanian Academy, Romania)**
11:55-12:10	**IMPACT OF THERMAL RELAXATION TIME ON GENERALIZED BIOHEAT EQUATION : A COMPARATIVE STUDY OF ANALYTICAL AND NUMERICAL**

	MODELS **Alexandra Trefilov (National Institute for Laser, Plasma and Radiation Physics, Ilfov, Magurele)**
12:10-12:25	**MULTISCALE MODELLING OF A NON-ENZYMATIC GLUCOSE DETECTOR** **Adrian Moraru (National University of Science and Engineering POLITEHNICA Bucharest, Romania)**
12:25-12:40	**EXPLORING THE POTENTIAL OF PROMPT ENGINEERING IN ATOMIC-SCALE MODEL CALCULATIONS** **Ciprian Neagoe (National R&D Institute for Non-Ferrous and Rare Metals)**
12:40-12:55	**DFT CALCULATIONS ON ENERGETIC AND ELECTRONIC PROPERTIES OF INTERFACES IN Mg-BASED SYSTEMS FOR HYDROGEN STORAGE** **Viorel Chihaia (Ilie Murgulescu" Institute of Physical Chemistry of the Romanian Academy)**
13:00-13:40	**LUNCH**
13:40-14:30	**FESTIVITY: BEST POSTERS AWARDS**
Workshop	
14:30-15:10	**Workshop : PHOTOSTRUCT**
15:10-15:50	**Workshop AHEAD**
15:50-16:30	**Workshop project M2DESCO**

- **Note: EET (Eastern European Time)**
- **Note: Online access is available from 08.45. Participants are encouraged to log in as early as possible.**

MISSION

The National Research and Development Institute for Non-Ferrous and Rare Metals aims to carry out scientific research and technological development in the field of non-ferrous metallurgy, materials science and engineering, mainly based on non-ferrous and rare metals and applied inorganic chemistry, in accordance with the new directions of action of the European Green Deal.

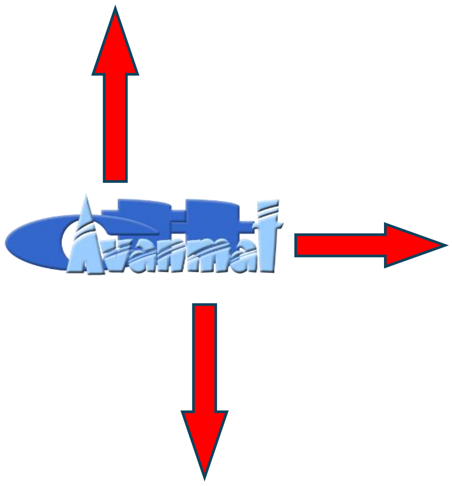


STRATEGIC GOALS

- generating new **knowledge**: competitive, top-level scientific results
- raising the **competitiveness** of the Romanian economy: **innovation** and **transfer of knowledge** to economic agents
- improving **quality of life**: technological solutions with societal and environmental impact (recycling, recovery, re-use, biomaterials for regenerative medicine).

MAIN DIRECTIONS IN R&D AND TECHNOLOGY TRANSFER

Energy and climate change: the development of new concepts and technologies for clean energy, leading to the reduction of the greenhouse effect and global warming, thus leading to the improvement of the quality of life.



Circular economy, materials and technologies for a sustainable economy: the implementation of new concepts and technologies for a clean industry, with a reduced consumption of raw materials and materials, for a circular economy with the sustained implementation of the four R's (recovery, remanufacturing, reuse and recycling).

Advanced manufacturing: new technological approaches (additive manufacturing) to meet the challenges facing society: global warming, energy transition, population aging and resource depletion.

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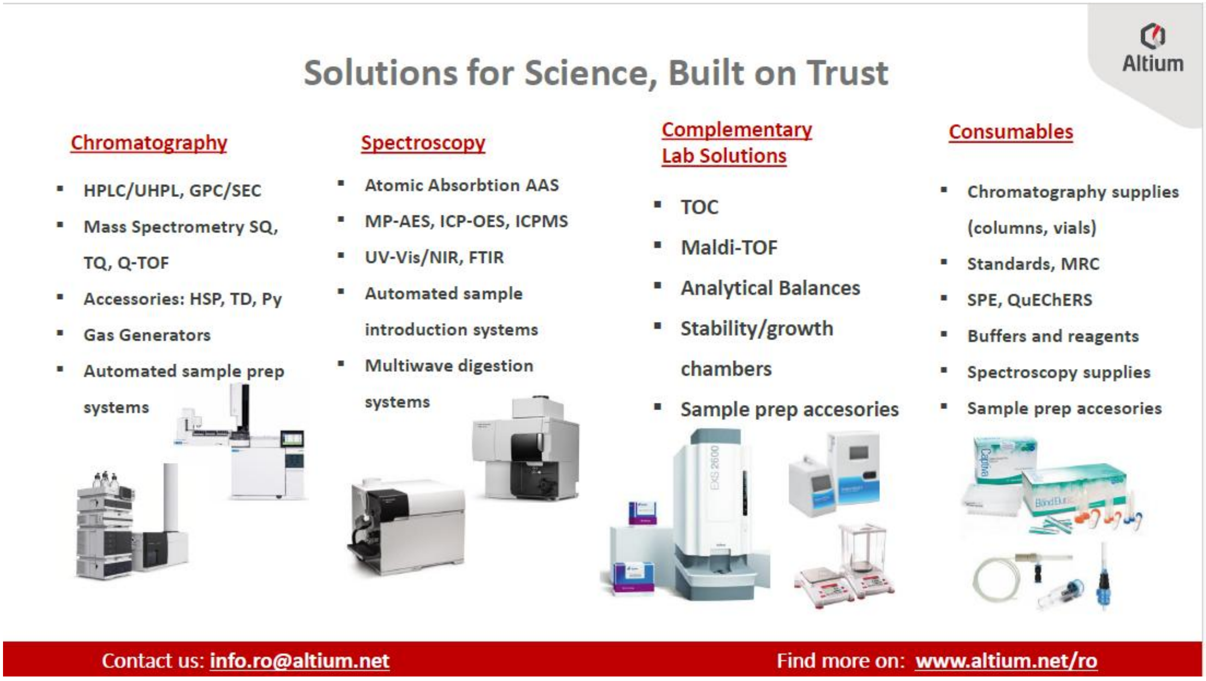

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More information available on our website: www.nanoteam.ro

Co-Organizer of EmergeMAT 2025

European Technology Platform on Sustainable Mineral Resources

European Technology Platform on Sustainable Mineral Resources (ETP SMR) is an Association of subjects operating in the Mineral Resources Industry at a wide scale (coal, metal ores, industrial minerals, ornamental stones, aggregates, smelters as well as technology suppliers and engineering companies) **in different sectors along the value chain, from exploration to extraction, processing, recycling**. ETP SMR is covering the entire range of mineral resources production in Europe. However, the production and tailored provision of mineral raw materials needs more than exploitation and/or recycling. **Technology and knowledge is the key to success.** Therefore, ETP SMR has also integrated many of Europe's very strong equipment and technology providers. Those organisations are usually part of every development process and necessary to be successful.

The ETP SMR was launched on March 2005 and officially recognized by the European Commission in September 2008. In 2013 the ETP SMR was born as a legal entity International Association without lucrative purpose.

The ETP SMR focuses its activities on **creating sustainable resources potential, access to, and supply of, essential and critical raw materials through research, development and innovation**, perfectly in line with the European Innovation Partnership on Raw Materials proposed by EU, based on three pillars: fostering sustainable supply within the EU, boosting resource efficiency and recycling as well as international collaboration.

The ETP SMR has become over the years a **reliable interlocutor of European Institutions**, a process that has brought the ETP SMR members to contribute to the SIP for EIP on Raw Materials, develop a Strategic Agenda and commit with the European Commission on the raw materials.

The ETP SMR members are major players from Industry, Research Institutes, Geological Surveys, Academia, and National and European Associations. They are united to address the future technological and societal challenges of the mineral sector, in order to jointly act towards a common vision.

More information available on our website: www.etpsmr.org

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CONFERENCE ABSTRACTS

SECTION 1. MATERIALS FOR ENERGY

TEXTILE THERMOELECTRIC ELEMENTS FOR THERMOELECTRIC GENERATORS

Aileni Raluca Maria[1*], Marin Adrian Cornel[1]

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The paper presents the development and application of flexible thermoelectric elements integrated in textile materials for thermoelectric generators. These innovative generators convert thermal energy into electrical energy through the Seebeck effect, a phenomenon that involves the interaction of two different metals. This energy conversion relies on maintaining a temperature gradient between two conductive materials. In our experiments, conductive elements were incorporated into textiles using conductive pastes deposited onto the fabric or conductive threads integrated through techniques such as sewing, weaving, or knitting. Materials used in our study included cotton and polyester fabrics, as well as conductive yarns for different junctions (e.g., silver-copper, iron-constantan, and silver-constantan), which are known for their effective thermoelectric properties. The principle underlying the operation of the thermoelectric module is that it generates a voltage when a temperature difference exists between its two junctions – one being heated (the hot side) and the other remaining at a lower temperature (the cold side). In our experiments, we carefully controlled the temperature of one side of the thermoelectric module to establish this temperature gradient. While the efficiency of flexible thermoelectric generators is lower compared to more conventional energy generation methods, they offer several significant advantages. Their flexibility allows them to be integrated into a variety of applications, especially in environments where traditional methods may not be feasible or practical. Additionally, they have the capacity to harness low-grade heat, such as body heat, thus making them particularly useful in wearable technology. Overall, these generators present a viable solution for generating low-voltage electricity in diverse settings, broadening the scope of energy harvesting capabilities.

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1. 1. V. Jangra, S. Maity, P. Vishnoi, *Journal of Electronic Materials (2025), pp.1-19.*
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4.L. Wang and K. Zhang, *Materials (2020), 3(1), pp.67-79.*

Acknowledgements:
This work was carried out through the Core Programme within the National Research Development and Innovation Plan 2022-2027, carried out with the support of MCID, project no. 6N/2023, PN 23 26 01 03, project title "Electroconductive materials based on multilayer metallization for thermoelectric systems, electromagnetic shielding and biomedical sensors integrated in IoT systems (3D-WearIoT)".

RESTORING LITHIUM STOICHIOMETRY IN A LAYERED NCM CATHODE MATERIAL VIA RELITHIATION

Ioana Anasiei[1,2], Beatrice-Adriana Șerban[1*], Ioana-Cristina Badea[1], Sabina Andreea Fironda[1,2], Mihai Tudor Olaru[1], Marian Burada[1], Elena Bacalum[1], Cristian Alexandru Matei[1,2], Ghita Mihai[1]

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The rapid implementation of Li-ion batteries in electric vehicles and portable devices requires an optimal cost-effectiveness ratio. It is also necessary to develop an efficient recycling process, especially for critical raw materials (CRM). Recycling of spent Li-ion batteries by pyrometallurgical and hydrometallurgical methods represents an ideal solution to create new opportunities from waste. However, the substantial economic and environmental implications have prompted the development of more practical and efficient strategies. Relithiation (direct recycling) involves restoring lithium stoichiometry in the spent cathode active material (CAM) with reduced energy consumption and minimal environmental impact. This process supports the development of a circular economy because it produces a functional active material that can be used to manufacture a new battery.
In this work, the spent cathode material of the $LiNi_{1-x-y}Co_xMn_y$ (NCM) type was subjected to a relithiation process, using Li_2CO_3 as a lithium source, because of its decreased environmental footprint. To increase the homogeneity between black mass and Li_2CO_3, the mixture was homogenized in a planetary mill, at 250 rpm for 25 minutes. The new material sintered at 850°C was analysed from a chemical and structural point of view. The results of the analysis demonstrated that a new cathode material can be obtained using reduced content of raw materials, low energy consumption and all this at an optimal cost.
Keywords: Li-ion batteries, cathode materials, critical raw materials, relithiation

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This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS/CCCDI – UEFISCDI, project number ERANET – ERAMIN - 3 – HETMOLION, within PNCDI IV; the Core Program within the National Research Development and Innovation Plan 2022-2027, financed by MCID, project no. PN 23 25 01 03 and by the European Union, from the Horizon Europe program, grant agreement number 101069789: project RELiEF – Recycling of Lithium from secondary raw materials and further. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Funded by the European Union

HEAT TREATMENT STRATEGIES FOR COMPLEX CONCENTRATED ALLOYS WITH HYDROGEN STORAGE POTENTIAL: OPPORTUNITIES AND CHALLENGES

Ioana-Cristina Badea[1], Sabina Andreea Fironda[1,2*], Ioana Anasiei[1,2], Beatrice-Adriana Șerban[1], Mihai Tudor Olaru[1], Laurențiu Moșinoiu[1], Dumitru Mitrică[1], Marian Burada[1]

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Complex Concentrated Alloys (CCAs) have emerged as promising candidates for solid-state hydrogen storage due to their tunable phase structures and favorable thermodynamic properties. Their multi-element composition, however, often results in microstructural complexity and elemental segregation, which must be controlled to achieve stable hydrogen absorption. Thermal treatments—including annealing, quenching, aging, activation and high-temperature homogenization—offer effective pathways to tailor these characteristics. In particular, homogenization treatments reduce segregation and promote the formation of hydrogen-compatible phases such as C14 and C15 Laves structures, leading to more uniform microstructures, enhanced sorption kinetics and improved stability during hydrogen cycling.
This work highlights the potential role of heat treatments in modifying the microstructure and diffusion/absorption properties of hydrogen in CCAs. Possible mechanisms include solid-solution homogenization, phase stabilization, thermal stresses generation and precipitation phenomena that can enhance reversible hydrogen absorption/desorption. Key challenges are also discussed, such as the absence of robust predictive frameworks and the need to bridge experimental studies with advanced modeling approaches (such as CALPHAD).
Through this conceptual perspective, the importance of heat treatments as a tool for optimizing CCAs for hydrogen storage is emphasized, while future directions are outlined toward the development of efficient and durable materials for the energy transition.
Keywords: hydrogen storage materials, heat treatments, complex concentrated alloys, microstructure

References:
1. Weiqi Wang, Lidan Qu, Yunzhuo Lu, Effect of heat treatment on microstructure and mechanical properties of lightweight high-entropy alloy, Journal of Alloys and Compounds, 2024, 176219, ISSN 0925-8388, https://doi.org/10.1016/j.jallcom.2024.176219.
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Acknowledgements:
This work was supported by the Core Program within the National Research Development and Innovation Plan 2022-2027, financed by MCID, project no. PN 23 25 01 05.

SEALING TECHNOLOGIES FOR HYDROGEN ELECTROCHEMICAL STACK

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Electrochemical systems are gaining importance within the current energy transition. Sealing technologies are fundamental in ensuring the required tightness of component assemblies in machines and mechanisms. Within electrochemical stacks, sealing serves critical purposes such as the prevention of leakages, the maintenance of system performance, and long-term durability. Consequently, sealing systems are indispensable for the reliable, safe, and efficient operation of modern energy technologies. Electrochemical stacks consist of multiple single cells. While numerous factors influence the stack performance and power output, enhancing the sealing represents an effective way to improve overall stack efficiency.[1] Regarding the sealing mechanism, researchers have investigated various approaches to sealing structures such as bipolar plate preformed seals, gasket sealing with sealant line, integral rubber edge gasket sealing, rigid protective frame sealing, and sealant sealing method. Also, the sealing material is a very important factor regarding the electrochemical stack performance. The material should meet the requirements of the environment, such as thermal and chemical stability, and appropriate mechanical behavior. Some of the most frequently adopted materials for this type of application are fluorine rubber, silicone rubber and EPDM rubber. [2]
This work aimed to obtain single gasket elements along the fluid circuit by using the sealant sealing method. In this case a variety of silicone-based materials has been selected in order to realize a form in place gasket (FIPG) using pneumatic direct injection equipment. The gaskets were directly injected into the bipolar plate sealing fields. This method demonstrated the importance of material properties in accordance with the operating parameters, to achieve uniform cross-section on the entire sealing field. The sealing efficiency under compression was tested using a mechanical tightness device with a test tablet. The test confirmed the absence of leakages, validating the effectiveness of the direct injection process. Also, the integration of form-in-place gasket technology directly into bipolar plates using silicone-based materials represents an innovative step forward, offering both design flexibility and improved assembly efficiency.

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MnO_2-3D GRAPHENE-Ni NETWORKS SYNTHESIZED BY COMBINED CVD AND HYDROTHERMAL METHODS

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The advancement of high-performance energy storage materials remains a dynamic area of research [1,2]. MnO_2 stands out as a highly promising electrode material for energy storage devices, due to its exceptional energy density, large surface area, and widespread natural availability [3]. Despite its promising attributes, MnO_2 suffers from intrinsically low electrical conductivity and limited electrochemical activity, which constrain further improvements in its specific capacitance (1370 $F \cdot g^{-1}$) [4]. Incorporating MnO_2 with conductive carbon materials offers an effective strategy to enhance its electrochemical performance. CVD is a highly effective technique for synthesizing 3D graphene with superior electrical conductivity, facilitating rapid charge transfer between current collectors and active materials [5,6]. Hydrothermal synthesis offers a versatile and straightforward approach for fabricating a wide range of hierarchical, multidimensional MnO_2 architectures. This method enables control over morphology and crystallinity, making it particularly valuable for tailoring the structural properties of MnO_2 to enhance its performance in energy storage applications [7]. Owing to their high specific surface area and superior electrical conductivity, 3D graphene/MnO_2 composites can be synthesized through various fabrication techniques, making them highly suitable as electrode materials for energy applications [8,9].
In this study, we present a hybrid synthesis approach combining CVD and hydrothermal processing to develop MnO_2 nanosheet-decorated 3D graphene networks. The 3D graphene framework was synthesized by CVD using nickel foam as template and methane as carbon source, followed by hydrothermal deposition of MnO_2 nanosheets.

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ULTRAFINE HIGH-ENTROPY SPINEL OXIDE NANOPARTICLES WITH HALF-METALLIC PROPERTIES FOR FULL-SPECTRUM PHOTOCATALYTIC WATER SPLITTING

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High-entropy oxides (HEOs) are emerging nanomaterials [1] as versatile photocatalysts owing to their compositional tunability, lattice distortion and defect-mediated charge dynamics [2]. In this work, we present the development of an eco-friendly synthesis techniques of obtaining ultrafine magnetic hexanary NiCuMnCoZnFe spinel oxide phase using a ternary deep eutectic solvent (DES). The co-precipitation in non-aqueous media lead to a uniform distribution of cations with various *d* electronic configurations that synergistically enhance band structure engineering. Structural and morphological analyses by XRD, FE-SEM and UHR-TEM confirm the formation of single-phase spinel crystalline phase with homogeneous elemental distribution while XPS analysis reveal cations mixed oxidation states. DRS UV-Vis analysis highlight dual bandgaps consistent with half(quasi)-metallic behavior previously reported in HEOs [3]. VSM measurements indicate good magnetic properties for all samples. All in all, the combination of multivalent *d* cations, lattice distortion and abundant oxygen vacancies facilitates an efficient electron-hole dynamics process which leads to a high activity in solar-driven photocatalytic water splitting without sacrificial agents [2]. The experimental results of the present study demonstrates to some extent that DES-mediated synthesis represent asustainable route to obtain ultrafine high-entropy spinel oxides nanoparticles as full-spectrum photocatalysts for solar energy production.

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SOURCING AND APPLICATIONS OF MATERIALS WITH PHASE CHANGE

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Phase change materials (PCMs) have recently been introduced to improve the thermal properties of building materials, including thermal mass, thermal inertia, and specific heat capacity. PCMs are substances capable of storing and releasing a large amount of heat energy when undergoing phase transitions. These are grouped into three main categories: organic, inorganic and eutectic mixtures. The incorporation of PCMs into materials such as concrete and gypsum significantly increases their thermal mass, which helps regulate the interior temperature of buildings. Consequently, energy conservation in buildings through thermal energy storage (TES) becomes more achievable.

The advantages of using PCM for the accumulation of thermal energy and cold, respectively, in construction and air conditioning installations, as well as in other fields, has led several scientific studies oin the field. Based on the external climatic parameters corroborated with the comfort microclimate: indoor, the technical applications of PCM can have the following destinations: heat storage systems; cold accumulation systems; mixed heat and cold storage systems. Regardless of the field and technical method of use, PCM applications are similar to regenerative heat exchangers, being characterized by cyclic operation, the exchanger being successively traversed by thermal agents. The most widely used inorganic PCMs in the temperature range specific to buildings and air conditioning installations [1][2] are: *crystallohydrates*: $AB{\cdot}nH_2O$, are crystalline solids derived from salts containing water molecules. Crystallohydrates are similar to alloys composed of salts, in most cases inorganic and water, which form a crystalline solid; *metals and metallic binary (eutectic) solutions* have low melting/solidification temperatures. The main advantage of metallic PCM is determined by the high thermal conductivity compared to the other PCMs. The main advantages of binary solutions with PCM [3]: variable temperature range of the phase change, depending on the composition; at eutectic concentration, the phase change is sudden, similar to pure substances; The latent heat volume is slightly higher than in the case of organic substances. Since binary solutions are a novelty in the field of technical applications, there is not enough information regarding their thermophysical properties [3]. The applications of phase-change materials (PCM) have become of great interest in recent years due to the beneficial effects on the thermal, mechanical and durability properties of building and paving materials. PCMs can alter the thermal mass and thermal inertia of building materials, thereby improving thermal energy storage.

This work uses the Pickering emulsion method to create new inorganic hydrated salt@SiO2 phase change microcapsules with a modified eutectic hydrated salt as the core and a dual-component silica/nanosilica shell.

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PREPARE AND CHARACTERIZATION OF CERAMIC MEMBRANES TYPE $NA_{1+X}ZR_2SI_2P_{3-X}O_{12}$ (NASICON) WITH THE ADDITION OF SODIUM EXCESS 2%

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Na-based ceramic membranes exhibit good ion conductivity, mechanical strength and thermal stability higher than other Na-based polymers and glassy electrolytes. They are mainly classified into categories of oxide, sulfide and hydride. Although oxide and sulfur-based ceramics exhibit higher ionic conductivity, sulfide-based ceramics are not relatively safe compared to oxide-based ceramics because of their instability to air, humidity, and toxicity. On the other hand, most hydride ceramics have relatively lower ionic conductivity values compared to oxides. Na-based oxide ceramics could be mainly classified into Na-aluminum and NASICON material family ($Na_{1+x}Zr_2Si_xP_{3-x}O_{12}$) [1]. Solid-state electrolytes (SSE) have attracted considerable attention as an alternative to liquid electrolytes to improve safety and durability. Superionic sodium conductors (NASICON), usually $Na_3Zr_2Si_2PO_{12}$, have proven very promising due to their high ionic conductivity and low thermal expansiveness [2]. In addition to high ion conductivity, the NASICON solid electrolyte also demonstrates good chemical and thermal stability and is claimed to be stable in humid air and aqueous solutions. These excellent characteristics make them one of the most promising solid Na^+ ion electrolytes [3]. The purpose of this work is to prepare and characterize NASICON ceramic membranes with high ionic conductivity. Thus, a solid-state chemical synthesis method (solid state reaction - SSR) was used at high temperatures, in two stages of sintering and an isostatic cold pressing stage, for the preparation of NASICON ceramic membranes, with an excess of 2% Na ($Na_{3.106}Zr_2Si_2PO_{12}$). NASICON 2% powder indicated an area of 7.0 $m^2\ g^{-1}$ and a volume of pores of 0.024 $cm^3\ g^{-1}$. NASICON membrane conductivity measurements were performed by electrochemical impedance spectroscopy (EIS) in a potentiostatic manner and reached ionic conductivities ranging from 8.5 $x10^{-5}$ (1150°C) to $4.0x10^{-4}$ S cm^{-1} (1175°C). Following the analysis of the experimental data, it was observed that the NASICON samples sintered at 1175°C and 1200°C respectively had higher ion conductivity values than the commercial one.

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CARBONIC MATERIALS OBTAINED BY ELECTROPHYLATION FOR THE MANUFACTURE OF ELECTRONIC DEVICES

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Carbonic materials obtained by methods based on electric fields attracted increased attention due to the unique combination of structural and functional properties. One of the most widely used techniques is electrofiling, followed by thermal carbonization of polymer precursors such as polyacrylonitrile or polyimide, which leads to obtaining nanofibers or membranes with high specific surface area and high electrical conductivity. By adjusting the carbonization conditions (temperature, inert atmosphere, holding time), the degree of graphitization and porosity can be controlled, thus influencing the final performance of the materials. Other processing routes include electrophoretic deposition of carbonic precursors on conductive substrates, followed by heat treatments, or high-energy ion irradiation, which induces partial carbonization and improved conductivity. These materials have a number of advantages for electronic applications. In the field of energy storage, charred nanofibers can be used as electrodes or even as substitutes for metal current collectors in supercapacitors and batteries, reducing weight and increasing the stability of charge-discharge cycles. Due to their large surface area and chemical stability, they serve as effective supports for catalysts or enzymes, being integrated into electrochemical and biosensory sensors. In addition, the flexibility and morphology of the fibers recommend them for portable electronics and ",,wearable devices, including piezoelectric generators or resistive memory elements. In conclusion, charred materials obtained by electrofiling and related methods are a versatile platform for the development of advanced electronic devices, and current research seeks the optimal balance between performance, cost and scalability.

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Mechanical and impact behavior of biodegradable poly(lactic) acid fabricated by fused deposition modelling

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This study systematically investigates the mechanical and impact behavior of 3D-printed neat polylactic acid (PLA) fabricated via fused deposition modeling (FDM). Specimens with 100% infill density were produced to evaluate key mechanical properties, including tensile strength, flexural modulus, and impact toughness. The research focuses on complex geometries exhibiting auxetic behavior, aiming to correlate FDM printing parameters with mechanical performance. To understand deformation mechanisms under high-load conditions, both impact and compression tests were conducted on 2D auxetic structures. Visual analysis and infrared thermal monitoring were employed to capture real-time structural responses and thermal signatures during testing. The findings contribute to the design optimization of biodegradable polymer structures for advanced engineering applications requiring enhanced energy absorption and mechanical resilience.

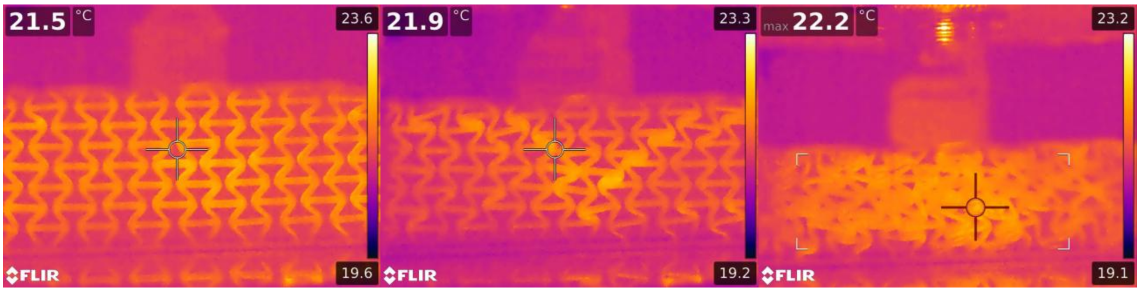

Fig. 1 Thermographic images during the compression test

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STATE OF THE ART CERAMIC MATERIALS FOR SOLID OXIDE FUEL CELL ELECTRODES

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Solid Oxide Fuel Cells represent advanced electrochemical devices, used to produce electrical energy. They are among some of the most promising energy conversion systems, offering high efficiency and low environmental impact. Both their performance and durability depend on the choice of materials for each component. Solid oxide fuel cells operate at high temperature, between 800°-1000°C. In this context, significant attention has been directed toward ceramic materials. Some of the main components regarding a solid oxide fuel cell are the electrodes, respectively anode and cathode, and the electrolyte. The electrochemical reduction of oxygen occurs at cathode, and it is important that the materials used for this electrode have high physical and chemical compatibility with the electrolyte and the cell environment, at the operating time. Some of the materials used for cathode are the perovskite-based materials, which are notable for their electron conductivity properties [1]. Some of the trends in this area are focused on lowering the cell operating temperatures, to 600°-800°C, in order to lower the manufacturing costs. Different studies highlight the importance of choosing materials according to different operating temperature range, such as LSM, LSC and LCSF [2]. Electrochemical oxidation of hydrogen takes place at anode side of the fuel cell. In this case, the electrode materials should not only exhibit high electrical conductivity, and excellent physical and chemical compatibility with both the electrolyte and the environment, but high catalytic activity for gas oxidation while minimizing the risk of carbon deposition. Also, for both anode and cathode, material porosity represents a crucial factor for optimal performance of the fuel cell [1]. Some of the most commonly used ceramic materials for anode are Ni-YSZ composites. However, due to carbon deposition, this material present limitations in overall fuel cell performance, therefore more advanced materials such as composite cermets were studied [3].

This work aims to explore a variety of ceramic and ceramic composite materials regarding optimal compatibility for the solid oxide fuel cell electrode applications.

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INFLUENCE OF VARIABLE SILVER CONTENT ON THE MECHANICAL AND TRIBOLOGICAL PROPERTIES OF THE SnSb11Cu6 ALLOY

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The aim of this study was to investigate the influence of varying Ag content on the microstructure and mechanical and tribological properties of the SnSb11Cu6 alloy. Optimization of the chemical composition of a commercial alloy with Ag addition was aimed at improving the mechanical properties and reducing wear of alloys used in sliding layers of bearing shells.

Alloys with modified chemical compositions (with 0.2%, 0.5%, and 1% Ag additions) were manufactured by melting and static casting. The obtained ingots were subjected to tests of chemical composition, Brinell hardness, Vickers microhardness, and microstructural analysis using digital and scanning electron microscopy. Bearing properties were determined by tribological testing under dry friction conditions using the Pin-on-Disc method, which determined the average coefficient of friction, the coefficient of friction as a function of sliding distance, and the degree of material wear.

The influence of the silver alloying element and the associated microstructural changes on the tribological properties of the tested bearing alloys was observed. The addition of 1% Ag reduced the average coefficient of friction by approximately 3% and reduced wear of the sample by almost 30%. For the SnSb11Cu6 + 0.2% and 0.5% Ag alloys, the average coefficient of friction increased while reducing the wear of the sample compared to the commercial SnSb11Cu6 alloy. The hardness of the bearing alloy increases with the increase of the silver content in the alloy.

The research was carried out as part of the Lider project, the main goal of which is to develop a technology for producing a wire from a tin-based bearing alloy with an optimized chemical composition intended for layer welding of the sliding layer on bearing shells using the innovative WAAM (Wire Arc Additive Manufacturing) 3D printing method, as well as to develop a technology for producing a sliding layer from a newly developed wire using the WAAM 3D printing method.

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Electrical Behavior of $BiFeO_3/Bi_{25}FeO_{40}$–Silicone Composites

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The electrical properties of three silicone rubber (SR) composites containing $BiFeO_3/Bi_{25}FeO_{40}$ powders with varying $Bi_{25}FeO_{40}$ concentrations (10%, 20%, 30%) were investigated. Conductivity measurements from 0.5 kHz to 2 MHz revealed a low-frequency DC plateau and a high-frequency AC region, allowing calculation of key parameters, including DC conductivity and band gap energy, which increased with $Bi_{25}FeO_{40}$ content ($5.61 \times 10{-}5$ to $7.67 \times 10{-}5$ S/m) (fig. 1). Charge transport was analyzed using Jonscher's universal response, the correlated barrier hopping model, and the polaron model at elevated temperatures. Aging tests indicated a decline in conductivity over time, attributed to microstructural defects rather than phase transitions. These findings provide guidance for tailoring composite conductivity through filler concentration and processing. [1]

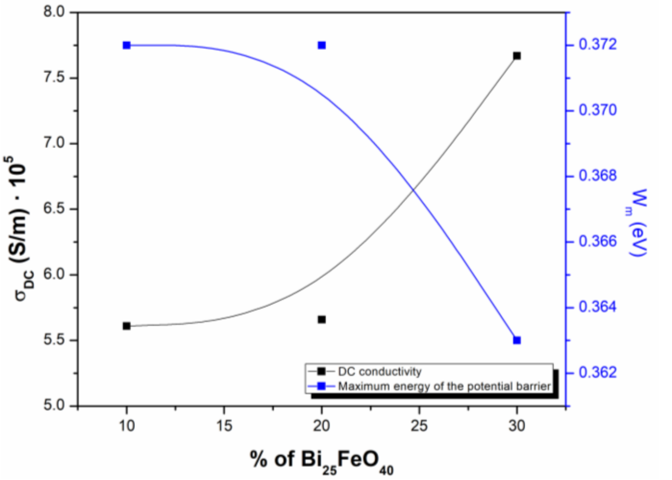

Figure 1. The concentration dependence of the maximum energy of the potential barrier W_m and the DC conductivity in BFO-doped silicone rubber

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PIEZOELECTRIC PERFORMANCE OF ZnO NANOWIRES ARRAYS INTEGRATED ON METALLIC SUBSTRATES FOR ENERGY HARVESTING DEVICES

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Advances in energy harvesting systems require novel piezoelectric architectures capable of combining efficiency with mechanical flexibility. In this paper, we present a comparative study of zinc oxide (ZnO) nanowires (NWs) arrays grown on Au or Pt coated rigid substrates and thin Ti foil, with the aim of evaluating their potential in next-generation piezoelectric devices.

ZnO NWs were vertically aligned and synthesized using a low-temperature hydrothermal process on a crystalline seed layer deposited by sol-gel spin deposition. To improve the structural stability and compatibility of the devices, the nanowire arrays were subsequently encapsulated in a polymethylmethacrylate layer. The nanostructures were systematically examined at several fabrication stages using scanning electron microscopy, transmission electron microscopy, and spectroscopic ellipsometry, confirming uniform growth and crystallinity [1,2]. The piezoelectric performance was evaluated by direct measurements of the d_{33} coefficient, allowing a direct comparison between flexible and rigid substrates.

The results showed that ZnO NWs grown on titanium foil exhibited a much higher piezoelectric coefficient than those grown on Pt or Au, highlighting the advantages of flexible platforms in optimizing the piezoelectric response. This improvement is attributed to the improved vertical integration and mechanical adaptability of the ZnO nanostructures on the flexible substrate. The findings demonstrate that low-cost, solution-processed ZnO NWs networks on metal foils represent a promising route towards efficient, scalable, and eco-friendly energy harvesting devices, with potential applications in portable electronics and self-powered systems.

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DESIGN, FABRICATION AND CHARACTERIZATION OF 3D STRUCTURES BASED ON $BaCe_{0.7}Zr_{0.3}O_3$

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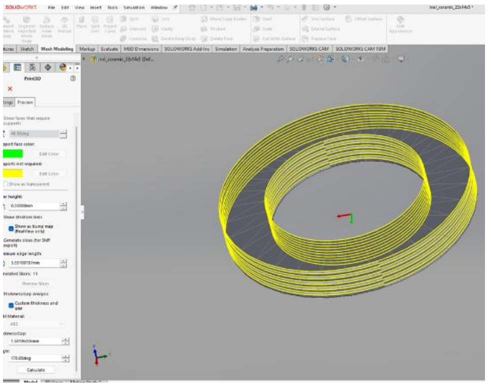
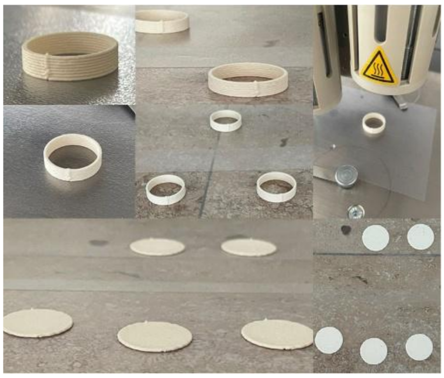
This study aimed to obtain 3D structures based on $Ba(Ce_{0.7}Zr_{0.3})O_3$ (noted BCZO) as a promising candidate for use as an electrolyte. The structures obtained had both planar and cylindrical shapes. To evaluate the mechanical strength of the structures, the sintering behavior was investigated. The BCZO-based pastes were characterized from the point of view of rheological behavior. Integrated CAD Design Process and the 3D structures based on BCZO were characterized from the point of view of: microstructure (SEM-EDS), structural analysis (FT-IR), and thermal stability (DSC-TG).



3D Print slicing preview – yellow layers, layering on ceramic ring model (Print3D)



Representative 3D structures based on BCZO obtained by robocasting

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FeCo MAGNETIC, ELECTRICALLY INSULATED NANOPOWDERS - ADVANTAGES AND APPLICATIONS

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The high-frequency behavior of electrically insulated FeCo nanopowders is generally favorable for applications requiring high magnetic flux and low power loss at high frequencies, such as power converters and microwave devices. Electrically insulating coatings, such as alumina (Al_2O_3), are applied to the FeCo nanoparticles to increase their electrical resistivity, thereby suppressing Foucault current losses and maintaining high effective permeability. This insulation also prevents interparticle conduction, ensuring stable magnetic properties across a wide range of frequencies. The FeCo/Al_2O_3 type materials that are the subject of this work are core–shell nanopowders, that were chemical synthesized by a new route, avoiding the conventional aqueous sol–gel technique [1]. These nanopowders can be consolidated through compaction, followed by sintering into bulk body, with desired shape and sizes. The paper presents the experimental research related to the synthesis of FeCo/Al_2O_3 nanopowders and the results of evaluation of magnetic, electrical properties and also of their behavior on high frequency. The FeCo nanoparticles were successfully prepared by sol-gel techniques, starting from Fe and Co salts and covered with a thin layer of Al_2O_3 [1] by adding of Al-based salt. The main magnetic characteristics of FeCo/Al_2O_3 nanostructured material are depending on the Al_2O_3 content: magnetisation at saturation M_S = 136 – 213 emu/g and coercivity H_c ~24.5 kA/m; the resistivity level of sintered materials reach 10^{14} Ω·m [2]. The samples of FeCo/Al_2O_3 nanopowders presented values of electromagnetic shielding effectiveness SE_{dB} in the range of 48 - 80 dB at 26 GHz frequency.

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STATE OF THE ART OF POLYMERIC MATERIALS IN SEALING SYSTEMS FOR PEMFC

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Proton exchange membrane fuel cell (PEMFC) is an electrochemical device that convert the chemical energy of hydrogen and oxygen into electricity, typically operating at moderate temperatures (60-80 °C), in an acidic environment and requiring controlled humidity.
The sealing represents a critical point in the functionality of every system. The main role of the sealing systems based on polymeric materials is to provide an efficient barrier against gases and liquids leakage, keeping at the same time the structural integrity of the assembly. Polymers are used on a large scale as sealing materials, due to the unique combination of mechanical, chemical and thermal properties that can not be obtain for metallic or ceramic materials. In the modern applications, such as energy conversion systems based on fuel cells, the requirements imposed to the polymeric materials become more strictly. The gaskets are exposed to moderate-high temperatures, variable humidity and constant exposure to hydrogen and oxygen.
Based on a variety of research and experimental testing there are a small amount of polymers which can be used for sealing. The most common polymer is ethylene propylene diene monomer (EPDM), because many manufacturers choose this polymer based on the lost cost and stability to humid and oxidative environment [1]. More suited for this type of environment are fluorinated elastomers (FKM, FFKM) because they can resist under critical applications and they have reduced permeability to gases. FKM provide good performance in a wide range of conditions, while FFKM (perfluoroelastomers) provide almost absolute stability, being practically chemically inert. The main disadvantages are high costs and difficult processability, which they are limited for premium applications [1],[2]. Recent studies shows that silicone composites obtain properties far beyond conventional polymers where they can aquire all the requirements of critical applications encountered in energy conversion systems. One of them is platinum cured silicone which stands out for excellent elasticity, thermal stability and easy processability, being ideal for *form-in-place* tehnologies [2]. For an optimal sealing fluorinated materials are an excellent option based on chemical resistance and as gas barrier, while EPDM are an economical option for energy conversion systems. Future trends focus on the development of silicone composites for their good processability and good properties, being the most promising candidates for future sealing applications.

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Phenoxazine-based polymers with NIR electrochromism and energy storage capability used in prototype devices

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In pursuit of discovering innovative substances designed for addressing contemporary technical challenges, we constructed molecular units enabling formation of polymers suitable for electrochromic (EC) energy-related storage media. Within this framework, and deriving from previous investigations [1], this work proposes an alternative methodology toward generating novel electroactive POZ-based frameworks incorporated into electrochromic energy-storage (EES) architectures. Accordingly, an originally engineered diamine containing a pendant dual electron-donating fragment by connecting POZ with diphenylamine (DPA) framework was conceptualized and prepared. Such molecular tactic aimed at improving mainly electrochemical endurance alongside solubility improvement of synthesized entities. Afterwards, to examine operational capacity regarding the diamine's POZ–DPA fragment, three macromolecular backbones were considered, namely polyimide (PI), polyazomethine (PAz) together with polyamide (PA). By employing this methodology, we attempted determining the optimal candidate from mentioned diverse polymer categories concerning electrochemical as well as electrochromic functionality. Authentic molecular configurations of synthesized species were validated through standard spectroscopic methods, accompanied with thorough physicochemical plus computational characterization. Consequently, the POZ–DPA polymer demonstrating optimal electrochemical/EC performance under three-electrode electrochemical configuration was chosen for subsequent evaluation. This encompassed development of lab-scale EES demonstrator systems to verify performance relative to dual EC behavior plus energy-storage capability and robustness, thereby revealing complete technological applicability (Fig. 1).

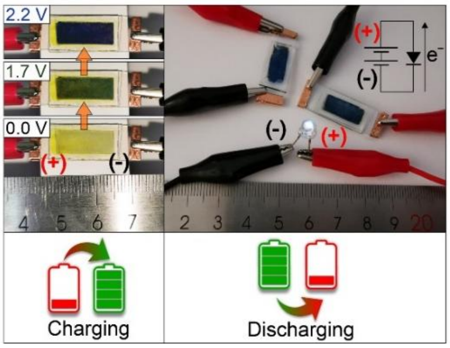

Fig. 1. The structure of the EES prototype devices.

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EVALUATION OF THE ENERGY POTENTIAL OF SOME FILMS BASED ON CELLULOSE DERIVATIVES USED AS BIODEGRADABLE PACKAGING

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Nowadays, due to the negative impact of non-biodegradable materials on the environment, the increasing need to develop sustainable, eco-friendly alternatives, such as biodegradable packaging materials based on natural biopolymers and bioactive compounds, represents a promising solution [1, 2]. Until 2050, based on literature data, it is estimated that global food supplies will increase by 50%, leading to a corresponding growth in food packaging materials [3, 4]. Packaging materials must ensure food quality while minimizing their effects on the environment and consumer health. Regarding minimizing the environmental impact, biodegradable food packaging derived from renewable sources has the property to fully decompose into carbon dioxide, water, and biomass when subjected to controlled composting conditions [5, 6].

From this perspective, biodegradable films based on cellulose derivatives, incorporating essential oils with functional properties, represent an alternative. This study evaluates the thermal behavior and energy potential of these biodegradable films by calorimetric techniques. Differential scanning calorimetry (DSC) analyses provided information on thermal stability and phase transitions, while combustion calorimetry allowed the determination of combustion enthalpies and calorific value, relevant for energy recovery [7, 8]. These data are essential both for understanding the industrial processing of materials and for evaluating waste management scenarios through energy recovery. The obtained results highlighted good thermal stability, as well as favorable values of energy parameters, suggesting that these films can not only replace conventional plastic food packaging but can also contribute to a sustainable life assessment, with energy recovery at the end of use.

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Hydrothermal synthesis of A-site doped $LaFeO_3$ perovskites: study on structure-property relationships

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Lanthanum ferrite, $LaFeO_3$, is a p-type semiconductor perovskite oxide with a range of promising properties, including high thermal and chemical stability, and a narrow band gap. However, its practical applications are often limited by insufficient electrical conductivity, low surface area, and rapid recombination of photogenerated electron-hole pairs.
This study explores the effects of doping $LaFeO_3$ at the A-site (La^{3+}) with metal cations to enhance its functional properties for applications in solid oxide fuel cells [1].
Doping with divalent ions like Sr^{2+} at the La^{3+} site introduces oxygen vacancies and changes the Fe valency from Fe^{3+} to a mixed Fe^{3+}/Fe^{4+} state, significantly increasing electrical conductivity. This enhances its performance as a cathode material for intermediate-temperature solid oxide fuel cells. Furthermore, doping strategies have been shown to affect the material's morphology, influencing particle and grain size, which in turn impacts surface area and catalytic performance.
Overall, the strategic doping of $LaFeO_3$ provides a versatile pathway to engineer its properties, overcoming inherent limitations and unlocking its potential for a wide array of advanced technological applications.
To comprehensively evaluate the material's properties, the hydrothermally synthesized powder was subjected to a series of characterization techniques. These included**:** Brunauer-Emmett-Teller (BET) surface area analysis, Inductively Coupled Plasma – Optical Emission Spectrometry (ICP – OES), X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) thermal analysis and Electrical Impedance Spectroscopy (EIS).

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INFLUENCE OF UNIAXIAL PRESSING ON THE DENSIFICATION AND SINTERING OF ADVANCED CERAMIC POWDERS

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This study investigates the critical role of uniaxial applied pressure in shaping advanced ceramic powders, specifically focusing on oxide-based systems. The study aims to determine how varying pressures influence the compaction characteristics and subsequent properties of the green body.
Disc-shaped compacts were fabricated from a specific oxide powder, subjecting them to a controlled range of applied pressures. The resulting green bodies were then analyzed for their dimensional stability before being sintered at elevated temperatures. The current findings demonstrate that higher pressures generally lead to a denser green body and improved final properties after sintering. However, excessive pressure can induce defects, such as cracking and delamination, which may persist or worsen during sintering.
To fully characterize the material's behavior, we used several analytical techniques: Brunauer-Emmett-Teller (BET) analysis to measure surface area, X-ray Diffraction (XRD) to examine crystallographic structure, Scanning Electron Microscopy (SEM) to observe particle morphology and packing, and thermal analysis to identify key thermal events and determine an optimal sintering profile.
This research provides a methodology for optimizing uniaxial pressing parameters. An optimal pressure range is necessary to maximize green density while minimizing defect formation.
The proposed methodology provides a practical framework for optimizing uniaxial pressing parameters, offering a promising path for the rational design and optimization of advanced ceramic manufacturing processes.

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Integrating Solid Oxide Fuel Cells – Biogas: Sustainable Pathway to Clean Energy and Advancing the Circular Economy

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Solid oxide fuel cells (SOFCs) represent a promising technology for highly efficient, carbon-free energy production. Their high operating temperatures, typically ranging from 600°C to 900°C, provide significant fuel flexibility, making them viable for a wide range of mobile and stationary applications.
A highly effective way to power SOFCs is with biogas, which can be produced from gasification or anaerobic digestion. The two systems work exceptionally well together, making this a very compelling area of research.
Integrating biogas-SOFC systems maximizes clean energy production and aligns with the European Union's clean energy policies by using waste biomass.
Biogas production helps promote the circular economy by valorising waste and reducing the amount of material sent to landfills. The energy obtained from the biomass → biogas → electricity and/or thermal agent chain is renewable energy. This is because the CO_2 released into the atmosphere when biogas burns comes from CO_2 assimilated by plants during their growth, or from feed consumed by animals [1].
The use of biogas as fuel in energy conversion devices, such as SOFCs, has been reported for stationary applications [2]. Furthermore, high-temperature operation offers the possibility of utilizing the heat for cogeneration cycles.
Our work lays the groundwork for future research by highlighting the need for robust and optimized system designs that can tolerate fluctuating fuel compositions.
Ultimately, overcoming these operational challenges will be key to unlocking the full potential of biogas-SOFC technology as a commercially viable, carbon-neutral solution.

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THE EXPERIMENTAL INVESTIGATION OF THE COMPOSITE COMPOUND OF PYRAZOLE, PYRAN, AND FURAN: BOND COORDINATION, ADSORPTION, AND CORROSION MITIGATION

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From electrochemistry view, one of the most efficient, cost-effective, and valuable corrosion inhibitors is the utilization of organic molecules with P, N, O, and S in their molecular structures. Due to their ability to transfer their electrons (charge) to the metallic d-orbitals and create a solid metal protective layer through coordinate bonding. The corrosion inhibition potential of heterocyclic compounds with one or more heteroatoms can correlate with their electronegativity.

Literature study suggests that heterocycle compounds having N, S, and P in their chemical structures are widely used in corrosion mitigation[2]. Obviously, in most of the cases these heteroatoms serve as site for bonding with the metallic surface. Noticeably, they also possess empty p or d-orbital where they can accept electrons being transferred from metallic d-orbitals. This process is called retro-donation. Thus. both donation and back (retro-) donation modes of chemical bonding are reinforced by these heteroatoms [3]. With each heterocyclic, we get different properties and characteristics according to its size and the heteroatoms, but in the case of combining them, will they still provide great performance or vice versa?

To answer this question, 3 different heterocycles have been adopted in such a way that pyran, pyrazole, and furan assemble to form a compound, including hetero-functional groups. To figure out their behaviour, a set of experimental studies have been carried out, such as PDP, EIS, adsorption studies , and MEB/EDX . In which the results spotlighted a magnificent behaviour of the studied compound beside its potential and ability to interact via the different active sites in different mechanisms according to the environment surrounding.

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CHARACTERISTIC PARAMETERS OF DEFLAGRATIONS OF FUEL-AIR MIXTURES UNDER ADIABATIC CONDITIONS

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Gaseous fuels, whether they come from deposits or from renewable and less polluting sources, present a high risk of explosion. As they are very often used in households to provide energy, prepare food or hot water, their study is always relevant to limit or even eliminate any risk to the population and surrounding assets. Therefore, researchers take into account in their studies a series of aspects such as: fuel concentration and type, initial temperature and pressure of the mixture, type of oxidizer, closed vessels or tubes open at one end, intensity of the energy source and its position, presence of some inert gases [1-3]. They also make both experimental measurements and a series of numerical modeling using dedicated programs [4,5].
Unfortunately, conducting experiments requires expensive equipment, large amounts of reagents, and a lot of time. Therefore, numerical modeling is an option to avoid these drawbacks and obtain a detailed characterization of these flammable gas mixtures.
The present study aims to characterize some fuel-air gaseous mixtures through numerical calculations performed under adiabatic initial conditions. Various fuel concentration, and mixture initial pressure and temperature are considered.
The results obtained from this research provide important information for the design of explosion vessels or relief devices, the development of safety recommendations, or hazard assessment of a process.

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THE INFLUENCE OF THE MICROSTUCTURAL CONSTITUENTS ON THE WELDABILITY OF NI-BASED SUPERALLOY

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Ni-based superalloys are commonly used in high-temperature applications, such as gas turbines, because of their exceptional mechanical strength, creep resistance, and oxidation stability. However, their complex chemical composition and multiphase microstructures render them vulnerable to weld-related defects, particularly liquation cracking in the heat-affected zone (HAZ). This study investigates the impact of microstructural constituents on the weldability of the cast Ni-based superalloy. A detailed microstructural characterization in the pre-weld condition revealed a dendritic structure consisting of a γ matrix with a high volume fraction of γ' precipitates, as well as interdendritic eutectic γ- γ', MC carbides, $M_{23}C_6$ carbides, and M_5B_3 borides. Hot ductility tests revealed that the alloy exhibits limited plasticity at elevated temperatures, with a peak tensile strength observed at 975 °C, followed by a rapid loss of ductility above 1200 °C. The low values of parameters such as ductility recovery rate, the ratio of ductility recovery, and the hot cracking factor collectively suggest poor weldability for this alloy. Gas tungsten arc welding trials indicated that liquation cracking in the HAZ largely resulted from the constitutional liquation of γ' precipitates, which was further influenced by the partial dissolution of $M_{23}C_6$ carbides and M_5B_3 borides. Thin, non-equilibrium liquid films formed along high-angle grain boundaries, creating easy pathways for crack initiation and propagation under thermal stress. Although MC carbides were present, their role in liquation cracking was found to be minimal. Instead, their morphology—rather than direct liquation—had a more significant impact on crack susceptibility. The edges of the re-solidified cracks typically showed an eutectic mixture of γ and γ', confirming that the formation of metastable liquid played a role in the cracking mechanism. These findings highlight that the weldability of Ni-based superalloys cannot be assessed solely by their γ' content. It is also essential to consider the presence, stability, and morphology of secondary phases such as carbides and borides. Understanding the interactions among these microstructural components is crucial for developing effective repair strategies and optimizing joining processes for advanced gas turbine components.

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NANOSTRUCTURED CARBON MATERIALS WITH APPLICATIONS IN FUEL CELLS ELECTRODES

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Recently, the interest for nanostructured carbon based materials has increased because of their unique potential to optimize fuel cells electrodes. Fuel cells (FCs) are considered to be the key for a sustainable development and energy security, based on its ability to provide a cleaner and more efficient chemical-to-electrical energy conversion, especially PEMFCs (Proton Exchange Membrane fuel cells) [1]. One of the main challenge of FCs is represented by the electrode materials that have a great impact on their cost, stability and performance. Nanostructured carbon materials are the answer to this issue due to their remarkable physicochemical properties such as large specific surface area, high electrical conductivity, tunable pore structures and strong chemical stability that make them highly suitable for enhancing electrochemical processes at the electrode-electrolyte interface [2]. In this theoretical work, a wide range of nanostructured carbon materials will be discussed from carbon nanotubes, graphene, carbon nanofibers, mesoporous carbon to carbon aerogels which have been intensively documented as supports for catalytic nanoparticles or as active components themselves, each offering distinct structural and functional advantages.
Nevertheless, nanostructured carbon materials play a crucial role in advancing the efficiency, durability, and scalability of fuel cell technologies, while reducing reliance on expensive noble metals, positioning them as one of the most promising classes of materials for next-generation energy conversion devices.

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RECTANGULAR-SHAPE CATHOD VAPOR FED (CVF) PEM WATER ELECTROLYSIS CELL FOR 1 NEWTON CLASS PROPULSION SYSTEM

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This paper aims to develop an electrolyser cell that performs water molecule separation to create Gaseous Hydrogen and Gaseous Oxygen which are stored at higher pressure for subsequent use for 1Newton class Water Electrolysis Propulsion System. For the current application it was selected the 49 cm^2 active area for a Cathode Vapor Fed (CVF) Electrolyser that offers several advantages for optimizing space utilization and efficiency in confined environments like cubesats or very small satellites [1,2]. The key points of the principle are as follows: (i) water is supplied to the anode side of the Electrochemical Hydrogen/Water Compressor (EHC) and diffuses in a vapor state to the cathode side of the PEM-CVF electrolyser; (ii) the water vapor further diffuses through the Nafion 115 membrane, driven by the concentration gradient across different layers of the electrolyser; (iii) once the water vapor reaches the anode, it undergoes electrochemical decomposition into oxygen and protons; (iv) at the cathode side of the PEM-EHC, the system produces pressurized hydrogen and at the anode side of the CVF electrolyser, pressurized oxygen is generated, respectively.

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SUPERCRITICAL WATER AS A REACTION MEDIUM FOR ZnO NANOMATERIALS SYNTHESIS

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ZnO nanostructures are promising candidates for lead-free piezoelectric materials, with their properties being strongly influenced by the synthesis method [1]. The use of supercritical water (SCW) as a reaction medium enables precise control over the morphology, size, and structure of ZnO nanomaterials [2]. In this work, ZnO nanoparticles were synthesized under SCW conditions using SINAS ("SINteză în Apă Supercritică"), a custom-made continuous flow reactor (Fig. 1). Syntheses were performed under isobaric conditions at 250 bar using an aqueous solution of $Zn(NO_3)_2 \cdot 6H_2O$ as the zinc source and KOH as the mineralizer, both at 0.1 M concentrations. SCW was maintained at 450 °C and mixed rapidly with the precursor streams in a confined jet mixer. The total flow rate determined the residence time, while controlled heating ensured stable reaction temperatures. After rapid cooling, filtration, and depressurization via a back pressure regulator, ZnO was separated by centrifugation and dried. The resulting powders were characterized by XRD, Raman, and DLS, confirming pure hexagonal ZnO phase (Fig. 2).

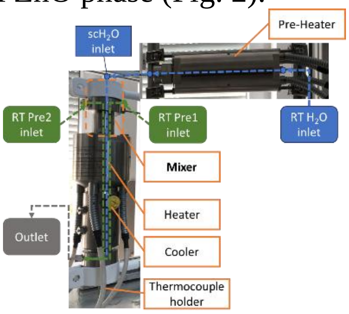

Fig. 1. Image of the custom-built SINAS reactor designed for continuous-flow synthesis in supercritical water.

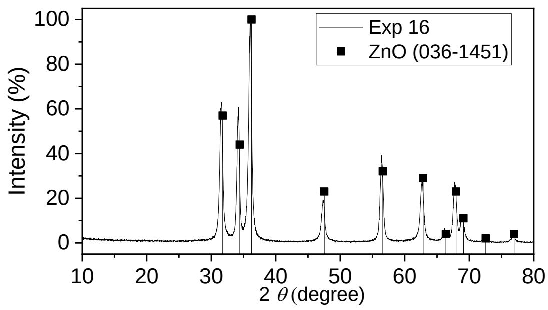

Fig. 2. XRD pattern of ZnO sample obtained by supercritical hydrothermal synthesis.

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The topic of this study is included in the Yearly Research Plan approved by the Romanian Academy. The equipment used in this work, SINAS, was developed during the project APASUPER, by UEFISCDI grant number PN-III-P4-ID-PCE-2020-1241, within PNCDI III. FM acknowledges the PNRR project ReSPonSE, PS4 (MARALTECH), Prof. S. Coman, for partial financial support. Master student A. Osoianu is truly acknowledged for lab support during her On ShipBOARD practical stage.

INFLUENCE OF VARIABLE ANTIMONY AND COPPER CONTENT ON THE PROPERTIES OF A TIN-BASED BEARING ALLOY

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Tin-based bearing alloys with the addition of copper and antimony are characterized by high abrasion resistance, good mechanical properties, and good thermal conductivity. Furthermore, this alloy is widely used in transportation, especially railways, for sliding bearings.

In addition to the melting and casting process parameters, chemical composition has a key impact on the formation of hard phases and the final properties of the SnSb11Cu6 bearing alloy. The main alloying additions, Sb and Cu, introduced into the Sn matrix, increase mechanical and bearing properties while reducing ductility. With a constant antimony content, increasing the copper content causes a decrease in elongation and plasticity. Sb and Cu additives can optimise properties such as hardness, wear resistance and structural stability. However, it is important to maintain the correct proportions, as excess can lead to brittleness and deterioration of performance properties.

The study focused on examining the influence of varying Cu:Sb ratio on the microstructure, mechanical, and tribological properties of the SnSb11Cu6 bearing alloy. The material was produced by melting and casting using an induction furnace.

It was found that the modification of the chemical composition affects the microstructure, hardness, and tribological properties of the produced alloys. Increasing the Sb and Cu content in the chemical composition resulted in an increased proportion of the Sb-Sn phase, which was smaller and more evenly distributed in the matrix, higher hardness (3% increase for the SnSb12Cu6.5 alloy compared to the SnSb11Cu6 alloy) and tensile strength (6% increase for the SnSb12Cu6.5 alloy compared to the SnSb11Cu6 alloy). The alloy with increased copper content (SnSb12Cu6.5) exhibited the lowest wear rate in tribological tests (approximately 19% reduction compared to the SnSb11Cu6 alloy) and the smallest wear track width.

The research was carried out as part of the Lider project, the main goal of which is to develop a technology for producing a wire from a tin-based bearing alloy with an optimized chemical composition intended for layer welding of the sliding layer on bearing shells using the innovative WAAM (Wire Arc Additive Manufacturing) 3D printing method, as well as to develop a technology for producing a sliding layer from a newly developed wire using the WAAM 3D printing method.

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EXPLORING EB-PVD FOR TEXTILE SUBSTRATES: DEPOSITION OF METALLIC LAYERS AND FUNCTIONAL PROPERTIES

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Electron Beam Physical Vapor Deposition (EB-PVD) represents an advanced technique primarily employed for obtaining high-performance coatings on metallic or ceramic substrates. In this work, we address a less explored direction: the application of EB-PVD on textile materials. The main objective was to investigate how metallic layers can be deposited onto flexible and porous substrates, characteristic of textile fibers, and to evaluate the potential functional properties achieved. Metallic coatings on textiles open up significant perspectives, ranging from imparting electrical conductivity essential for the development of smart textiles to providing antimicrobial effects, valuable in the medical field or protective equipment. Preliminary results highlight good adhesion of thin films onto fibers, with uniform microstructural distribution, without compromising the flexibility of the substrate. Therefore, EB-PVD proves to be a promising technology for textile functionalization, enabling the combination of the mechanical and comfort properties of fibers with advanced characteristics specific to metallic materials. This study contributes to extending the applications of this method towards multifunctional textiles, with impact both in industry and in fundamental research.

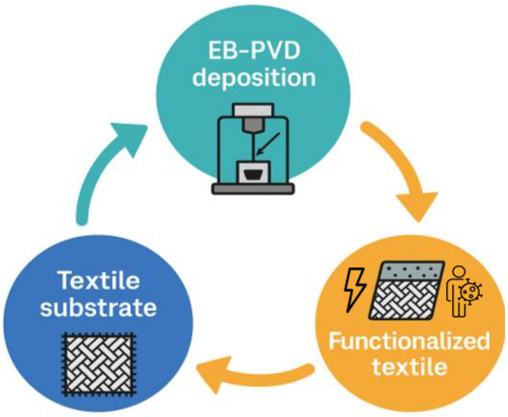

Fig 1. Graphical Abstract: Metallic Layer Deposition on Textiles via EB-PVD

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BOOSTING FUEL CELL EFFICIENCY BY NEW MATERIALS

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The hydrogen economy represents a pivotal pathway toward achieving global decarbonization, energy security, and sustainable development. Fuel cells with proton exchange membranes (PEMFCs) are promising clean energy technologies, but their large-scale deployment is still limited by the high cost of platinum catalysts, durability issues, and membrane conductivity challenges. Recent advances in materials science have focused on three key directions:
(1) Catalyst supports from sustainable sources – e.g., porous carbon derived from recycled polystyrene, which enabled 92.1 % retention of initial power density after 30,000 cycles compared to only 35.8 % for commercial Pt/C catalysts [1].
(2) Platinum alloy catalysts – such as Pt–Ni and Pt–Co, which exhibit 3–5× higher oxygen reduction reaction (ORR) activity. However, under accelerated stress tests, degradation processes such as Ostwald ripening, Pt dissolution, and Co leaching significantly reduce long-term stability [2-3].
(3) Advanced membranes – doped polymers and composites with inorganic fillers (Zr, Si) or sulfosuccinic acid (SSA), as well as biopolymer blends (e.g., chitosan). These approaches achieved proton conductivities up to 0.307 S/cm at 90 °C and 100 % RH, significantly outperforming Nafion [4].
Together, these innovations demonstrate that advanced materials can substantially boost the efficiency, durability, and sustainability of PEM fuel cells. Future work should address cost optimization, large-scale synthesis, and integration into commercial stacks.

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MEMBRANE ELECTRODE ASSEMBLY – THE KEY OF THE HYDROGEN ECONOMY IMPLEMENTATION

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The hydrogen economy is one of the most promising directions for the energy transition towards a sustainable future, with the potential to reduce dependence on fossil fuels and reduce greenhouse gas emissions. At the heart of this transition are proton-changing membrane fuel cells (PEMFCs), which are considered key technologies due to their high efficiency, quiet operation and absence of pollution at the point of use. The fundamental component of these cells is Membrane Electrode Assembly (MEA), a layered assembly that provides the electrochemical processes of converting hydrogen into electricity. MEA includes proton-conducting membrane, catalytic layers and gas diffusion layers, each of which has a critical role in performance, durability and cost. MEA optimization is essential for the large-scale implementation of the hydrogen economy, as it determines parameters such as power density, service life and the economic feasibility of fuel cells. Currently, major challenges include the high costs of platinum-based catalysts, membrane degradation under dynamic operating conditions, and water management difficulties. The research directions are aimed at developing low-content or non-precious metal catalysts, improved conductivity membranes and innovative architectures to ensure increased performance. Thus, MEA represents the „heart" of the fuel cell and the key to implementing the hydrogen economy. Technological advances in this field will dictate the speed and scale with which hydrogen will become a central energy vector of the global transition to clean and sustainable sources.

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FUEL CELL – SCALING TO APPLICATIONS

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Fuel cells are one of the most promising for polution free energy, as they convert chemical energy directly into electricity through electrochemical reactions, offering in the same time high efficiency and minimal environmental impact [1]. Compared with conventional combustion-based systems, fuel cells achieve efficiencies up to 60% in electrical mode and even higher when integrated in combined heat and power (CHP) systems [2]. Aditionally, they operate silently, produce little to no harmful emissions at the point of use, and demonstrate scalability for a wide range of applications.
Scaling these technologies from laboratory prototypes to commercial implementation requires addressing critical challenges. These include lowering the cost of catalysts and membranes, enhancing durability to meet lifetime expectations, and ensuring reliable large-scale manufacturing processes [1]. Modular stack design, system standardization, and integration with renewable hydrogen infrastructure are among the most promising strategies for overcoming these barriers. Pathways to commercialization are strongly tied to reducing system costs, establishing reliable supply chains, and developing hydrogen infrastructure supported by enabling policies. [3-4].
Applications are rapidly expanding: fuel cell vehicles are being deployed in several countries, heavy-duty trucks and buses powered by hydrogen fuel cells are entering fleets, and microgrids are supplying distributed and resilient power. At the same time, portable fuel cells are enabling applications in drones, electronics, and remote sensing. These developments denote both the versatility of this technology and its alignment with global decarbonization targets [3]. Proton exchange membrane fuel cells (PEMFCs) are the leading choice for transportation and portable power applications due to their low operating temperature and rapid start-up capabilities, while solid oxide fuel cells (SOFCs), which operate at high temperatures, offer excellent fuel flexibility and efficiency.[5] Alkaline fuel cells (AFCs), historically used in space programs, continue to find industrial applications, and to have the highest potential for residential applications [4, 5].

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NANOSTRUCTURED CARBON MATERIALS OF THE GRAPHENE TYPE WITH MEDICAL APPLICATIONS

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In the contemporary medical context, conventional biomaterials struggle to meet the increasing demands for early diagnosis of diseases and development of effective targeted therapies. Issues such as limited biocompatibility, low sensitivity and poor adaptability to complex biological environments highlight the urgent need for innovative alternatives. In this context, carbon nanostructured materials from the graphene family emerge as fascinating candidates, due to their unique combination of mechanical strength, high electrical conductivity, large specific surface area and remarkable biocompatibility [1].
This work aims to highlight the extraordinary properties of graphene-like nanostructures and its derivatives, such as graphene oxide (GO), reduced graphene oxide (rGO) and graphene quantum dots (GQDs), and to shed light on their biomedical potential. These two-dimensional carbon-based architectures, characterized by their large specific surface area and functional versatility, are distinguished by properties that confer them a great biomedical potential [2]. This theoretical paper also aims to highlight and analyze the major directions in which graphene-type nanostructures can be exploited in the medical field, providing a synthesis of recent advances and associated challenges.
Overall, graphene-type nanostructured carbon materials are emerging as multifunctional solutions with a central role in modern biomedicine, with the potential to support the development of new generation medical technologies.

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SUPERCRITICAL WATER AS A REACTION MEDIUM FOR ADVANCED MATERIALS DEVELOPMENT

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In the context of rising global energy demand and the need for sustainable technologies, supercritical water (SCW) has emerged as a green, efficient medium for converting organic waste—including biomass and wastewater—into energy-rich products. SCW-based processes such as supercritical water gasification and supercritical water oxidation offer viable routes for producing energy relevant products, such as hydrogen and methane. However, the extreme conditions of SCW reactors pose significant challenges for the development of stable and functional materials, especially catalysts, catalyst supports, and sorbents [1].

This study provides a multidisciplinary overview of advanced materials used in SCW environments, focusing on metal oxide nanomaterials supported on porous carbon. ZnO/C and CuO/C composites were synthesized via a novel continuous-flow SCW impregnation method that eliminates the need for mineralizers or seed layers, enabling rapid preparation and high-performance functionality [2]. ZnO/C composites demonstrated excellent sulfur adsorption capacity (1.55 molS/molZn), effectively mitigating catalyst poisoning *via* a pseudomorphic replacement mechanism during biomass gasification [3].

At the fundamental level, this work also explores the pseudo-boiling (PB) phenomenon—a structural transition from liquid-like to gas-like phases across the Widom line [4,5]. Using *in situ* neutron imaging combined with computational analysis, the first quantitative thermodynamic characterization of PB in SCW it was presented. These insights contribute to defining the structure–property relationships essential for optimizing operating conditions in SCW reactors for environmental and energy applications.

Altogether, this integrated research advances material design and reactor engineering for scalable, efficient waste-to-energy systems based on SCW technologies.

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INDIRECT DETERMINATION OF FUEL-AIR AND FUEL-HYDROGEN-AIR MINIMUM IGNITION ENERGIES

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For flammable mixtures within the flammability range, explosion initiation occurs when the energy transferred from the ignition source exceeds a threshold value, equal to the minimum ignition energy (MIE). Measurement of the minimum ignition energy uses as ignition source capacitive electric discharges, which simulate the sparks produced by static electricity discharges. Besides these high voltage electric sparks, low voltage electric sparks produced by the mechanical breaking of a low voltage circuit containing an inductive component ("break" sparks) are used in studies of the intrinsic safety of electrical equipment working in gaseous environments with explosion hazard, according to IEC 60079-20-1 standard [1]. The characterization of the sensitivity of gases towards ignition by break sparks is made by the minimum ignition current, i_{min}, as recommended by IEC 60079-11 standard method [2]. From the minimum ignition currents one can calculate the associated critical ignition energies, H'_{min}, which can be largely different from the minimum ignition energy by high voltage sparks, H_{min}, commonly used in assessing hazards associated with flames of gaseous mixtures [3,4]. In this study, the minimum ignition energies are calculated from both measured quenching distances, using a validated correlation model, and from measured minimum ignition currents. The measurements of critical ignition parameters - quenching distance, and minimum ignition current, of stoichiometric hydrocarbon-air and hydrogen-hydrocarbon-air flames are reported at various initial pressures and various amount of added hydrogen.
The present indirect method for determining minimum ignition energies at ignition by high voltage sparks could thus be a convenient alternative to the recommended method based on use of capacitive sparks. Compared to these values, the ignition energies at initiation by break sparks are systematically higher, due to important energy losses appearing at the contact between electrodes.

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HEAT OF COMBUSTION OF VARIOUS BIOMASS PELLETS AS FEEDSTOCKS FOR BIOENERGY

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The increasing demand for renewable energy options has intensified interest in biomass as a sustainable replacement for fossil fuels. This research aims to assess and compare the net calorific value and ash content of nine types of biomass pellets obtained from three different sources: rural vegetation (Thorn, Milk Thistle, Eryngo); forest vegetation (Stone Lichen, Agropyron Repens,Viscum Album) and agricultural/industrial by-products (sorghum grists, grape pomace, corn cob). The goals of this study are: (1) to measure the combustion heat of chosen biomass feedstocks using combustion calorimetry method; (2) to evaluate their ash content as a factor affecting combustion efficiency and emissions; and (3) to determine the most appropriate biomass species for bioenergy applications based on energy and environmental considerations [1], [2]. The results reveal considerable variation among different species. Milk Thistle exhibited the highest net calorific value (23.87 MJ/kg), followed closely by grape pomace (21.50 MJ/kg) and Viscum Album (21.32 MJ/kg). In terms of ash content, Agropyron Repens showed the lowest percentage (1.22%), indicating its excellent combustion properties and minimal residue production. In contrast, corncob had the highest ash content (12.5%), which could hinder its effectiveness in efficient energy systems due to the potential for increased slagging and maintenance issues [3].

In conclusion, Milk Thistle is regarded as the most energetically valuable source of biomass, whereas Agropyron Repens provides superior outcomes regarding clean combustion. Both species are promising options for additional advancement in biomass energy production. These results contribute in optimizing the selection of biomass resources, supporting efforts toward a cleaner and more sustainable energy future [4], [5].

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INFLUENCE OF THE SUBSTRATE ON THE MICROSTRUCTURAL, OPTICAL AND VIBRATIONAL PROPERTIES OF ITO FILMS PREPARED BY SOL–GEL METHOD

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Transparent conducting oxides (TCOs) are an integral part of modern optoelectronics devices such as photovoltaic cell, solar cells, flat panel displays and infrared reflection glasses. Indium tin oxide (ITO) films show high visible transmittances have attracted more attention for practical optoelectronics applications.

In the present work multi-layered ITO films have been obtained by dip coating sol-gel route on three different types of substrates (silicon, glass and glass covered with one layer of SiO_2). The as-prepared and thermally treated films for one hour at 500ºC were comparative characterized by X-ray Diffraction (XRD), Atomic Force Microscopy (AFM), Transmission Electron Microscopy (TEM) coupled with Selected Area Electron Diffraction (SAED), Infrared Spectroscopic Ellipsometry (IRSE) and Raman spectroscopy analyses.

The results showed that the microstructural and optical properties of ITO films depend the thickness (number of deposited layer), temperature used for thermal treatments and the type of substrate. Using IRSE and Raman techniques, the vibrational bands and their-assignment were determined in parallel.

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ONE STEP SYNTESYS OF NPC-AMOPRHOUS THIN PIROPHOSFAT FOR SUPERCAPACITOR APPLICATION

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In recent years, pyrophosphate materials (MxP_2O_7, M = Ni, Co, Cu, Sn, Zn, Fe, etc.) have emerged as some of the most promising candidates for supercapacitor applications due to their improved electrical conductivity compared to phosphate-based materials[1].

Nanoporous metals synthesized by the dealloying process have also been highlighted as a convenient method for producing porous structures with high surface area. Among them, nanoporous copper (NPC) is one of the most widely studied materials for energy storage applications because of its high electrical conductivity and the increased number of active sites at the metal–oxide interface, which enhances the utilization of the active material[2].

The research team reported for the first time the integration of $Sn_2P_2O_7$ into supercapacitor applications, highlighting both its electrochemical performance and the cell behavior in a symmetric configuration[3]. Furthermore, this work demonstrates, for the first time, the synthesis of $Sn_2P_2O_7$ via a dealloying process starting from amorphous ribbons, providing evidence of the strong interaction between NPC and $Sn_2P_2O_7$[3].

The electrochemical behavior was investigated using cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), and electrochemical impedance spectroscopy (EIS) techniques in a three-electrode system as well as in symmetric two-electrode cells.

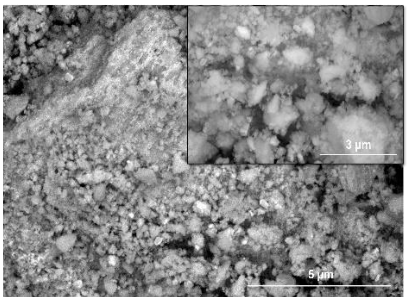

Figure 1. The structural morphology of NPC/amorphous-$Sn_2P_2O_7$

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SUSTAINABLE HARD CARBON MATERIALS FROM BIOMASS PRECURSORS FOR SODIUM-ION BATTERY APPLICATIONS

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In recent years, the demand for eco-friendly and cost-effective energy storage systems has grown significantly, driven by rapid technological advancement and the associated high consumption of natural resources. Currently, Li-ion batteries satisfy market needs in terms of performance and affordability. However, the limited availability of Li resources raises concerns about their long-term sustainability. In this context, Na-ion batteries have gained increasing attention due to the abundance of Na in the Earth's crust, offering a promising low-cost alternative for future energy storage solutions [1].
Meanwhile, biomass represents a renewable and low-cost precursor for producing hard carbon (HC) materials, with promising potential for Na-ion batteries applications [2].
In this work, we report the development of HC materials derived from coconut shells, walnut shells, and corn silk biomass waste. The materials were synthesized via pyrolysis at 1300 °C followed by acid washing to eliminate inorganic impurities, resulting in HC with low and similar surface areas (<10 $m^2 g^{-1}$).
Physico-chemical analyses indicated a higher structural disorder in the HC obtained from coconut shells, while the corn silk-derived HC exhibited a combination of disordered carbon and localized graphitic domains. Different organic and inorganic compositions were found to tailor various carbon features in order to obtain good performance in Na-ion batteries, i.e., a capacity between 293 and 315 mAh g-1 at 50 mA g-1 with good retention (87%–93%) after 100 cycles.

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INNOVATIVE CATALYSTS USED TO SCALE UP THE GREEN METHANOL PRODUCTION PROCESS

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An area that has been intensively studied in recent years is the conversion of carbon dioxide (CO_2) into various chemical compounds, producing liquid organic hydrogen carriers LOHC), including green methanol (CH_3OH). The production of green methanol, an environmentally friendly alternative to conventional methanol, is experiencing global growth [1-2]. This is explained by its contribution to reducing greenhouse gas emissions and supporting the decarbonization process. Methanol is a basic product of organic chemistry, widely considered both as one of the fuels of the future and as a precursor in the production of organic compounds. The catalyst plays an important role in the production of methanol by reducing carbon dioxide [3]. Various types of metal catalysts have been studied, but copper-based catalysts are considered the most promising catalytic systems for the production of methanol due to their affordable cost and high yield. Moreover, the incorporation of zinc oxide (ZnO) enhances the catalytic system's performance by increasing CO_2 conversion to methanol and facilitating the generation of active sites at the Cu/ZnO interface. The scaling of the process of obtaining green methanol is directly influenced by the copper/zinc (Cu/Zn) ratio of the performance of the innovative catalysts used [4]. However, the ratio between Cu and Zn has a significant influence on the activity and stability of the catalyst. Therefore, preserving the optimal formulation of the Cu-Zn based catalyst is crucial to ensure the desired features that enhance its functionality. In this context, our goal is to synthesize advanced catalysts characterized by reduced crystallite sizes, minimized agglomeration, uniform particle distribution, enhanced reducibility and copper dispersion, and a high Cu surface area. This approach will support the scale-up of green methanol production for industrial applications.

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TYPES OF METAL CATALYSTS USED TO OBTAIN METHANOL BY REDUCING CARBON DIOXIDE

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Over time, fossil fuels have led to the development of life for human society, but the increase in carbon dioxide (CO_2) emissions has led to an increase in the greenhouse effect, and consequently to pollution. Fossil fuels are exhaustible. That is why the use of renewable energy is considered, which minimizes the impact on the environment. An example in this regard is the conversion of carbon dioxide into various chemical products, many of which serve as fuels. The reduction of carbon dioxide in the presence of certain catalysts (heterogeneous catalysis) and reaction conditions (pressure, temperature) leads to the production of methanol (CH_3OH). Methanol, a chemical raw material of particular importance, is considered the fuel of the future, being used for fuel cells (methanol fuel cell) and internal combustion engines. Methanol is a fuel that, in terms of both reactivity and price, constitutes a compromise between hydrogen and hydrocarbons. In recent years, studies have been carried out and major progress has been made in the development of ideal catalysts for obtaining methanol by reducing carbon dioxide. The preparation techniques used are state-of-the-art: impregnation, co-precipitation, and sol-gel. In the structure of these catalysts, we can find metals, metal oxides, and intermetallic compounds. The challenges regarding the obtaining of these catalysts consist in the development of catalysts with promising catalytic performance and stability over a long period of time. The catalysts used to obtain methanol by reducing carbon dioxide are classified as follows: copper-based catalysts ($Cu/ZnO/Al_2O_3$), indium oxide-based catalysts (In_2O_3), gallium oxide-based catalysts (Ga_2O_3), bimetallic catalysts (Cu-Zn, Cu-Zr, Cu-In), noble metal catalysts (Pt, Pd, Ru, Rh), and electrochemical and photochemical catalysts. This paper will present comparative studies of the catalysts used (structure, operating parameters, conversion, selectivity, advantages, disadvantages) for obtaining methanol.

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STUDIES ON THE BEHAVIOR OF POLYPROPYLENE FILM CAPACITORS SUBJECTED TO THERMAL TREATMENTS

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This paper studies the behaviour of polypropylene film capacitors exposed to heat treatment involving temperature variation. Eighteen thermal cycles were performed, with temperatures ranging from 0°C to 140°C. The effect of the heat treatment on the capacitors' properties was underlined by measuring their capacitance, dissipation factor, and ESR (equivalent series resistance). These measurements revealed changes in the studied parameters and, consequently, changes in the capacitors' structure, offering insights into their degradation under extreme operating conditions.

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A COMPREHENSIVE ELECTROCHEMICAL ANALYSIS FOR Pt BASED CATALYST

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In the context of the ongoing transition towards sustainable and clean energy systems, proton exchange membrane fuel cells (PEMFCs) are emerging as a promising technology for the efficient conversion of chemical energy into electrical energy. The performance of such systems is directly influenced by the effectiveness of the electrocatalysts used, especially in the Oxygen Reduction Reaction (ORR) [1].
This study investigates how both the composition and the nature of the support material affect catalytic activity under conditions relevant to PEMFC operation. The paper presents linear sweep voltammetry (LSV) results for a series of platinum (Pt)-based catalysts, with metal loadings of 10% and 40%, supported on two different carbon materials: reduced graphene oxide (rGO) and carbon black.
The findings reveal notable variations in current densities and ORR onset potentials, underlining the benefits of using graphene-based supports, which promote improved Pt particle dispersion and greater electrochemical stability. Nanostructured carbon materials such as rGO offer an optimal platform for forming active interfaces between the catalyst and support, enabling a reduction in Pt loading without compromising electrocatalytic performance. Lowering the Pt content while maintaining high activity also contributes to cost reduction and enhanced durability of the system [2].
Overall, this work deepens the understanding of the electrochemical behavior of advanced catalytic materials and offers valuable insights for optimizing electrode design in PEMFC applications.

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ATOMIC LAYER DEPOSITION: A VERSATILE TECHNIQUE FOR THE DEVELOPMENT OF NANOSTRUCTURED ELECTROCATALYSTS

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Proton exchange membrane fuel cells (PEMFCs) are considered among the most promising technologies for the efficient and environmentally sustainable conversion of chemical energy into electrical power, with applications ranging from electric transportation to stationary energy generation. Nevertheless, their large-scale commercialization remains hindered by the high cost and limited durability of the electrode components, particularly the catalytic layer. Platinum (Pt)-based catalysts provide the highest performance; however, their elevated cost necessitates strategies that optimize the utilization of the active material while ensuring stability under demanding electrochemical conditions.

Within this framework, the atomic layer deposition (ALD) technique has emerged as a highly effective approach for synthesizing advanced catalytic materials, enabling precise control over film thickness, composition, and morphology at the atomic scale. ALD is a vapor-phase process in which chemical precursors sequentially react with the substrate surface, thereby facilitating the controlled deposition of ultrathin layers with atomic-level accuracy [1].

The use of ALD in the development of catalysts for PEMFC electrodes offers several key advantages: the synthesis of nanostructured materials with tailored dimensions, the uniform deposition of corrosion-resistant transition metal oxides, and the fabrication of stable and efficient bimetallic structures. Furthermore, ALD enables the precise functionalization of various supports (such as carbon nanomaterials or conductive oxides), thereby enhancing metal–support interactions and mitigating catalyst degradation during operation. By fine-tuning process parameters—including precursor type, reactive gas, temperature, and cycle number—critical catalyst properties can be systematically adjusted, directly influencing the electrochemical behavior and overall performance of PEM cells [2].

This study aims to highlight and systematize the potential of the ALD technique in the design of nanostructured catalysts for PEMFC electrodes, with emphasis on the fundamental mechanisms of the ALD process, precursor selection, and optimization of metal–support interactions to enhance fuel cell performance.

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CHARACTERIZATION OF THE MICROSTRUCTURE AND STABILITY OF PT-MODIFIED NI-BASED SUPERALLOY FOR AEROSPACE APPLICATIONS

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Single crystal (SX) Ni-based superalloys are currently used in both civil and military aeroengines at operating temperatures of up to 1100–1150 °C. A characteristic feature of cast nickel-based superalloys is their high volume fraction of γ’ precipitates, which are stable at temperatures up to 1000 °C. The mechanical strength of these superalloys is influenced by the volume fraction, morphology, size, and chemical composition of the precipitates. The design of the next generation of superalloys, which aims to exhibit enhanced creep resistance and higher service temperatures, is currently limited by the stability of the γ’ phase. In this research, the Ni-based superalloy René N5 (composed of Ni-7.0Cr-8.0Co-2.0Mo-3.0Re-5.0W-6.2Al-7.0Ta-0.2Hf) has been modified by adding varying amounts of platinum (Pt=0, 1, 2, 3, 4, or 5 wt%). A total of 20 grams of the Ni-based superalloy and platinum feedstock were used to fabricate rods measuring 5x50 mm through suction casting. Observations and analyses of six variants were conducted using ThermoCalc simulations, differential scanning calorimetry (DSC), synchrotron X-ray diffraction, light and scanning electron microscopy. The thermodynamic simulations revealed that the addition of platinum (Pt) significantly influences the stability of the γ' phase and increases its volume fraction. Furthermore, it raises the solvus temperature of γ'. DSC studies indicated that the addition of Pt does not have a strong impact on the solidus and liquidus temperatures of René N5, thus allowing the same heat treatment procedure to be used. The microstructure of the produced castings is characterized by a typical dendritic structure, predominantly featuring a cubic-like intermetallic γ' phase. It was also noted that platinum has a significant effect on altering the morphology of the γ' precipitates, making them more cubic in shape, which enhances their creep resistance. Additionally, platinum is known for its low coefficient of thermal expansion, and its addition reduces the coefficient of thermal expansion of the René N5 superalloy at elevated temperatures. The incorporation of Pt has been shown to greatly improve oxidation resistance by promoting the formation of Al_2O_3.

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METAL-DOPED LANTHANUM MANGANITES: COMPARATIVE INSIGHTS INTO PHYSICAL AND ELECTROCHEMICAL PROPERTIES

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Perovskite-type materials, particularly lanthanum manganites ($LaMnO_3$), have attracted significant attention due to their versatile properties—ranging from catalytic and electronic to magnetic and ionic functionalities—which render them valuable for applications in energy conversion, sensing, and catalysis [1–3]. This study presents a comparative investigation of pristine $LaMnO_3$ and its Ca- and Pd-substituted analogs, synthesized via the sol-gel method followed by low-temperature thermal treatment to maintain nanoscale characteristics.
The structural and morphological features of the synthesized powders were characterized using X-ray diffraction (XRD), confirming single-phase cubic perovskite structures (space group Pm-3m) with average crystallite sizes between 18 and 20 nm, as estimated via the Scherrer equation. Fourier-transform infrared spectroscopy (FTIR) identified key vibrational modes associated with metal-oxygen bonds, while Transmission Electron Microscopy (TEM) provided direct visualization of the nanoscale morphology. Energy-dispersive X-ray spectroscopy (EDX) supported the elemental composition, and Brunauer–Emmett–Teller (BET) analysis provided surface area values relevant to catalytic performance.
Electrochemical evaluation was performed using cyclic voltammetry on Ni electrodes modified with the synthesized perovskite materials, tested in 1 M KOH electrolyte containing varying ethanol concentrations. Compared to bare Ni electrodes, those modified with $LaMnO_3$-based materials showed significantly improved electrocatalytic behavior, particularly in terms of increased oxygen evolution overpotential and enhanced current response—indicative of more efficient electron transfer and catalytic activity.
Among all tested samples, the Pd-doped $LaMnO_3$ exhibited the most notable performance enhancement. This suggests that Pd incorporation positively influences the electronic structure and oxygen vacancy distribution, which are critical for catalytic activity. These findings underscore the potential of doped $LaMnO_3$ perovskites—especially those modified with noble metals like Pd—as effective electrocatalysts for ethanol oxidation and related energy applications.

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INFLUENCE OF TEMPERATURE ON THE MATERIAL PROPERTIES OF CARBON FIBER COMPOSITES MANUFACTURED USING OUT-OF-AUTOCLAVE TECHNIQUES

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This study presents a comparative analysis between two carbon fiber composite materials manufactured using the same resin infusion technology but under different curing conditions. One material was cured at room temperature, while the other underwent curing with the application of an external temperature of 50 °C± 3°C. Both laminates were fabricated from untreated carbon fibers arranged in six plies with the sequence [90/0/45/−45/0/90], using L20 epoxy resin with Hardener EPH 161. To evaluate the influence of curing temperature on material performance, several experimental techniques were employed, including mechanical tests (tensile and three-point bending) and Heat Deflection Temperature (HDT) measurements under load. The results provide a direct comparison of the mechanical and thermal properties of the two composites, highlighting the role of controlled curing temperature in improving stiffness, strength, and thermal resistance. This work contributes to a better understanding of the correlation between curing conditions and the performance of out-of-autoclave composite structures.

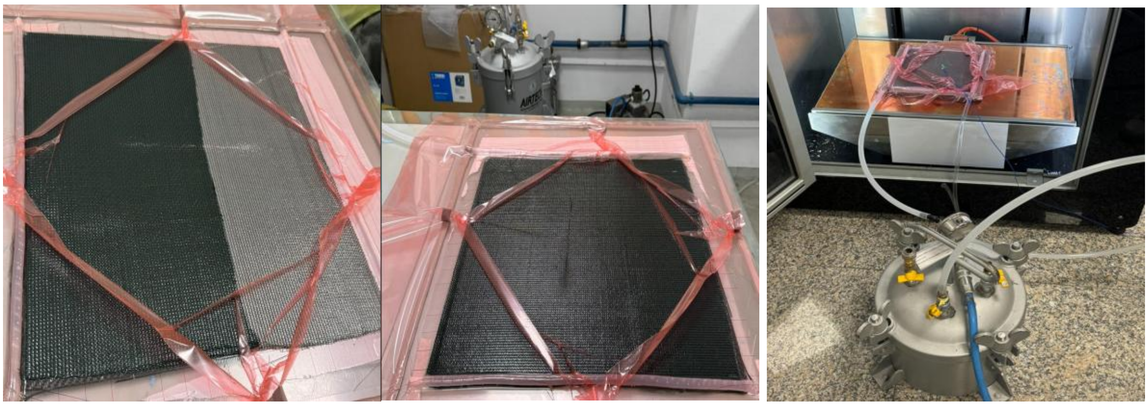

Fig. 2 Carbon fiber composites plates manufactured via resin infusion with and without external heating

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IMPACT OF LOW-ENERGY H^+ IMPLANTATION ON THE FORMATION AND PROPERTIES OF NANOSCALE SILICON OXIDES

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In modern devices with multi-layered structures, failure mechanisms often appear due to thermal expansion mismatches at material interfaces. In silicon-based devices, the Si-SiO_2 interface plays a decisive role having strong influence on the growth of reliable nano-scaled thermal oxide on silicon for fabrication of smaller and faster device structures. However, ultrathin SiO_2 with easily controllable thickness, high dielectric quality and perfect interfaces is difficult to be obtained at temperatures lower than 900°C.

In order to grow high quality ultra-thin SiO_2 layers with decreased mechanical stress at rather low oxidation temperatures, we have applied a new technological approach, modifying a shallow Si surface layer by RF plasma ion immersion (PII) implantation of low-energy H^+ ions before its thermal oxidation.

In the present study we have investigated silicon dioxides with thicknesses of (10-12) nm grown on Si(100) substrates implanted with 2 keV H^+ ions at 10^{13} to 10^{15} cm^{-2} fluence by PII implantation followed by oxidation at 700 and 800°C in dry oxygen. For comparison purposes, bare Si(100) substrates were oxidized together with the implanted ones. Electroreflectance and spectroscopic ellipsometric measurements in UV-Vis and infrared regions have established that oxidation of H^+ modified Si substrates results in enhanced oxidation rates and reduced stress levels at the Si–SiO_2 interface and the more ordered oxide layer. AFM imaging has shown the creation of small pits on the implanted Si surfaces, which are flatten out during the followed oxidation and forming a homogeneous and smooth oxide surface morphology.

These studies have shown that by the proposed procedures at certain technological parameters, more stoichiometric oxides with lower intrinsic stress with faster oxidation rate are grown. The presence of hydrogen atoms in the Si structure creates favorable conditions for growing nearly stoichiometric oxides with lower refractive indices and less intrinsic stresses at low temperatures, unusual in Si technology.

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FROM FOSSIL FUELS TO LI – ION BATTERIES: NEW TRENDS IN DEVELOPING ANODE MATERIALS

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Transition from the intensive exploitation of fossil fuels to the use of new renewable and more environmentally friendly energy sources has become a necessity, therefore leading to the development of innovative solutions that can keep up with the challenges of the present society. The continuous development and continuously increasing demand of the working environments have pushed the limits of knowledge, placing more and more emphasis on the continuous development of Li – ion battery components. In the anode manufacturing process, graphite has dominated the market for many years, owing to several advantages, including high reversibility, good electrical conductivity or reduced cost. On the other hand, graphite has certain limitations, such as lithium plating at high charging rated, that can lead to internal short circuits, limited specific capacity or volume expansion, that can contribute to mechanical stress over charge – discharge cycles. These constrains have encouraged the development of new materials, based on high entropy transition metal oxides (HETMO), with superior properties.

HETMO synthesis can be done through different methods, including combustion synthesis, sol – gel or co – precipitation, each bringing certain advantages in decreasing the environmental impact. However, a relatively new and promising route for synthesizing advanced anode materials involves a hybrid process that combines induction furnace melting with controlled oxidation in an attritor mill. This method allows for the efficient preparation of nanostructured complex oxides with well-controlled morphology and composition, suitable for lithium-ion battery applications.

This paper aims to provide an economical and ecological comparative analysis between different methods of obtaining complex oxides used in the manufacturing of anodes. An analysis of the simulation tools is considered, as well as the optimization possibilities of experimental parameters, to be able to obtain precise compositions, that are suitable for being used in Li – ion batteries anode.

Keywords: anode materials, high entropy transition metal oxides, manufacturing processes, environmental impact

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Advancing Thin Film Morphology Control: A Novel Solvent Vapor Annealing Approach for P4T4F-HD:Y12 Blend Films

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The control of molecular organization in organic semiconductor thin films remains a central challenge for achieving high-performance optoelectronic devices. Here, we present a newly developed solvent vapor annealing (SVA) method specifically applied to P4T4F-HD:Y12 blend films, which enables a more precise regulation of nanoscale morphology compared to conventional spin coating. The process relies on a thermally controlled chamber equipped with a Peltier element, allowing the thin film to be initially cooled below room temperature. Organic solvent vapor is introduced into the chamber, which gradually penetrates and swells the thin film matrix. This swelling stage provides sufficient free volume for the polymer chains to reorganize. Subsequently, the chamber temperature is increased in a slow and highly controlled manner, driving the evaporation of the solvent while allowing the polymer chains to settle into a more ordered configuration [1].

AFM imaging reveals that this approach results in significantly larger crystalline domains and a more interconnected phase-separated network compared to both spin-coated films and films processed by convective self-assembly (CSA) [2]. The domains exhibit a significantly larger size and improved continuity, highlighting a degree of molecular ordering that cannot be achieved by conventional spin coating, where rapid solvent evaporation prevents extensive structural reorganization. Such enhanced domain formation is expected to strongly impact the optoelectronic performance of organic devices. Larger crystalline regions can facilitate improved charge carrier mobility, more efficient exciton dissociation, and reduced trap states. Consequently, this technique holds promise for advancing device architectures where long-range order is critical, such as organic light-emitting diodes (OLEDs) and organic field-effect transistors (OFETs).

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HYBRID THERMOFILLERS FOR THERMAL MANAGEMENT APPLICATIONS

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The performance of electric and electronic devices is highly influenced by heat accumulation as a consequence of their minimization [1-2]. Using interface materials with and without phase change materials (PCMs) represents one of the thermal management strategies. Since the most commonly known interface materials are polymers with low thermal conductivity, the addition of the thermofillers is required. Although metals and carbon-based thermofillers possess the highest thermal conductivity, the short circuits must be prevented [2]. Hence, obtaining hybrid thermofillers with a dielectric shell covering the metallic core is a viable strategy in improving the thermoconductivity of polymer-based composites for thermal management applications.

Green and hydrothermal synthesis [2-4] were used for the preparation of core-shell hybrid nanoparticles. UV-VIS spectroscopy-assisted core synthesis has enabled optimization of method parameters (time, temperature, PH, etc.). DLS, Zeta potential, UV-Raman spectroscopy, XRD, and SEM measurements were carried out to characterize the obtained hybrid nanofillers. Improved dispersion of copper core nanoparticles (CuNPs) functionalized with PVP was derived by the zeta potential negative values (Fig. 1a). Functionalization and partial oxidation of the CuNPs were highlighted by UV-Raman spectroscopy (Fig. 1b), while CuNPs formation was supported by X-ray data.

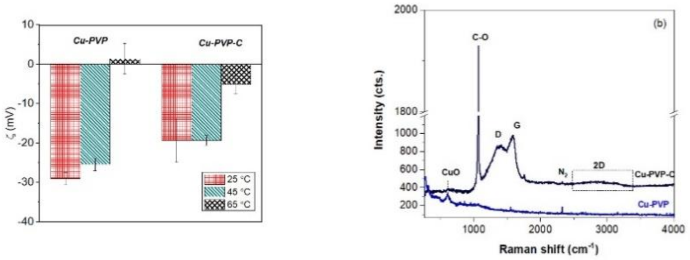

Figure 1 Zeta potential and UV-Raman spectra of the Cu-PVP and Cu-PVP-C (ascorbic acid). D, G, and 2D bands refer to sp^2 hybridized carbon atoms.

The thermal parameters of the PEG 6000-thermofiller composites have been assessed by means of DSC and thermal conductivity measurements.

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SUSTAINABLE PEDOT/GO COUNTER ELECTRODES FOR EFFICIENT INDOOR DYE SENSITIZED SOLAR CELLS

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Large-scale manufacturing of dye-sensitized solar cells (DSSCs) for indoor photovoltaics is expected in the near future, highlighting the need for sustainable, cost-effective device components. This study introduces a simple and rapid eco-friendly aqueous electrochemical deposition method to fabricate Pt-free counter electrodes (CEs) based on poly (3, 4-ethylenedioxythiophene) (PEDOT)/graphene oxide (GO) hybrids. Structural analyses (XRD, Raman) confirmed the embedding of porous GO within the PEDOT matrix, establishing strong π–π^* interactions and improving charge transport.

For the first time, the performance of PEDOT/GO-based CEs was validated in indoor DSSCs under two commercial LED light sources using a quasi-solid I^-/I_3^- redox electrolyte. The incorporation of GO enhanced electrocatalytic activity ($\Delta Ep = 0.250$ mV, sheet resistance = 6.80 Ω/sq) and significantly boosted device efficiency. Compared to PEDOT-based CEs (13.35%), PEDOT/GO achieved 19.75% efficiency under 2700 K LED illumination, while under 4000 K LED light a remarkable 60% improvement was observed, confirming the synergistic catalytic effect of GO and PEDOT. Long-term stability was also preserved after 720 h of operation.

These findings demonstrate that PEDOT/GO electrodes combine efficiency, durability, and sustainability, providing a promising route toward scalable Pt-free indoor DSSCs with superior electrocatalytic and electrical properties.

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BIOLOGICALLY ACTIVE NATURAL AND SYNTHETIC COMPOUNDS WITH ANTI-TUMOR ACTIVITY

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Worldwide, colorectal cancer (CRC) has become a significant health problem, being the most commonly diagnosed cancer in women and the third in men, contributing substantially to morbidity and mortality. The pathogenesis of this disease involves a series of well-characterized genetic alterations that disrupt the normal regulation of cell growth, division, and differentiation. Natural compounds have over time gained considerable attention as potential therapeutic agents due to their diverse bioactive properties and long-standing use in traditional medicine as remedies for various conditions. Among these, piperine (Pip), an alkaloid derived from the berries of Piper nigrum L. (black pepper) and Piper longum L. (long pepper), has demonstrated promising effects against colorectal cancer in various in vitro and in vivo models. Studies have shown that Pip induces apoptosis, inhibits cancer cell proliferation, and interferes with key signaling pathways involved in cancer progression.

One of the most exciting challenges facing medicinal chemistry researchers is the creation of new small molecules as antitumor agents. [1-3]

In this paper, we aimed to present bioactive compounds extracted from black peppercorns, as well as the synthesis, characterization and testing of some aminopyrazole derivatives, which share antitumor activity.

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NEW HETEROCYCLIC AZO DYES. SYNTHESIS AND APPLICATIONS

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The pyrazole nucleus is the most studied azole, as it has wide applications in various fields, such as technology, medicine, agriculture. Pyrazole and its derivatives have attracted much attention through a wide range of pharmaceutical activities, such as antifungal, antibacterial, anti-inflammatory, antitumor, antiviral.
Azo compounds are the most important organic dyes, structurally they have at least one azo chromophore group linked to one or more aromatic rings. They provide intense color, light stability, washable, solvent resistance.
They are widely used due to their advantages, which they have as a dyeing method, advanced applications in organic chemistry, biological properties, thermochromic, photovoltaic, fluorescent devices. [1-3]
A series of new pyrazole azo dyes were synthesized, physicochemical characterized and tested for their antitumor activity.

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SYNTHESIS, CHARACTERIZATION, TESTING AND CHROMATIC PERFORMANCE OF PYRAZOLE DERIVATIVES

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Azo dyes, which contain one or more azo groups, chromophores, are the most extensive category of synthetic dyes, which are distinguished by excellent coloring properties presenting a wide range of colors, from yellow to red. The pyrazole ring incorporated into a conjugated chromophoric and auxochromic system presents unique opportunities for structural modifications that can significantly influence both the coloring properties and biological activities of the resulting compounds. The pyrazole nucleus exhibits a variety of biological properties, such as antibacterial, antitumor, antiviral, anti-inflammatory, antifungal. [1-3]
Another series of new pyrazole azo dyes were synthesized, characterized from a physicochemical point of view and tested for biological activity.

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SUBSTRATE BIAS EFFECTS ON THE STRUCTURAL AND ELECTRICAL PROPERTIES OF EPITAXIAL VN/MgO(001) THIN FILMS

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Transition-metal nitrides (TMNs) have attracted significant attention due to their remarkable physical and chemical properties, including ultrahigh hardness, high melting point, excellent thermal stability, corrosion resistance, and metallic conductivity. Vanadium nitride (VN), a representative TMN, has long been employed as an additive element in steels to improve hardness, toughness, and wear resistance. More recently, VN has gained renewed interest as a promising electrode material for solar cells and supercapacitors [1, 2], as well as a hybrid electrode/active layer in deep ultraviolet (DUV) and solar-blind photodetectors [3, 4]. For such device applications, single-crystalline VN layers with high structural quality and excellent conductivity are essential.

In this work, we report the epitaxial growth and characterization of VN/MgO(001) heterostructures synthesized at 800 °C using radio frequency magnetron sputtering (RFMS) in a reactive Ar–N_2 atmosphere. We systematically examine the influence of substrate bias voltage (U_b) and reactive gas composition on the structural, microstructural, and electrical properties of VN epilayers. Our findings demonstrate that applying a positive substrate bias yields films with optimized crystallinity and electrical conductivity. The results indicate that epitaxial VN thin films are highly promising for use as electrode materials in energy storage and conversion devices and as adequate platform for next-generation DUV photodetectors.

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SECTION 2. RAW MATERIALS

DETECTION OF NITROPHENOLIC COMPOUNDS IN WATER USING A FIBER OPTIC PLASMONIC SENSOR

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The increasing presence of pesticide-related pollutants in aquatic environments has raised major concerns about water quality, ecosystem health, and public safety. Among these pollutants, nitrophenolic compounds such as 4-nitrophenol and 2,4-dinitrophenol are of particular importance due to their widespread use in pesticide synthesis and agricultural applications, as well as their persistence and high toxicity [1]. Traditional detection methods, while effective, often require complex sample preparation and sophisticated equipment and are not easily adaptable to on-site monitoring [2].

In this work, we present the design and use of a fiber optic plasmonic sensor for the quick, sensitive, and label-free detection of 4-nitrophenol and 2,4-dinitrophenol in water solutions [3]. The sensor utilizes the surface plasmon resonance (SPR) effect created by the gold thin film coated on the silica fiber surface, allowing real-time interaction between the evanescent field of guided light and analyte molecules in the solution. Experimental results demonstrate that the FO-SPR sensor can detect 4-nitrophenol and 2,4-dinitrophenol at environmentally relevant concentrations with high reproducibility and stability. Distinct resonance wavelength shifts that match different analyte concentrations verify the system's ability to perform quantitative analysis. Additionally, the fiber optic design offers inherent benefits such as being compact, resistant to electromagnetic interference, and suitable for remote or in-situ monitoring. The developed plasmonic sensor is a promising tool for real-time water quality assessment, providing a cost-effective and portable alternative to traditional laboratory methods.

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CARBON FIBERS-SILICON CARBIDE COMPOSITES FOR SPECIALIZED APPLICATIONS

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Silicon carbide is an exceptionally valuable material for high-temperature applications and is commonly utilized in applications like gas turbines, heat exchangers, and space shuttles. Its exceptional strength, resistance to oxidation, and chemical stability at high temperatures make it an ideal option. Furthermore, due to their low induced radioactivity when exposed to neutron irradiation, SiC and its composites are being investigated as potential structural materials for advanced fission and fusion reactors [1-4].
Research on carbon fiber-reinforced silicon carbide (Cf/SiC) composites has been a significant area of global interest for a long time. Composites with a SiC matrix reinforced with unidirectional fibers exhibit anisotropic mechanical and thermophysical properties, which is a significant drawback. This issue can be addressed by randomly incorporating short fibers within the matrix phase [5-8]. Various production methods for Cf/SiC composites include chemical vapor infiltration, polymer infiltration and pyrolysis, hot pressing, and liquid silicon infiltration [5, 9]. However, these methods can be expensive and time-consuming, even for producing simple shapes [8]. Spark plasma sintering (SPS) is a quicker method that enables Cf/SiC composites to achieve near full density at lower temperatures and in shorter times [6]. The challenges still remain in sintering pure SiC and uniformly dispersing short carbon fibers into the SiC matrix. In this study, Cf/SiC composites were produced using SPS, incorporating various types of short carbon fibers alongside sintering additives. This research investigates the impact of carbon fibers on the structure and mechanical properties of these composites.

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SUSTAINABLE BIONANOCOMPOSITE COATINGS WITH CARBON-SEPIOLITE FOR CORROSION PROTECTION OF AA2024-T3 ALUMINIUM ALLOY

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Aluminium alloys, such as AA2024-T3, are extensively employed in aerospace and transportation owing to their outstanding strength-to-weight ratio. Nevertheless, their susceptibility to corrosion remains a critical limitation that reduces service lifetime. For decades, chromium-based coatings have been the benchmark for corrosion protection, but their application is increasingly restricted due to associated environmental and health hazards [1]. Therefore, the development of low-toxicity alternatives is necessary.

Herein, we address this need with the development of bionanocomposite coatings using natural precursors for corrosion protection of AA2024-T3 aluminium alloy. The coatings were formulated with chitosan and zein biopolymeric matrices combined with caffeic acid and a sepiolite–carbon hybrid filler [2]. The bionanocomposite suspensions were deposited onto AA2024-T3 aluminium alloy substrates via dip-coating. This coating was further protected with a barrier organic–inorganic hybrid topcoat, synthesized through a sol–gel process employing γ-methacryloxypropyltrimethoxysilane and tetramethyl orthosilicate [3]. The materials were characterized by field emission scanning electron microscopy (FESEM), Fourier transform infrared spectroscopy (FTIR) and thermogravimetric/differential scanning calorimetry (TGA/DSC). The corrosion protection performance was studied by electrochemical impedance spectroscopy (EIS). The results showed a two-stage degradation process. Initially, the sol-gel topcoat provided a strong barrier. After this phase, the bionanocomposite base coating actively inhibited corrosion. The FESEM images of samples after testing in 0.06 M NaCl solution showed minimal degradation, confirming the coating's high integrity even after prolonged exposure. This work demonstrates the potential of bionanocomposites to be applied as green protective systems for aluminium alloys, presenting a sustainable alternative to hazardous coatings.

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FLUORESCENT SILICA AEROGELS FOR ADVANCED AND FORENSIC APPLICATIONS

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This study reports on the design and characterization of fluorescent silica aerogels as hybrid materials with potential in additive manufacturing for multifunctional applications. We establish a synthesis pathway for producing nanocomposite aerogels that incorporate fluorescein, BSTFA for surface functionalization, and Fe_3O_4 nanoparticles. Comprehensive characterization (XRD, BET, TGA, SEM-EDS, FTIR, and fluorescence spectroscopy) demonstrates how nanoscale engineering strategies translate into macroscopic optical, structural, and functional properties. The resulting aerogels combine high porosity, tunable luminescence, and magnetic responsiveness, making them strong candidates for advanced integration into additively manufactured systems. Photophysical studies reveal stable, excitation-dependent fluorescence with high emission intensity, while structural analyses confirm the preservation of the aerogel framework after modification. Surface functionalization enhances hydrophobicity without impairing optical performance. Beyond applications in energy systems, biomedical platforms, and aeronautical technologies, these engineered aerogels also show great promise in forensic science, where their fluorescent response enables sensitive and reliable fingerprint development. Overall, this work highlights fluorescent silica aerogels as versatile hybrid materials and provides a framework for their tailored design in additive manufacturing across both technological and forensic domains.

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VLS GROWTH OF NANOSTRUCTURES FOR LASER PARTICLE ACCELERATION APPLICATIONS

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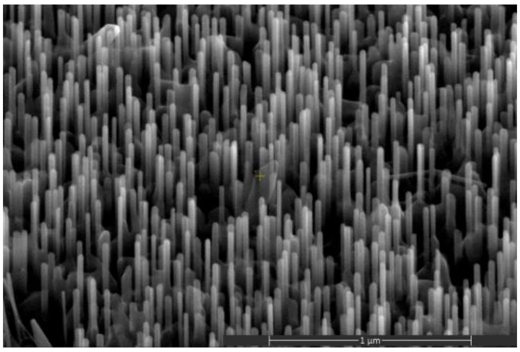
For applications such as laser particle acceleration, nanostructured targets are a promising way of improving the absorption of laser energy into the target, improving acceleration efficiency [1]. In the present study, ZnO nanowires have been grown on different substrates (quartz, alumina) through the Vapor-Liquid-Solid (VLS) bottom-up approach using pulsed laser ablation as particle source [2]. Substrate temperature and laser power were used to control nanowire morphology, obtaining different cross section shapes and sizes. Nanowires with varying lengths (200 nm – 1.2 μm) and diameters (30 – 200 nm) were grown. By changing the growth substrate from quartz to alumina ($(11\bar{2}0)$ cut), a straight, vertical nanowire alignment was obtained (Fig. 1-left). Using the same growth method on unpolished $(11\bar{2}0)$ alumina yielded different multi-scale structuring of the target surface (Fig. 1-right), promising better energy absorption efficiencies. Light absorption simulations on ZnO nanowires grown surfaces showed an increase of up to 3-4 times, for the case of 3 μm-long nanowires. Based on these results, signifficant effiency increase of laser-particle acceleration process is expected.



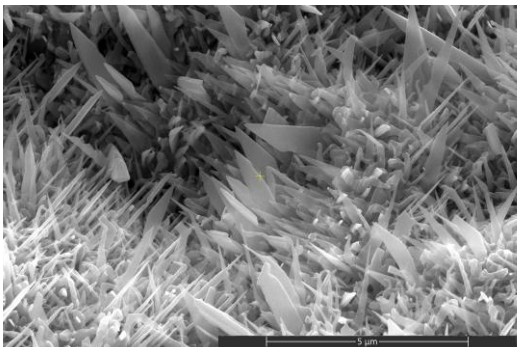


Figure 1. SEM images of ZnO nanowires (left) and other nanostructures grown on unpolished alumina (right)

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PH-RESPONSIVE RELEASE OF SODIUM RISEDRONATE FROM HYDROTHERMALLY SYNTHESIZED ZINC-DOPED HYDROXYAPATITE

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Hydroxyapatite (HAp), $Ca_{10}(PO_4)_6(OH)_2$, is the main mineral component of bone and a promising material for controlled drug delivery [1-2]. Sodium risedronate is a bisphosphonate drug used in osteoporosis treatment. Zinc-doped hydroxyapatite ($Ca_{9.5}Zn_{0.5}(PO_4)_6(OH)_2$) was hydrothermally synthesized, showing a pure apatite phase confirmed by X-ray diffraction (XRD) analysis. In this work, a pH-sensitive risedronate delivery system based on Zn-doped hydroxyapatite impregnated with the drug is described. The risedronate-loaded Zn-doped hydroxyapatite matrix was characterized using dynamic light scattering (DLS), Fourier-transform infrared spectroscopy (FTIR), and differential scanning calorimetry (DSC). The risedronate-loaded Zn-doped HAp particles exhibited a zeta potential of -21 ± 1.3 mV. FTIR identified characteristic phosphate, hydroxyl, and carbonate groups, highlighting structural changes induced by Zn incorporation. Additionally, UV–Vis spectroscopy was used to quantify drug loading efficiency and the release profile of sodium risedronate. The results showed a pH-dependent release, indicating the potential of Zn-doped hydroxyapatite as a smart delivery system for osteoporosis and other bone metabolic disorders.

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STRUCTURAL AND THERMAL PROPERTIES OF THE SILVER DOPED HYDROXYAPATITE SYNTHESIZED FROM EGGSHELLS

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Hydroxyapatite (HA), with the chemical formula $Ca_{10}(PO_4)_6(OH)_2$, constitutes the primary inorganic component of human bones and teeth. Various natural precursors have been employed to obtain HA-derived biomaterials for various fields such as bone tissue engineering, targeted drug delivery systems, dye adsorption technologies, and catalytic applications [1-4]. The high biocompatibility of hydroxyapatite (HA) synthesized from calcium rich waste eggshell precursors make it a promising candidate for incorporation into bone tissue substitute materials. Moreover, silver doping into the HA lattice introduces antimicrobial functionality to the HA-based materials.

This study examines the effects of silver doping and amino acid (AA) surface functionalization on the structure and thermal parameters of the obtained HA nanocrystalline powders. Surface and structural modifications of Ag-HA in the presence of threonine were examined by BET, X-ray, FTIR and UV-Raman spectroscopies, DLS, and Zeta potential techniques. TG-DSC (thermogravimetry and differential scanning calorimetry) data at high temperatures highlighted the stable thermal behavior of samples doped with Ag and synthesized in the presence of the amino acid. The thermal behavior of the obtained compounds is important in order to analyze the stability during processing as biomaterials. Furthermore, UV-Raman data regarding the surface modification of HA under threonine structure-directing agent, along with silver induced lattice distortion and crystallinity changes can be corelated with enhanced bioactivity of the HA-synthesized materials.

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STRATEGIC ALIGNMENT OF SUSTAINABLE METALLURGY AND MATERIALS SUBSTITUTION: THE ETP SMR SRIA 2023 ROADMAP FOR CRITICAL RAW MATERIALS

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The sovereignty of the European Union for its strategic sectors such as defence, digital, aerospace and its transition to clean energy fundamentally depend on the secure and sustainable supply of critical raw materials, as outlined in the Critical Raw Materials (CRM) Act. This includes also the need for high-performance applications operating under extreme conditions (high temperatures, stress, corrosion).

This document presents a focused analysis of the European Technology Platform for Sustainable Mineral Resources (ETP SMR) Strategic Research and Innovation Agenda (SRIA) 2023 [1], demonstrating its direct strategic contribution to the development of new, resilient materials and processes for this demanding sector.

The SRIA's core ambitions set out a critical policy roadmap for Raw Materials Research & Innovation (R&I). These ambitions include, among others:

- **Sustainable Processing:** The strategy commits to increasing European refining capacity through sustainable, carbon-neutral, and resource-efficient technologies aimed at a "zero waste" industrial vision. This drive for maximum yield from primary and secondary sources mandates the advanced separation and refining techniques necessary to achieve the ultra-high material purity required for predictable reliability and structural integrity under extreme stress.
- **Material Substitution:** The strategic pillar of "Forecast and Substitution" explicitly aims to reduce CRM criticality by developing materials that deliver enhanced durability. This emphasis on durability serves as the essential technical qualification metric, ensuring that substituted materials meet or exceed the performance and extended lifespan required in high-value, extreme-environment components.
- **Sector Resilience:** By prioritising the strengthening of the currently fragmented European R&I sector, the SRIA promotes the establishment of integrated infrastructure and expertise, which are essential for implementing the complex, long-term R&I activities required for the sustainable supply of raw materials.

In conclusion, the ETP SMR SRIA 2023 unifies the imperatives of supply security, circularity, and high-performance engineering. It provides the essential framework linking sustainable metallurgical processes with material substitution to secure both European supply resilience and technological leadership in advanced manufacturing.

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HARNESSING INDUSTRIAL BY-PRODUCTS FOR RESOURCE-EFFICIENT AND DURABLE INORGANIC MATERIALS

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Industries have an impact on the environment because it uses natural resources and produces a lot of industrial waste. The demand for building materials has grown in the last years for industrial and civil buildings. The Portland cement production has a significant impact on carbon emissions, and natural resource use, which affects environmental sustainability [1, 2]. Therefore, there is an urgent need to implement alternative green materials with low carbon emissions to replace ordinary Portland cement [3, 4]. The newly developed materials are alkali-activated semi-crystalline aluminosilicates formed as a result of the reaction of aluminosilicates in alkaline media [5]. The recovery of industrial waste presents advantages in terms of environmental protection, resources preservation and has a wide addressability both in the research and economic communities.
Our research proposes the integration of industrial waste into the formulation of inorganic materials. This approach is not only beneficial for the environment, but also allows the preservation of resources. New inorganic materials were designed, followed by mechanical and durability characterization. Was analyzed how different types of industrial waste influence the characteristics of the materials, with the aim of obtaining sustainable and high-performance products. The obtained material is economical, environmentally friendly, mechanically resistant as seen in its high value of compressive strength: 70-80MPa at 28 days, while the flexural strength is in the range of 10-11 MPa at 28 days, both values above requirements. In chemical agents, mass losses were below 10% for all designed materials.

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SOL–GEL DERIVED BAGHDADITE ($Ca_3ZrSi_2O_9$) POWDERS: STRUCTURAL AND MORPHOLOGICAL INSIGHTS

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Baghdadite ($Ca_3ZrSi_2O_9$) is a bioactive ceramic belonging to the CaO–ZrO_2–SiO_2 system, known for its high bioactivity, efficient apatite-forming ability, and potential to stimulate osteogenic cell proliferation [1–3]. Compared to other calcium silicate-based ceramics such as wollastonite or diopside, baghdadite exhibits superior biological performance and improved stability in physiological conditions [2]. Its monoclinic crystal structure allows for strong ionic interactions with calcium and phosphate ions in simulated body fluids, accelerating the nucleation of hydroxyapatite layers on its surface. Furthermore, zirconium incorporation into the silicate framework enhances mechanical strength and chemical durability, making baghdadite a promising candidate for load-bearing applications in bone tissue engineering [3].
In this work, preliminary experiments were performed to synthesize baghdadite powders by the sol–gel method using different calcium and zirconium precursors combined with tetraethyl orthosilicate (TEOS) as silica source. The obtained gels were dried, calcined at 900 °C for 2 h, and characterized by chemical analysis, BET surface area measurements, FT–IR spectroscopy, X-ray diffraction (XRD), and scanning electron microscopy (SEM–EDX).
The results indicate that the chemical nature of the precursors strongly influences the purity and morphology of the powders. Samples prepared from $Ca(NO_3)_2\cdot 4H_2O$ and $ZrCl_4$ showed the closest stoichiometry to the theoretical composition, a porous microstructure, and the highest relative content of baghdadite phase as confirmed by XRD. SEM–EDX confirmed more homogeneous elemental distributions for the optimized compositions, while FT–IR spectra supported the formation of characteristic Si–O–Si and Zr–O bonds.
These findings demonstrate the feasibility of the sol–gel route for obtaining nanostructured baghdadite powders with controlled morphology. Future work will focus on pressing and sintering these powders into pellets, followed by biological evaluation to validate their potential for bone tissue engineering applications.

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ADVANCED NANOTECHNOLOGY FOR OPTIMIZING SPORTS MEDICINE AND RECOVERY PROCESSES IN FOOTBALL PLAYERS

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The meniscus is a key component of the knee joint, responsible for absorbing and distributing loads while maintaining joint stability. Meniscal injuries compromise these essential functions, leading to instability, impaired load transmission, and, over time, the development of degenerative osteoarthritis.

Conventional treatment approaches—such as transplantation or surgical repair—aim to preserve meniscal function, yet clinical outcomes are often unsatisfactory. Tissue engineering has emerged as a promising alternative, particularly through the use of biological scaffolds and nanomaterials designed to support and enhance meniscal tissue regeneration.

The novelty of this study lies in presenting the theoretical foundations of tissue engineering nanomaterials and highlighting their potential applications in the rehabilitation of sports-related meniscal injuries. Tissue engineering nanomaterials are essential in regenerative medicine, particularly for bone repair, due to their biocompatibility, osseointegration, and osteoconductivity.

Carbon nanofibers (CNFs) provide high mechanical strength and are used as reinforcing agents in bone scaffolds, enhancing both stability and biological performance [1,2].

Recent studies show that nanomaterials support the proliferation and differentiation of meniscal fibrochondrocytes, confirming their potential in cartilage and meniscus regeneration.

These results emphasize the remarkable potential of nanotechnology as a key tool for advancing modern sports medicine, offering new perspectives in diagnosis, treatment, and tissue regeneration. The integration of nanomaterials into recovery therapies not only accelerates the healing process in athletes but also contributes to enhanced performance and the prevention of long-term complications.

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TRIPHYLITE ($LIFEPO_4$) FROM CONȚU – NEGOVANU PEGMATITES, SOUTHERN CARPATHIANS, VIEWED FROM AN ECONOMIC PERSPECTIVE

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Triphylite [1] it is the accesory mineral in the Conțu – Negovanu Li-pegmatites. The color of the triphylite is dark – green and they appears like a nests – nodules from a few milimeters to 5 centimeters in diameter, in the albite feldspar cleavelandite variety and spodumene mass [2]. Triphylite is the first member of series Quensel – Manson: Triphylite – Ferrisiclerite – Heterosite. Triphylite is isostructural with olivine, and has a Mohs hardness of 4. Triphylite can provide the ”raw material” to extract lithium from phosphates and then, following an industrial process of transforming litium phospahtes into lithium carbonate and lithium hydroxide, it can ultimately become LFP (lithium iron phosphate) for the production of batteries.
Advantages of LFP batteries provide [3]:

- Reduced environmental impact
- Longer lifespan
- Higher thermal stability
- Enhanced safety
- Better performance at high temperatures
- Cost- effectiveness in certain applications

LFP batteries are ideal for many uses [3]:

- LFP is very good for electric vehicules
- Home energy storage (LFP are safety, has a thermal stability and longevity).

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ADVANCED HYBRID HYDROGEL COMPOSITES PROCESSED BY ELECTRON BEAM TECHNOLOGY FOR BIOMEDICAL APPLICATIONS

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The development of hybrid hydrogel composites presents new opportunities in biomedicine, particularly for controlled drug delivery [1] and site-specific therapies [2]. In this study, hybrid hydrogels composed of agar, sodium carboxymethylcellulose, poly(vinylpyrrolidone), and poly(ethylene glycol) were fabricated and sterilized using electron beam (e-beam) irradiation, an efficient, eco-friendly method that avoids toxic chemical initiators. The resulting materials were systematically characterized for their physicochemical, mechanical, and structural properties, including swelling behaviour, pH-dependent stability (acidic, neutral, and alkaline media), biodegradation, drug loading capacity, and in vitro release performance. The hydrogels exhibited remarkable swelling ratios exceeding 1000% in acidic and neutral environments, a high elastic modulus (~30 MPa) indicative of a robust macromolecular network, and favourable biodegradation profiles (<5% mass loss within 30 days). The anticancer drug 5-fluorouracil was efficiently incorporated, achieving cumulative release above 80% within 24 hours under both acidic and neutral conditions. These findings highlight e-beam cross-linked hybrid hydrogels as advanced biomaterials with strong potential for controlled drug delivery and intelligent wound dressing applications.

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CrN COATINGS DEPOSITED BY REACTIVE MAGNETRON SPUTTERING METHOD

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Thin film coatings have attracted considerable attention for their ability to tailor the surface properties of structural materials, enhancing performance in advanced mechanical and tribological applications. The behavior of these coatings depends on the intrinsic properties of the material, the deposition technique, and the substrate's physical and chemical characteristics [1].

Transition metal nitrides, such as CrN, are widely employed in engineering applications due to their exceptional physical and chemical properties, including high hardness, excellent wear resistance, thermal stability and strong corrosion [2]. Consequently, recent research has focused on the development and characterization of CrN as functional thin film coatings.

Thin films can be fabricated using a variety of deposition techniques, including electrochemical methods, physical vapor deposition (PVD) and chemical vapor deposition (CVD). Electrochemical deposition is commonly used for chromium-based coatings, in the case of CrN, this involves chromium film depositing, followed by high-temperature heat treatment in a nitrogen atmosphere to form the CrN phase [3]. However, this process typically employs chromic acid solutions containing toxic hexavalent chromium (Cr(VI)), posing serious environmental and health hazards [4].

Sputtering techniques, by contrast, offer precise control over deposition parameters, enabling the tailoring of residual stress, hardness, surface morphology, and microstructure to meet the demands of structural and functional applications [5, 6].

In this study, CrN coatings were deposited by reactive dcMS deposition. This "dry" deposition approach provides an environmentally friendly alternative to conventional electrochemical methods, eliminating the use of highly toxic hexavalent chromium while enabling high-performance coating production.

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SILICON CARBIDE COMPOSITES REINFORCED WITH CARBON FIBERS FABRIC PREPARED THROUGH POLYMER INFILTRATION AND PYROLYSIS

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Carbon fiber–reinforced silicon carbide (Cf/SiC) composites are widely recognized for their ability to withstand extreme temperatures exceeding 1700 °C. This remarkable performance arises from the combination of carbon fibers, which contribute with high strength and structural reliability, with silicon carbide (SiC) matrix that imparts a high modulus of elasticity, excellent oxidation resistance, superior thermal shock resistance, a low coefficient of thermal expansion. The properties of fiber-reinforced composites can be optimized through fiber volume and orientation control. Carbon fiber–reinforced SiC-based ceramic matrix composites (CMCs) are particularly notable, serving as prime candidates for high-temperature structural applications in aerospace, defence, and energy systems [1-3].
While the polymer infiltration and pyrolysis (PIP) technique presents certain limitations, it demonstrates considerable potential for industrial-scale applications, particularly in the production of advanced ceramic composites like Cf/SiC. By addressing the issue of incomplete pore filling between the reinforcement and the matrix, PIP offers a reliable approach for enhancing microstructural integrity while providing precise control over the functional properties of ceramic matrix composites (CMCs). Recently, it has been demonstrated that non-oxidic ceramics such as carbides and nitrides can be obtained by pyrolysis of suitable metal-organic polymer precursors in a controlled atmosphere. Of the various systems already synthesized, SiC obtained from polycarboxylane (PCS) is certainly the most studied [4,5]. In this study, Cf/SiC composites were obtained using the PIP technique, using functionalized carbon fiber fabric and PCS as a polymer precursor. Through these experiments, we intend to obtain Cf/SiC composites with improved mechanical properties.

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STUDY OF ELECTROCHEMICAL BEHAVIOR OF VIB GROUP METAL OXIDES IN TUNGSTATE MELT

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The aim of the work is to study the electrochemical behavior of VI-B group metal oxides in tungstate melts and to identify the possibility of the existence of equilibria involving VI-B group metal electrodes. Achieving this goal will make it possible to control the acid-base properties of melts and to use the results of studies of the electrochemical behavior of VI-B metal oxides in tungstate melts for the practical implementation of electrodeposition of VI-B metals and their compounds, knowing that Cr,Mo and W are crucial in various industries. Thermodynamic assessment of the probability of interaction of metal oxides of group VI-B with tungstate melts, the results of the study of the acid-base properties of tungstate melt by potentiometric method, X-ray phase analysis and IR spectroscopy of cooled samples proved the possibility of the existence of dimeric particles of chromium, molybdenum and tungsten compounds. Analysis of the presented experimental data on the study of the electrochemical behavior of chromium, molybdenum and tungsten under equilibrium and non-equilibrium conditions allows us to conclude that it is possible to implement multi-electron reversible equilibria and electroreduction processes involving oxide forms of chromium, molybdenum and tungsten (VI) in tungstate melts. The electrochemical behavior of group VI-B metal oxides in tungstate melt was studied in the range of polarization rates 0.02-5.00 V/s using platinum electrodes at a temperature 1173 K, and using electrodes made of group VI-B metals at a polarization rate 2 mV/s and a temperature 1173 K. The mechanism and final product of electroreduction of oxide forms of metal (VI) depend on the acid-base properties of the medium.

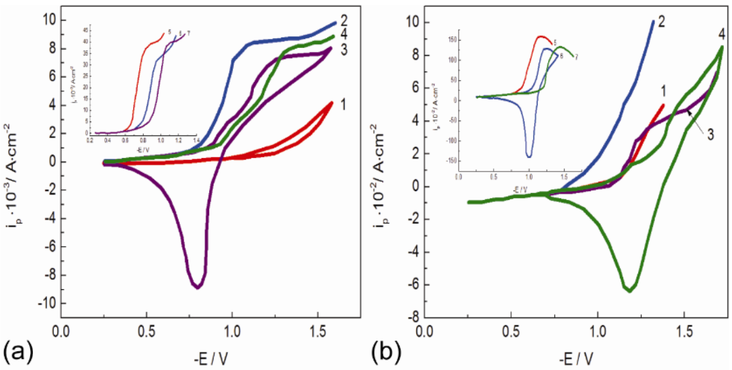

Figure 1. Stationary voltammetric dependences of the melt containing a) MO_3 (M: Cr, Mo, W); 1 - Na_2WO_4 background; 2, 5 - CrO_3 addition [CrO_3]: 4 mol/cm^3, 9 mol/cm^3; 3, 6- MoO_3 addition [MoO_3]: 4 mol/cm^3, 9 mol/cm^3; (4, 7) - WO_3 addition, [WO_3]: 4 mol/cm^3, 9 mol/cm^3; T = 1173 K, cathode - platinum, polarization rate - 0.02 V/s; b) Na_2WO_4 melt; 1 - Na_2WO_4 background; 2, 5- CrO_3 addition [CrO_3]: 6 mol/cm^3, 10 mol/cm^3); 3, 6- MoO_3 addition [MoO_3]: 6 mol/cm^3,10 mol/cm^3; 4, 7 - WO_3 addition, [WO_3]: 6 mol/cm^3, 10 mol/cm^3; T = 1173 K, cathode - platinum, polarization rate - 0.02 V/s.

DEVELOPMENT AND CHARACTERIZATION OF TRICALCIUM PHOSPHATE/BIOGLASSCERAMIC COMPOSITE MATERIALS

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This work focuses on the development of tricalcium phosphate (TCP) – bioglassceramic (BVC) composite materials with improved mechanical strength and good biocompatibility, which can be used in regenerative medicine or tissue engineering. Materials that combine the properties of calcium phosphates (e.g., TCP or HAP) with those of bioglassceramics ultimately exhibit improved biological properties with a better and faster bioactive response than if used independently. In the context of rapid scientific development and for the effective functioning of biocomposites, they are designed so as not to induce any form of toxicity or inflammatory response in the body, to be corrosion resistant, to be stable over time, and to have a modulus of elasticity, compressive strength, and flexural strength appropriate to the replaced tissue [1-3].

The design of a biomaterial depends on its field of application, which includes filling bone defects in the knee, dental crowns, dental veneers, bioimaging, regeneration of damaged tissues, and local induction of antibacterial and antifungal effects [4-5]. The aim was to obtain biocomposites by the solid-phase reaction method from TCP powders and bioglassceramic powders, the pressed composites being sintered at 1200–1300℃ for 2 hours. Complex characterization was performed by: X-ray diffraction (XRD), scanning electron microscopy (SEM), determination of mechanical strength, and determination of cell viability. Preliminary tests confirmed good biocompatibility, the presence of relevant mineralogical compounds, and good mechanical results compared to those reported in the literature.

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ADVANCED ABLATIVE MATERIALS BASED ON POLYSILOXANE RESIN AND GRAPHITE FELT

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This paper presents the development of novel ablative composites designed for thermal protection applications, obtained by combining a high purity graphite felt reinforcement with a polysiloxane-based resin matrix. The selected materials are designed to gradually consume under extreme thermal loads, thus dissipating the incident heat through pyrolysis, oxidation and carbonization and have been adapted to provide low thermal conductivity, oxidation resistance, and high structural stability under extreme thermal loads.
The composites were fabricated by a controlled impregnation-consolidation technique. Graphite felt preforms [1], heat-treated at ~2200 °C to ensure high purity and stability, were impregnated with UHTR-6398S polysiloxane resin [2] after adjusting the viscosity to allow for efficient infusion of the felt. The impregnated preforms were subsequently pressure cured at 225 °C, followed by a controlled cooling regime to minimize residual stresses. Optimization of the resin viscosity was found to be critical in avoiding structural defects such as voids or delamination, while the applied pressure ensured a homogeneous compaction of the laminate.
Morpho-structural investigations confirmed the uniform penetration of the resin, the integrity of the fiber-matrix interface, and the progressive degradation mechanisms under ablative conditions. The resulting ablative materials demonstrate promising characteristics for thermal protection applications in extreme environments.

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DEVELOPMENT OF BIOCORROSION RESISTANT COATINGS BASED ON HIGH ENTROPY ALLOYS

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Microbiologically influenced corrosion (MIC) or biocorrosion refers to the corrosion initiated, facilitated or accelerated by the direct or indirect action of microorganisms or metabolism products [1]. Usually, conventional steel-based alloys are particularly vulnerable to MIC, especially in humid or oxygen-limited environments, where biofilms can block the access of natural corrosion inhibitors. In contrast, high-entropy alloys (HEAs), due to their multicomponent composition and homogeneous structure, exhibit superior corrosion resistance, and may inhibit biofilm formation or reduce the electrochemical corrosion rate, providing a promising alternative to traditional materials in applications exposed to aggressive microbial environments [2, 3]. The aim of this study is to develop a new type of biocorrosion resistant coating by embedding biocorrosion inhibitor metals into HEA material composed of five or more elements. HEA coatings have been developed by an innovative approach: the first step was to obtain HEA ingots by melting and casting using an electromagnetic induction furnace in controlled atmosphere. In the next step, HEA ingots were used as targets for coatings deposition by DC Magnetron sputtering technique. The HEA coatings were subjected to characterization of their physical, structural, and morphological properties. Additionally, their corrosion behavior was evaluated through electrochemical testing in a NaCl solution and biocorrosion assays involving a *Pseudomonas aeruginosa* bacterial consortium. A correlation was established between the physical and morpho-structural properties of the HEA coatings and their resistance to both electrochemically induced corrosion and biocorrosion caused by *Pseudomonas aeruginosa*. This correlation enabled the identification of an optimal elemental composition for enhanced antibacterial corrosion resistance.

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DRUG RELEASE KINETICS OF DOXORUBICIN AND CIPROFLOXACIN FROM Mn^{2+} DOPED CALCIUM PHOSPHATE SCAFFOLDS DERIVED FROM AVIAN EGGSHELLS FOR OSTEOSARCOMA THERAPY

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A potential way for the management of osteosarcoma and the mitigation of chemotherapy side effects for improvement in patient outcomes is a drug delivery system (DDS) with controlled therapeutic drug release. The current work investigates the development of DDS from avian eggshell-derived Calcium Phosphate (CaP) by calcination and further doped with Mg^{2+}. The chemotherapeutic agents, Ciprofloxacin (CFX) and Doxorubicin (DOX), were encapsulated in 3D scaffolds made of Mg^{2+} doped CaP/polyvinyl alcohol (Mg-CaP-PVA) composite, synthesised by freeze gelation process meant for targeting and inhibiting the proliferation of osteosarcoma cells. The physicochemical characterisation established the presence of biphasic CaP (HAp/β-TCP). The XRD diffractogram established the inverse proportionality of Mg^{2+} concentration with the crystallite size of the CaP. CFX exhibited an initial burst release with a prolonged release ideal for mitigating osteosarcoma metastasis and decreasing the frequency of drugs. DOX was released in a controlled biphasic pattern, leading to an improved circulation time and decreased cytotoxicity. Further antimicrobial study of 3D scaffolds embedded with drugs and Mg^{2+} doped CaP indicated great potential for the management of osteosarcoma.

Keywords: Eggshells, Valorisation, Hydroxyapatite, Magnesium Doping, osteosarcoma, 3D scaffold, drug delivery system

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E-BEAM PROCESSED HYBRID HYDROGELS: EMERGING MATERIALS FOR BIOMEDICAL APPLICATIONS

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Hydrogel-based local delivery systems are increasingly recognized as promising platforms for cancer therapy, providing targeted drug administration while minimizing systemic toxicity, compared to conventional approaches. In this study, we developed a hybrid hydrogel by combining natural polymers (collagen, sodium carboxymethylcellulose) with synthetic polymers (polyvinylpyrrolidone, polyethylene oxide), aiming to achieve an optimal balance of biocompatibility, structural stability, and controlled drug release. Electron beam (e-beam) irradiation at a sterilization dose of 25 kGy was employed as a clean cross-linking method, simultaneously ensuring network formation and sterilization without the use of toxic initiators. The resulting hydrogel demonstrated a high drug loading capacity, remarkable swelling behavior exceeding 1750%, and sustained release of the model anticancer drug doxorubicin (DOX) over three days under both neutral and mildly acidic conditions. Throughout the release period, the hydrogel maintained its transparency and elasticity, allowing visual monitoring and confirming the integrity of its cross-linked structure. These results highlight the potential of e-beam-processed hybrid hydrogels as advanced biomaterials for targeted chemotherapy and future therapeutic applications.

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FROM ERA-MIN to RAMP: DRIVING RAW MATERIALS RESEARCH TO A EUROPE´S GREEN AND DIGITAL FUTURE

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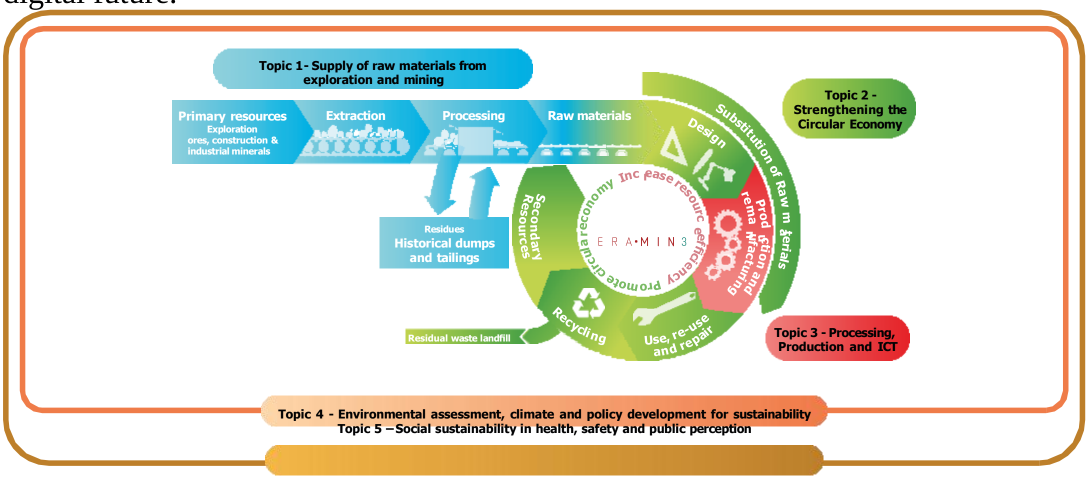
ERA-MIN, as a Public-Public Partnerships (P2Ps) in research and innovation, has the main objective to establish networks of public research funding organizations (ministries, funding agencies, programme managers) from interested EU countries/regions and beyond. Its mission has been to build strong networks and align research activities under a shared vision for sustainable raw materials.The ERA-NET Cofund instrument under Horizon 2020 aims at implementing one substantial call with top-up funding from the European commission. ERA-MIN 3 follows the activities of previous projects, ERA-MIN 2 and ERA-MIN, aiming to continue strengthening the mineral raw materials community through the coordination of research and innovation programmes on non-fuel, non-energy and non-food raw materials (metallic, construction and industrial minerals).
Building on the achievements of ERA-MIN and ERA-MIN 2, **ERA-MIN 3** continues to strengthen the mineral raw materials community. Looking ahead, this effort will evolve into the **RAMP – Raw Materials Partnership for the Green and Digital Transition**, ensuring the long-term coordination of research and innovation programmes. Together, ERA-MIN and RAMP are driving the sustainable supply of raw materials essential for Europe's green and digital future.



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OVERVIEW OF CONVENTIONAL METHODS FOR RECYCLING NdFeB PERMANENT MAGNETS

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Rare earth elements (REEs) are critical materials with unique magnetic, optical, and catalytic properties, increasingly demanded by green and digital technologies. Their uneven natural distribution and the environmental costs of mining highlight the need for circular economy strategies and sustainable recycling technologies.

NdFeB (neodymium–iron–boron) magnets are the most important REE application due to their high energy density and efficiency, being indispensable in electric vehicles, wind turbines, electronics, and defence systems. Despite this, recycling rates remain low, emphasizing the urgency of efficient recovery methods. Permanent magnets recovered from PC-HDD voice coil motors typically contain rare earth elements in the following proportions: Nd: 20–23 wt.%, Dy: 1–7 wt.%, and Pr: 0.5–6 wt.%.

Current recycling approaches include pyrometallurgy, hydrometallurgy, and hybrid processes. Pyrometallurgy is suitable for large volumes but energy-intensive and polluting, while hydrometallurgy offers higher selectivity and purity but generates liquid residues. Recent advances using organic acids achieved over 85% TREE recovery from end-of-life NdFeB magnets.

Emerging techniques such as microwave-assisted processing enable rapid demagnetization, reduced processing times, and improved energy efficiency, especially when combined with hydrometallurgy. Direct hydrogen processing (HPMS) and hybrid methods also show promise, achieving high recovery yields while lowering environmental impacts. Integrated microwave–hydrometallurgical systems, supported by life-cycle assessment, represent a promising path toward a circular economy for NdFeB magnets.

The experiments carried out at IMNR focused on recycling NdFeB magnets through the liquid metal extraction (LME) method, using magnesium as the extractant. The process was followed by vacuum distillation to separate the target metals, with the magnesium being recoverable and recirculated for subsequent cycles. A range of experimental parameters — including operating temperature, process duration, magnesium-to-REE-PM ratio, and particle size of the REE-PM feed — were systematically investigated to determine the optimal extraction conditions.

At a temperature of 800°C, a duration of 8 h, a granulation of the magnets of 2-5mm, using a LiF-LiCl-MgF_2 protecting flux and furnace Ar atmosphere, the Nd content was 45wt.% and the extraction yield of >90%. When separating Nd from the alloy by vacuum distillation, at temperatures of 850-900 for 8 hours, a Nd sponge with a content of > 98% Nd was obtained.

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Electrospun PCL/Merwinite and Zn-Doped Merwinite Composite Fibers for Bone Tissue Engineering Applications

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Merwinite ($Ca_3Mg(SiO_4)_2$, MW) is a calcium–magnesium silicate ceramic that has recently attracted attention as a bioactive bone substitute due to its balanced resorption rate, high Ca^{2+} release, and osteoconductive potential. In this work, MW and zinc-doped MW ($Ca_3Mg_{1-x}Zn_x(SiO_4)_2$, x=0.1) powders were synthesized by the sol–gel method and calcined at 600 °C, a process that enabled the formation of nanostructured precursors with controlled composition. The electrospinning process enabled the incorporation of MW and MW-Zn powders into a polycaprolactone matrix, generating continuous fibrous scaffolds with interconnected porosity. By varying electrospinning parameters such as voltage, flow rate, and collector distance, the fiber morphology and distribution of ceramic particles within the polymeric network were effectively controlled.

Morphological investigations by scanning electron microscopy (SEM) confirmed the formation of continuous, interconnected fibrous networks with embedded ceramic particles, where Zn^{2+} doping influenced both fiber uniformity and particle dispersion. Structural and chemical analyses (XRD, FTIR) validated the successful incorporation of merwinite phases within the PCL fibers. Biological evaluation was carried out by MTT assays on MC3T3 pre-osteoblasts, demonstrating high cytocompatibility of the composites, with Zn-doped merwinite fibers exhibiting improved cell viability compared to undoped ones. These findings highlight the synergistic effect of Zn^{2+} in enhancing both osteogenic potential and scaffold performance.

The combination of sol–gel derived merwinite powders with electrospinning of PCL-based suspensions provides a versatile route for producing fibrous scaffolds with favorable morphology, bioactivity, and mechanical properties. Such fibrous structures may be further optimized toward advanced bone tissue engineering applications, bridging the gap between synthetic ceramics and native extracellular matrix architectures.

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ZINC OXIDE–CHITOSAN NANOCOMPOSITES OBTAINED BY THE HYDROTHERMAL METHOD WITH BIOMEDICAL POTENTIAL

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Zinc oxide (ZnO)–chitosan nanocomposites are attracting increasing attention due to their multifunctional properties and potential biomedical applications. ZnO nanoparticles (NPs) are well known for their antimicrobial activity and chemical stability, but recent studies also highlight their antitumor effects, particularly through the generation of reactive oxygen species (ROS) and induction of apoptosis in cancer cells, including melanoma and breast cancer models [3]. Chitosan, a natural biopolymer, is biodegradable, biocompatible, and enhances antibacterial and wound-healing performance, making it an ideal matrix for biomedical formulations [2]. In this work, we propose the hydrothermal synthesis of ZnO–chitosan nanocomposites, an ecological and environmentally friendly technique that enables control over particle size and morphology while promoting strong interactions between the inorganic and organic phases. Similar systems have recently been reported as promising platforms for anticancer drug delivery and wound-healing materials [1,2].

The literature suggests that ZnO–chitosan composites could be further developed for applications in antibacterial wound dressings, drug delivery systems, and innovative therapeutic strategies against skin cancers such as melanoma [1–3]. Ongoing studies will focus on the structural and biological characterization of the obtained materials.

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BIOACTIVE GLASS FUNCTIONALIZED WITH ARNICA AND THYME ESSENTIAL OILS: ANTIMICROBIAL AND REGENERATIVE POTENTIAL

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This study discusses the sol–gel synthesis and functionalization of 45S5 bioactive glass (BG) which has a composition of 45 wt% SiO_2, 24.5 wt% CaO, 24.5 wt% Na_2O, and 6 wt% P_2O_5. The BG was functionalized using arnica and thyme essential oils at two different concentrations (2.5% and 5%) for potential biomedical applications. The obtained BGs were characterized by X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM), energy-dispersive spectroscopy (EDS), thermogravimetric analysis, and the MTT assay to evaluate their composition, crystallinity, morphology, stability, and cellular viability. Results revealed that functionalization with essential oils enhanced the antimicrobial activity of the 45S5 BG without compromising its bioactivity or the regenerative potential. Notably, thyme essential oil at 5% concentration exhibited remarkable antimicrobial activity against Osteoblast-like MG-63 cells (CLS, Heidelberg, Germany).

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These data will be part of the first author's doctoral thesis.

EXTRACTIVE WASTE: A POTENTIAL SOURCE OF CRITICAL ELEMENTS AND CONSTRUCTION MATERIALS

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The growing global demand for critical raw materials and sustainable construction materials increased the interest in circular economy strategies, particularly the valorization of industrial residues [1]. Extractive waste is often treated as environmental burdens. However, these materials contain important concentrations of valuable elements and minerals suitable for use in the production of construction materials [2]. This study investigates the potential of extractive waste to be valorized as source of valuable elements and of low-carbon construction materials. The comprehensive characterization of the selected wastes revealed promising concentrations of valuable elements and suitable properties to be integrated in construction materials and chemicals. The findings support the viability of an integrated valorization approach which facilitates the reclassification of extractive waste from end-of-life residues to valuable secondary resources, fostering both critical material security and sustainable infrastructure development.

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Plasmonic Soft Hydrogel based on Metallic Nanoparticles for Optical Biosensing

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Stress is a widespread physiological condition with significant global health implications. The stress we face every day is considered a factor which can affect patients' life under an acute or chronic form. Cortisol, a primary biomarker of stress, has been associated to numerous chronic disorders when its levels remain elevated over time, including heart diseases, metabolic disorders or obesity. Consequently, the development of rapid, straightforward, and reliable real-time cortisol monitoring systems is of considerable interest to improve humans' lives.

This work is focused on the development of an innovative plasmonic biosensor based on silver nanospheres (AgNPs) and gold nanobipyramids (AuBPs) for cortisol detection. Both metallic nanoparticles were synthesized under chemical reactions as the first step in the development of the biosensor. After their synthesis, they were optically and morphologically characterized to prove their nanometric dimension and their enhanced sensing performances. The antibacterial effect was also proved based on disk diffusion method using two different bacteria strains. To enable specific cortisol detection, the synthesized nanoparticles were surface-modified using glutaraldehyde (GA), a well-established linker molecule. GA was employed to immobilize monoclonal antibodies specific to cortisol. The resulting plasmonic biosensor was tested with cortisol at clinically relevant concentrations to assess its Localized Surface Plasmon Resonance-based detection capability.

Finally, hydrogel matrices were proposed to obtain the hybrid plasmonic hydrogel as further application. This approach will facilitate cortisol detection by also offering a comfortable and easier measurement at home for patients. The hydrogel based on biodegradable soft polymers proved to be an innovative solution for easy cortisol detection while also comfort is assured improving therefore the healthcare outcomes for a high number of patients.

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DICYANIDE-SALEN BASED CHROMIUM(III) COMPLEXES. SCSC PROCESS WITH SELF-HEALING MOLECULAR CRYSTALS

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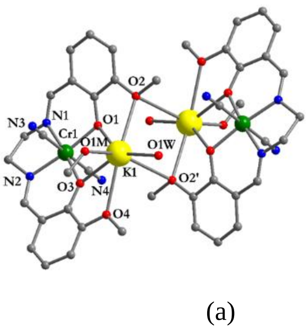
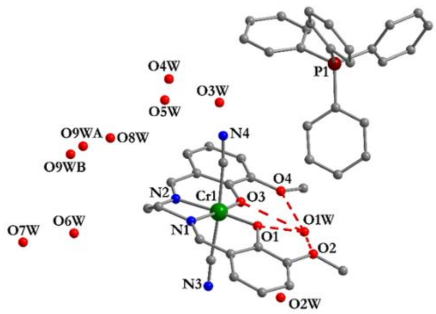
Cyanidometallate complexes are among the most widely used metalloligands in metallosupramolecular chemistry and magnetochemistry, owing to their distinctive properties. These include the ability to predict magnetic interactions between neighboring metal ions through the short cyanido bridge, as well as the capacity to control the structure of the final cyanido-bridged heterometallic complex by carefully selecting the capping ligands [1-3]. Solid-state structural transformations in a single-crystal-to-single-crystal (SCSC) manner are both intriguing and captivating. In some cases, they result in the formation of unusual products that cannot be achieved through conventional synthetic methods. This approach allows for the direct visualization of molecular structural changes during the transformation process [4].
Herein, we present the synthesis and crystallographic, magnetic, and thermal characterization of two new Cr(III) heteroleptic dicyanido-based complexes containing the bis(*o*-vanillin)ethylenediimidate ligand, $[K(H_2O)(CH_3OH)Cr^{III}(valen)(CN)_2]_2$ (**1**) and $PPh_4[Cr^{III}(valen)(CN)_2]\cdot 8.5H_2O$ (**2**) (Figure 1). By heating, compound **1** undergoes a solid-state phase transformation, followed by uptake of two aqua ligands upon exposure to air, accompanied by a rare process of cracking crystals to self-healing, giving rise to new compound $[K(H_2O)_2Cr^{III}(valen)(CN)_2]_2$ (**3**).



(a)



(b)

Figure 1. Perspective view of compounds **1** (a) and **2** (b).

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SYNTHESIS, ADME STUDIES AND ANTIOXIDANT PROPERTIES OF *N*-HETEROCYCLE COMPOUNDS

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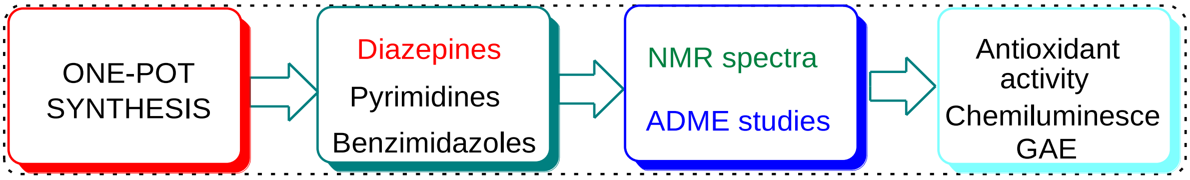
N-heterocycles are versatile scaffolds with medicinal and biological potential [1]. The literature reports a very wide range of pharmacological activities for diazepine compounds, such as hypnotics, anxiolytics, antidepressants, anticancer, anticonvulsants, antibacterials, and muscle relaxants [2].

In this study, our group synthesized a series of N-heterocycles: benzimidazole, pyridines, pyrimidines, and pyrazoles using different strategies. The compounds were characterized by NMR, FTIR, spectroscopies and mass spectrometry. A study was carried out regarding the influence of the substituents in the "2" position of the benzimidazole derivatives and the ^{1}H NMR chemical shift. The experimental observations are in agreement with previous research reported in the literature for heterocyclic compounds [3-7].

Determination of the total antioxidant capacity of the compounds was achieved by a chemiluminescent method (CL) [8]. All the compounds have a good antioxidant capacity, correlated with the substituent present in the molecule. The parameters obtained by DFT calculations for the synthesized compounds are in agreement with the resulting antioxidant activities.



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FLEXIBLE CARBON HEATING FILM ON PAPER SUBSTRATE

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Heaters, composed of conductive layers and substrates, generate heat through the Joule effect when an electric current passes through them. They can be used in various applications, but newly developed heaters are consistently expected to offer the same key advantages: lightweight design, good heating stability and flexibility. With recent advances in soft electronics, flexible and stretchable heaters are increasingly in demand on the market [1]. A commercial carbon-based conductive paste designed for screen-printing on flexible substrates is suitable for fabricating such heaters. In this paper, we present a heater made from JELCON CH-8 carbon paste on a paper substrate. Two samples with different layer thicknesses were prepared and subsequently inspected using an IR FLIR SC5600-M camera (Fig 1).

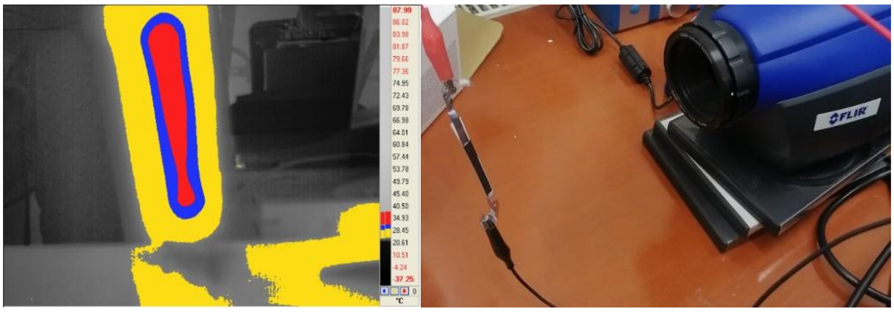

Fig. 1 Thermal test carried out with the help of the IR FLIR SC5600-M camera

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GRAPHENE APPLICATION FOR INNOVATIVE MEDICAL DEVICES

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Graphene is a groundbreaking allotrope of carbon and its excellent physical and mechanical attributes make it an advanced, cutting-edge nanomaterial. Due to its unique combination of thermal and electrical conductivity, mechanical strength and flexibility, graphene is emerging as a versatile material with transformative potential in the medical and energy industries. Research has shown that graphene-derived materials have been proposed for the biomedical field, some of its many applications including biosensors, antibacterial coating material and medical devices used for bioimaging. The crystalline nanostructure of graphene provides a two-dimensional crystal lattice with exceptional surface area that supports cell adhesion, proliferation, and differentiation, making it an ideal candidate for biomaterials used in regenerative medicine. Graphene's precise architecture acts like scaffolding at the molecular level, enabling breakthroughs in tissue engineering, from stem cell growth to organ repair. In addition, due to their high nanoparticle adsorption and antibacterial action, graphene-based films and hydrogel could be a highly suitable option for coating endovascular implants. This solution significantly outperforms existing alternatives in terms of enhanced hemocompatibility and accelerated endothelial cell coverage. Furthermore, by attaching chemically active moieties to its structure, graphene can be tailored into sophisticated highly sensitive sensors for detecting biochemical compounds and, ultimately, specific cellular targets. These biosensors have also been explored for their promising responsiveness to physical stimuli, particularly cardiac electrical activity.
However, despite the encouraging outcomes, the majority of existing data stems from in vitro experimental results, and thus, several challenges persist regarding their implementation within living systems. Subsequent research is required before valid conclusions can be drawn about potential applications of graphene in the medical field.

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ECO-FRIENDLY SYNTHESIS AND OPTIMIZED THERMAL TREATMENT OF Y_2O_3 NANOPARTICLES

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Nanoparticles made of rare earth oxides, especially Y_2O_3, have garnered significant attention for their applications in biomedicine (drug delivery, imaging), optics (phosphors), and other related fields. The wide applicability of these materials is due to their exceptional chemical, mechanical, and thermal stability, high resistance to corrosive environments, low toxicity, and biocompatibility.

In this paper, Y_2O_3 particles were obtained by an eco-friendly method, using spirula extract (*Spirulina platensis*) as bioactive agent, yttrium nitrate ($Y(NO_3)_3{\cdot}6H_2O$) as metal precursor, and ammonium hydroxide (NH_4OH) as precipitation agent. The aim of optimizing the thermal treatment is to establish the technological parameters for obtaining nanoparticles with the desired properties. In this context, thermal treatment was carried out at 600°C and 1100 °C. The morphological, structural, optical properties, and wetting capacity of the synthesized samples were analyzed. Morphological analysis revealed differences depending on the temperature applied. The compositional analysis also identified Y and O as the main elements. The FTIR spectra display absorption bands that can be attributed to the vibration mode of the Y-O bond and biomolecules present in the extract. The XRD analysis confirmed the cubic structure of Y_2O_3, with an average crystallite size ranging from 7 to 15 nm, and structural parameters were modified with increasing temperature. The Raman spectra exhibited a series of typical peaks with a major peak at 375 cm^{-1}, which is related to the fundamental vibrational mode of cubic Y_2O_3. The wetting capacity determined by measuring the contact angle highlights the maintenance of the hydrophilic character, with the angle varying between 40-51°. The obtained results demonstrate that the extracts can be considered an effective method for obtaining Y_2O_3 nanoparticles with applicability in the biomedical field.

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GOLD NANOPARTICLES AND CARBON DOTS COMPLEX FOR LATERAL FLOW IMMUNOASSAY TARGETING CARDIAC BIOMARKERS

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This study presents the synthesis and characterization of nanocomposites designed for a rapid diagnostic test based on lateral flow immunoassay (LFIA) for the detection of the cardiac biomarkers. Gold nanoparticles (AuNPs) with average diameters ranging from 20 to 35 nm were synthesized via a simple and sustainable method using green tea extract, leveraging its rich content in polyphenolic compounds (notably epigallocatechin gallate) as natural reducing and capping agents. Gold nanoparticles have demonstrated broad applicability across fields such as catalysis, biosensing, and diagnostics due to their unique optical properties. However, conventional chemical synthesis methods often involve hazardously reducing agents that compromise biocompatibility and reduce the efficiency of antibody conjugation.

Fluorescent carbon dots (CDs, <10 nm) were prepared by grafting three amine-terminated PEG chains onto surface-oxidized carbon nanoparticles, yielding stable nanostructures with tunable optical properties. For hybrid assembly, AuNPs were first functionalized with cysteine, providing free carboxyl groups on their surface. Subsequently, PEGylated amine-terminated CDs were covalently conjugated to cysteine-modified AuNPs via amide bond formation.

The synthesized materials were characterized using UV-Vis, FTIR, TEM, DLS, and zeta potential analysis. Preliminary results demonstrate that both types of nanoparticles as well as the complex system exhibit high specificity for LFIA application, with differences in sensitivity, signal stability, and detection time. This evaluation highlights their unique strength and supports their potential use in sustainable and cost-effective lateral flow immunoassay (LFIA) platforms.

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SOLAR VS. CONVENTIONAL HEAT TREATMENT PROCESSING OF MODIFIED 1.4312 STAINLESS STEEL

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This paper presents a comparative study on the heat treatment processing of a modified AISI 301 (1.4312) stainless steel, supplementarily alloyed with 0.40 wt% Mo and 0.33 wt% Cu. The addition of Mo could improve its hardenability, while the presence of Cu might enhance the stabilization of austenite during solution treatment [1]. The specimens were subjected to solution heat treatment at 1050°C by two distinct heating methods: an electric furnace and a solar furnace, followed in both cases by water quenching and tempering at various temperatures. Customized stainless-steel samples were heat treated using a solar furnace according to [2]. The aim was to compare the efficiency and effects of conventional furnace heating versus concentrated solar energy, in terms of microstructural evolution and mechanical (hardness, wear behavior) and corrosion performance. Results showed that solar heating provided faster heating rates and energy efficiency, with hardness values between 230-270HV and wear rates of 3.89 × 10-4 [mm3/Nm] comparable with conventional treatment. Nevertheless, electric furnace heating ensured greater process stability and uniformity. The findings demonstrate that solar furnaces can serve as a sustainable and effective alternative to conventional heat treatment technologies for stainless steels.

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Nanomaterials of the type $Zn_3Nb_2O_8$ doped with Er^{3+} ions used in the optical field

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The optical properties of materials are the subject of a large number of scientific, theoretical, and experimental studies, due to their applications in many fields of activity, which are found in widely used consumer products or in components with specialized applications. Of particular interest are pseudo-binary oxides, such as $Zn_3Nb_2O_8$ -type compounds with a wide band gap and semiconductor properties. These compounds belong to the category of phosphorescent materials, effective for flat screens or those with emission in an electric field, which can operate at low accelerating voltages, ensuring high stability under electron flux irradiation [1-4].

For this conference, pseudo-binary oxide nanomaterials $Zn_3Nb_2O_8$, both undoped and doped with various concentrations of Er^{3+} ions, were synthesized using the hydrothermal method and studied for their optical properties. Key factors that must be considered in the design of nanomaterial synthesis methods include structural characteristics (crystalline or amorphous), particle size, shape, morphology and chemical properties. In general particle size and size distribution, degree of crystallinity, dispersion level can be significantly influenced by the kinetics of the synthesis reactions. Among the most critical parameters affecting reaction rate are the concentration of reactants, reaction temperature and pH.

In this study, the samples were synthesized via a hydrothermal method at 240 °C for 12 hours, with a filling degree of 80%. Analysis of the band gap spectrum reveals that the band gap width of the semiconductor consistently falls between those of $Zn_3Nb_2O_8$ and Er_2O_3.
Certain lanthanide salts, in this case Er, are luminescent due to 4f electron transitions. The technical importance of the luminescence phenomenon lies in its ability to convert invisible radiation (UV, X-rays) into visible light, in some cases with very high efficiency.

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BIOACTIVE TRI-COMPONENT COATINGS FOR TITANIUM IMPLANTS: ENHANCING CELL INTEGRATION AND PATHOGEN RESISTANCE

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This study introduces innovative multifunctional bioactive coatings composed of bioglass, vitamin D3, and melittin, applied to titanium surfaces using the Matrix-Assisted Pulsed Laser Evaporation method. The primary objective was to enhance the biological and physicochemical properties of titanium implants, particularly by improving osseointegration, corrosion resistance, and antimicrobial performance. Detailed characterization showed that the resulting composite coatings maintained excellent chemical stability and exhibited a micro/nanostructured surface morphology that supports cell adhesion and viability. Electrochemical testing confirmed a notable improvement in the corrosion resistance of titanium in simulated body fluid due to the coatings, suggesting improved long-term durability. Biological evaluations demonstrated high biocompatibility and promoted osteogenic differentiation, with no signs of cytotoxicity or immune-related adverse effects. In addition, the MAPLE-deposited coatings enabled a controlled release of active agents over a seven-week period and displayed strong antibiofilm effects against key bacterial strains, including *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli*. Overall, the combined use of bioglass, vitamin D3, and melittin offers a synergistic solution to current challenges in implant design, positioning these coatings as a promising candidate for next-generation biomedical implants with improved therapeutic outcomes and longevity..

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ORGANIC AND IONIC LIQUID ELECTROLYTES FOR METALLIC LITHIUM ELECTRODEPOSITION

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There is a growing need for uniform, high-quality metallic lithium, or lithium-coated materials, particularly in battery technology. However, electro-deposition techniques have not been practical or cost-effective due to the low solubility of most lithium salts in suitable solvents. We made systematic and complex studies for efficient lithium electro-deposition processes and baths that can be operated at low temperatures and relatively low costs, using organic/organic-ionic liquids electrolytes and $LiNO_3$ as lithium source. The choice of $LiNO_3$ helps stabilize the interface and reduce side reactions. Metallic lithium was electrodeposited on a copper electrode under appropriate conditions, but the process requires careful control to avoid side reactions, dendrite formation and the electrolyte decomposition. Copper serves as a good current collector due to its low reactivity and high conductivity, but copper electrode must be clean and free of oxides or contaminants to ensure uniform deposition. The deposition process can be temperature-dependent. Elevated temperatures may improve ion mobility but increase electrolyte degradation risk and we observed that best results were obtained at 298-303K. High current densities can lead to poor morphology, while low current densities may reduce efficiency. By cycling voltammetry studies we conclude the exact deposition potential in each electrolyte and that lithium deposition on copper often follows a Volmer-Weber mechanism, where initial nucleation sites form before continuous layers grow. During some electro-deposition process a foaming process was observed at the cathode, which can occur due to the following reasons: 1. electrolyte decomposition may generate gases. If water is present as an impurity or if trace amounts of oxygen-containing species are reduced, hydrogen gas (H_2) or other gaseous byproducts could form; 2. electrochemical reduction of organic solvents can produce gaseous decomposition products such as dimethyl sulfide or other sulfur-containing compounds, which may contribute to gas evolution and foaming;3. Nitrate ions can also undergo reduction at the cathode, potentially forming nitrogen-containing gases (such as nitrogen oxides or ammonia) depending on the applied potential and reaction conditions;4. the presence of organic molecules in organic electrolytes or decomposition products can act like surfactants, stabilizing bubbles and enhancing foaming behavior. It is crucial to control moisture levels of electrolytes and we choosed to purge pure Ar into and to keep the Li deposit under argon atmosphere. The Li deposit was analysed by ICP-OES, XRD and SEM measurements. Efficiency of the deposition of metallic lithium of 21-89% were reposted in different electrolytes.

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SKILLS4EII – SKILLS ALLIANCE FOR THE GREEN, DIGITAL AND SOCIAL TRANSFORMATION

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The **Skills Alliance for the Green, Digital and Social Transformation of the Energy Intensive Industries (Skills4EII)** will uptake the results of the European Steel Skills Alliance (ESSA) and the Skills Alliance for Industrial Symbiosis (SPIRE-SAIS) and further develop them within the project aligned with the LargeScale Partnership Energy Intensive Industries (LSP EII) under the Pact for Skills.

An essential part of Skills4EII is to identify and adjust additional skills gaps, both cross-sectoral and sector-specific, within national and regional skills and training ecosystems. Skills4EII will create a common framework integrating specificities of all industries to continuously and proactively adjust the skills demands of the energy intensive industries (including further process industries).

This will be done by expanding the results of the two blueprint projects and developing a broader alliance and framework to close the skills gaps for specific (additional) sector needs (e.g. SME specific skills in the ceramic sector) and use synergies for cross-sectoral relevant topics and activities (such as Image & Recruitment, cooperation for the exploitation of Industrial Symbiosis, Industry 5.0, Artificial Intelligence).

It is essential to open and scale up the challenges and gaps already identified and those still to come in a more general scope (beyond steel and industrial symbiosis) and to focus on the one hand, on the specific needs of the different industrial sectors (**Steel, Minerals, Water, Engineering, Logistics, Non-Ferrous Metals, Ceramics, Raw Materials, Chemicals, Cement, Pulp & Paper, Refinery**). On the other hand, the rollout of existing and new national-regional ecosystems is key.

A central element to support this is the online training platform **HUB 5.0** (integrating the ESSA steelHUB and the SPIRE-SAIS online platform SKILLS4Planet). Furthermore, Skills4EII is also taking the next steps toward a **Process Industry 5.0**, becoming more human-centric, sustainable, and resilient.

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HYDROXYAPATITE-ALUMINA-ZEOLITE COMPOSITE COATINGS OF NATURAL ORIGIN SYNTHESIZED BY PLD FOR BIOMEDICAL APPLICATIONS

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We synthesized bovine hydroxyapatite (BHA) coatings, along with BHA blended with clinoptilolite (CLIN) and alumina (Al_2O_3), using pulsed laser deposition (PLD) with a KrF* excimer laser source (λ = 248 nm, $\tau_{FWHM} \leq$ 25 ns). The primary goal was to investigate the potential of these films to prevent bacterial adhesion and inhibit biofilm formation.

The PLD coatings exhibited a morphology characterized by aggregated/fused round-shaped micrometric particulates, ranging in size from approximately 0.2 to 6.3 µm. We observed that the complex stoichiometry of the targets was accurately reproduced in the deposited films. The crystallinity of these composite coatings progressively decreased with increasing content of Al_2O_3 and CLIN. This reduction in crystallinity is significant, as it can facilitate a more effective release of active components. Furthermore, FTIR spectroscopy revealed a de-hydroxylation of the BHA-Al_2O_3-CLIN composite coatings when compared to the simple BHA material.

Our findings indicated that the two BHA-CLIN-Al_2O_3 composite structures achieved the best compromise between high cytocompatibility and sustained antibacterial activity. We believe that attaining such optimal biological activity profiles, particularly when associated with the use of sustainable and/or inexpensive materials, is of key importance for the future development of high-performance implant coatings. These coatings should ideally offer perfect compatibility with surrounding tissues while effectively preventing postsurgical endogenous or nosocomial infections.

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HIGH-THROUGHPUT FABRICATION OF HIGH-ENTROPY ALLOYS AND ANALYSIS OF MATERIALS ACCELERATION PLATFORMS' PROSPECTS FOR THEIR DESIGN AND FUNCTIONALIZATION

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High-entropy alloys (HEAs), composed of five or more principal elements (5–35 at.% each), are a promising class of materials for extreme environments due to their exceptional thermal, mechanical, and chemical properties. Their compositional flexibility allows tuning for thermal stability, strength, corrosion and oxidation resistance, wear resistance, and specialized functionalities such as antimicrobial activity to mitigate microbiologically influenced corrosion (MIC) [1].
Designing HEAs with tailored properties remains experimentally intensive and time-consuming. High-throughput fabrication techniques, combined with materials acceleration platforms (MAPs), offer a pathway to streamline development by integrating rapid synthesis, characterization, and predictive strategies. Challenges persist, including the diversity of fabrication routes, limited property datasets, complex composition–property relationships, and fragmented integration from synthesis to application.
This work highlights the state of high-throughput HEA fabrication and presents an analysis of MAPs' prospects for accelerating the design and functionalization of HEAs for extreme applications.

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INFLUENCE OF CuCl AND $CuCl_2$ ON THE THERMOPHYSICAL AND ELECTROCEHMICAL PROPERTIES OF CHOLINE CHLORIDE-ETHYLEN GLYCOL DEEP EUTECTIC SOLVENT

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Ionic liquids have interest in area of „green chemistry”due to their advantageons properties such high conductivity, wide potential windows, high solubility of metals. Use of ionic liquids as electrolyte medium separation or deposition of metals requires a knowledge of their physico-chemical properties and the influence of the addition of different concentrations of copper chlorate, because the ion mobility can change the transport properties through structural changes in the electrolyte medium .This study investigated the effect of temperature on the physical and electrochemical properties (cyclic voltammetry) of a choline chloride-ethylene glycol (ChCl-EG) deep eutectic solvent (DES) without/with the addition of CuCl/$CuCl_2$ for the use in the electro-deposition of Cu which is an important raw material. Thermophysical properties as density, refractive index, speed of sound and electrical conductivity were measured in the temperature range 288.15-338.15 K. For density and conductivity the corresponding pre-exponential factor along with the activation energy were calculated. The following thermodynamic acoustical and optical parameters were calculated using the standard relations employed in previous studies.: the acoustic impedance (Z), the isentropic (adiabatic) compressibility coefficient (k_S) for the pure solvent and liquid mixtures, the specific refraction (r_D), the molar refractivity (R_D), the space-filling factor (S), isobaric thermal expansion coefficient (α_p) , molecular volume (V_m) standard entropy (S^0), and lattice energy(U_{pot}) of all studied systems. Fitting Parameters A_i, Correlation Coefficient R^2 Obtained for Density (ρ), Speed of Sound (c) and Refractive Index along with the absolute average percentage deviation (AAD %) were also calculated. Correlation parameters k and d of the different empirical equations to correlate density versus refractive index of ILs along with O.F.=SD standard deviations were computed. Parameters of equations for the density calculated/predicted values in the temperature range of the studied ionic liquids were correlated. Cyclic voltammetry was used to study the process of copper electro-dpeosition from those electrolytes.

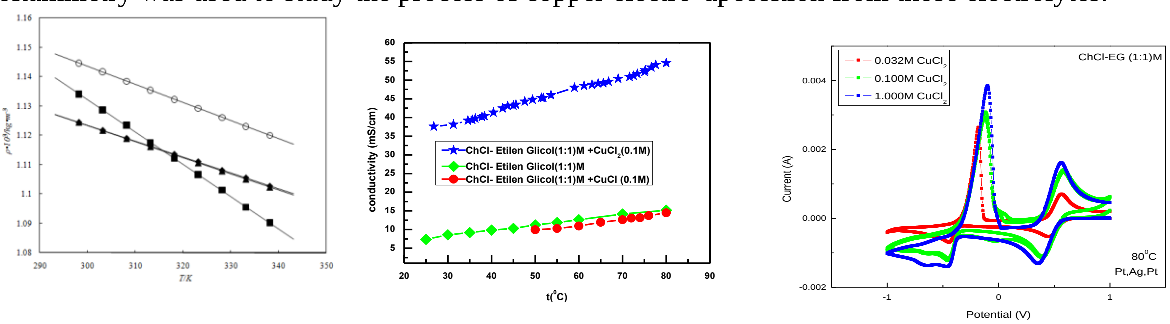

Fig.1 Dependence of density and conductivity with temperature; Cyclic voltammogramsof the system ChCl-EG without or with CuCl/$CuCl_2$addition.

THERMO-ACOUSTICAL AND OPTICAL INVESTIGATIONS OF BINARY AND TERNARY POLYETHYLENE GLYCOL 20000+DIMETHYLFORMAMIDE+DIMETHYLACETAMIDE MIXTURES, AT 298.15 K, WITH APPLICATIONS IN INDUSTRIAL PROCESSES

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The thermo-acoustical and optical properties for the binary and ternary mixtures of (polyethylene glycol 20000 + dimethylformamide) and dimethylacetamide, as well as their, have been measured at atmospheric pressure and different temperatures, from (298.15 up to 318.15) K.

The properties as densities, speed of sound, and refractive indices, respectively were measured and reported in this paper, at T = 298.15 K. Densities and ultrasonic speeds of mixtures solutions have been measured by vibrating tube densitometer Anton Paar 5000 M with a precision of $\pm 10^{-6}$ $g \cdot cm^{-3}$. The refractive indices were measured using an Anton Paar GmbH Abbe automatic refractometer with a precision of $\pm 10^{-6}$. The temperature of the samples was controlled within ± 0.001 K to measure the density and speed of sound, and with ± 0.01 K for refractive index determination, respectively.

From experimental results, the derived properties, such as apparent molar volumes, the isentropic compressibility, and molar refractions have been computed with a good accuracy.

The thermodynamic properties of polyethylene glycol 20000 in dimethylformamide and dimethylacetamide mixtures are discussed in terms of interactions, such as the hydration/dehydration effect of the solvent on the polymer.

Knowledge of the thermodynamics behavior of the dimethylacetamide in (polyethylene glycol 20000 + dimethylformamide) binary solvent is very important for biological, pharmaceutical and industrial processes.

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MICROBIAL BIOPROCESSES FOR CIRCULAR VALORIZATION OF AGRO-INDUSTRIAL WASTES

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Keywords: microbial bioprocesses, agro-industrial waste valorization, bio-based materials, circular economy, sustainable biotechnology.

Abstract: The shift towards a circular economy necessitates innovative strategies that both reduce dependency on critical raw materials and enhance resource efficiency. Microbial bioprocesses represent a sustainable approach for the conversion of agro-industrial residues into high-value bio-based materials, including biosurfactants, biopolymers, and other microbially derived metabolites with industrial relevance. Employing low-cost substrates such as food by-products and residual cooking oils, microbial fermentation processes not only mitigate environmental impacts but also generate multifunctional biomaterials [1]. Biosurfactants demonstrate exceptional functionality as emulsifiers, detergents, and bioremediation agents, while microbial exopolysaccharides and biopolymers offer credible alternatives to petroleum-derived compounds [2-5]. This framework underscores the dual benefits of waste valorization and the production of environmentally compatible materials applicable across energy, environmental, and industrial sectors. Moreover, microbial bioprocesses are fully aligned with circular economy principles, enabling the optimization of waste management pathways and driving innovation in material science. Overall, microbial biotechnologies provide renewable solutions to critical resource challenges, promoting sustainability, resource autonomy, and the advancement of advanced circular bio-based materials.

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PRODUCTION OF BIOSURFACTANTS BY *PSEUDOMONAS FLUORESCENS* STRAIN USING WASTE ENGINE OIL AS A CARBON SOURCE

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Keywords: waste engine oil, carbon source, Pseudomonas fluorescens ICCF 392, bioprocess, biosurfactant.

Abstract: *Pseudomonas* species are recognized producers of biosurfactants, secondary metabolites with applications in bioremediation and environmental protection [1]. This study evaluated the potential of waste engine oil as a substrate for biosurfactant production by *Pseudomonas fluorescens* ICCF 392 using the emulsification index (E_{24}) method. The strain was cultured in a liquid medium containing 2% waste engine oil, 1% bacto-peptone, and 1% yeast extract at 30°C, initial pH 6.5–7.0, 220 rpm, for 72 hours with 10% inoculum. E_{24} was calculated as the ratio of emulsion height to total mixture height, multiplied by 100. Experiments were performed in triplicate.

Culture supernatants were tested for emulsification against sunflower oil, heptane, and octane. Maximum emulsification was observed for octane (66.66%) and heptane (64.91%), while sunflower oil reached 54.71%. These results demonstrate that waste engine oil can serve as an effective carbon source for biosurfactant production by *Pseudomonas fluorescens* ICCF 392, highlighting the potential of valorizing oily waste streams for the production of eco-friendly biosurfactants suitable for industrial and environmental applications.

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INSIGHTS INTO THERMODYNAMIC PROPERTIES OF SOME ENTROPY-STABILIZED OXIDES

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The focus of our research is on the emerging class of “entropy-stabilized oxides”, which represents a "complex materials" class presenting a large diversity of electronic, magnetic, optical and electrochemical properties. The understanding of the interrelation composition-structure-properties is a central point for understanding the behavior of these complex systems. One of the key parameters responsible for this relationship is the change of the energetic parameters. In order to find new ways to tune, enhance and optimize the properties of novel materials designed for different applications, the thorough knowledge of the thermodynamics of the new materials is essential.
The canonical rocksalt entropy-stabilized oxide with the general formula (Co,Cu,Mg,Ni,Zn)O (named HEOx hereafter) were selected for discussion. In the present paper the HEOx thermodynamic properties have been investigated in the temperature range from ambient to 1273 K. For the first time, the relevant functions suitable for evaluation of the thermodynamic stability in particular temperature ranges associated with structural changes during heating have been measured.
The energetic parameters obtained by a couple of measurements (Drop Calorimetry, DSC/TG, Electromotive Force Measurements and Solid State Coulometric Titration) together with the thermal expansion and electrical conductivity data have been analyzed and the relationship of the thermodynamic stability with the defect structure has been revealed.
Integrating experimental observations with thermodynamic analysis we emphasize that the unique and potentially tunable properties of these materials are the result of synergistic interactions due to microstructural metastability of the competing phases, the entropy being the main driving force that is responsible for the formation of single-phase solid solutions.

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REDUCED GRAPHENE OXIDE AS PLATFORM FOR ELECTROCHEMICAL AND PHOTOTHERMAL ON-DEMAND INSULIN DELIVERY

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Reduced graphene oxide (rGO) is a promising material for controlled drug delivery due to its high surface area and excellent electrochemical and photothermal properties, resulting in an attractive carrier for therapeutic biomolecules. In this study, we developed two rGO-based systems for on-demand insulin release. The first system employed Au/rGO electrodes, where a −0.8 V electrical pulse triggered the release of about 70% of insulin in physiological conditions [1]. The second system combined rGO with PEG-dimethacrylate (PEGDMA) to form hydrogels that release insulin when exposed to near-infrared (NIR) light [2]. Both approaches preserved the biological activity of insulin. These results show that rGO can act both as a carrier and as a trigger-responsive material, offering a versatile platform for non-invasive insulin delivery as well as for future application in controlled release of a wide range of therapeutic biomolecules.

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DEVELOPMENT AND INVESTIGATION OF HYBRID STRUCTURES BASED ON RGO–Y_2O_3 WITH ELECTROCHEMICAL POTENTIAL

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Sensors based on nanocomposites obtained by associating of carbon materials with transition metals oxides, offer a new class of fast, reliable, and selective detectors etc., at a low price. Nanostructured carbon materials have a large surface area, significant mechanical strength, high electrical conductivity, and efficient electrocatalytic activity. At the same time, Y_2O_3 particles are physically and chemically stable, have a high melting point, high dielectric constant, a narrow band that allows electron transfer, and provides excellent electrochemical sensitivity. In this context, we propose a study on the development of nanocomposites based on Y^{3+} and reduced graphene oxide-type carbon materials and the improvement of the significant persuasive effect on electrochemical properties by attaching them to graphene. We present the obtaining of a hybrid RGO-Y_2O_3 structure by the hydrothermal synthesis technique using GO synthesized by the Hummer method, and yttrium nitrate as a precursor. The developed materials were analysed morphologically by scanning electron microscopy (SEM), and structurally using X-ray diffraction (XRD), Raman and FTIR spectroscopy. In the RGO sheets, Y_2O_3 exhibits uniform filler dispersion and spherical particles. Spectroscopy shows the formation of Y-O bonds and the existence of peaks associated with the G and D bands due to the existence of sp^2 carbon in RGO. XRD data complement the structural analysis and confirm the cubic structure of the oxide in the composite. The hydrophilicity of the composite was investigated by determining the contact angle below 90°. Cyclic voltammetry was used to evaluate the application potential of RGO-Y_2O_3 hybrid structures.

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SCINTILLATING NANOPARTICLES DRIVE X-RAY PHOTODYNAMIC CANCER THERAPY

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Cancer remains the second leading cause of death worldwide, emphasizing the urgent need for innovative and targeted therapies 1. Photodynamic therapy (PDT) offers advantages such as minimal invasiveness and low systemic toxicity, but its clinical use is limited by poor tissue penetration of activating light 2. To overcome this limitation, we developed $CeTiO_2$ scintillating nanoparticles (NPs), to convert ionizing radiation, such as X-rays, into visible light, thus activating nearby porphyrin-based photosensitizer. To assess the X-PDT capabilities of our complexes, we have examined the use of high-power laser-induced Bremsstrahlung radiation. The study employed a 7.5 PW laser (~250 J energy before compressor, 25 femtosecond pulse) with a gas jet target (98% helium and 2% nitrogen) to produce relativistic electron beams, which were directed at a metal foil to generate photon beams with an energy cutoff of ~100 MeV and ~3 mrad divergence. The radiation dose was measured using ionization chambers, BAS-MS image plates, and OSL detectors, with the BAS-MS selected for its high radiation sensitivity. Both healthy and cancerous cell lines were exposed to several radiation shots to achieve a relevant accumulated dose. Biological responses were evaluated through multiple assays, including cell viability assessment using the MTT assay to determine the cytotoxic effects of the treatment and the comet assay to analyse the induced DNA damage. The obtained results underscore the transformative potential of high-power laser systems for radiobiology and oncology. This approach provides a promising pathway for integrating nanoparticle-assisted PDT with advanced laser systems in precision radiotherapy.

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SUSTAINABLE CATALYSTS FOR DRM AND RWGS REACTIONS BASED ON ACTIVE METAL CONTAINED IN THE LEACHATE SOLUTIONS OF SPENT DIESEL AUTOCATALYSTS

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1% Pt-based catalysts have been fabricated by impregnation of both commercial and synthesized cerium oxide powders with platinum precursors from a leachate solution obtained from hydrometallurgical processing of spent diesel oxidation catalysts. Dry reforming of methane (DRM) and Reverse Water gas Shift (RWGS) tests were carried out in a fixed-bed reactor at temperature up to 850°C. A high conversion of CH_4 and CO_2, reaching values respectively of ~94 and ~96% and a H_2/CO ratio up to 0.9 at 850°C was achieved in DRM tests, while CO_2 conversion values of 60-70% with nearly 100% selectivity to CO was observed in RWGS tests. Time on Stream experiments revealed a quite good stability of catalysts.

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A STUDY OF LONG-TERM PERFORMANCE OF BIOCOATINCS IN SIMULATED BODY FLUIDS.

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Our research investigates the long-term degradation of coatings composed of biocoating blends. These coatings were subjected to simulated conditions. The degradation behavior was evaluated through mass loss measurements of the biocoating blends immersed in simulated body fluid (SBF) for a duration of 16 weeks. These results were correlated with data obtained from electrochemical experiments and supported by extensive compositional and surface analyses, including FTIR, GIXRD, SEM, and wettability assessments. Findings indicate that the degradation of the biocoatings is governed by the properties of the individual constituents: the PEG component exhibits rapid solubilization upon initial immersion, whereas the PCL component degrades gradually throughout the study period. Additionally, our data demonstrate that increasing the PEG content markedly enhances the degradation of the blend coatings. Biological evaluations further reveal that these coatings are beneficial for the adhesion and proliferation of both human-derived mesenchymal stem cells and endothelial cells.

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GOLD NANOPARTICLES ON TITANIUM DIOXIDE: A GREEN SYNTHESIS APROACH TO BIOACTIVE NANOCOMPOSITES FOR ENHANCED WOUND HEALING

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In a pioneering exploration at the intersection of nanotechnology and wound healing, this study introduces a novel biomaterial obtained from gold nanoparticles (AuNPs) synthesized on titanium dioxide (TiO_2) surfaces *via* an eco-friendly approach, leveraging an aminated hyaluronic acid derivative (HA-EDA) as a dual-purpose reducing and stabilizing agent [1]. Delving into the intricacies of wound repair, the research highlights the material's antimicrobial and anti-adherence effects against both standard and clinical microbial strains, alongside its cytocompatibility, anti-hemolytic, antioxidant and pro-wound healing activities, revealed by the stimulation of keratinocytes cells migration and proliferation. With its innovative synthesis method and multifaceted biological activities, this material showed a promising potential in modulating the inflammatory response and microbial colonization in wounds, offering a glimpse into future applications where it could contribute to the development of novel wound management strategies.

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CIRCULAR ECONOMY APPROACHES IN CEMENTITIOUS MATERIALS: INFLUENCE OF SUPERPLASTICIZERS IN WASTE-DERIVED COMPOSITES

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Global efforts are being made to achieve new materials in context of circular economy. The construction sector intends to achieve this goal by producing cementitious materials with different industrial wastes, minimizing the adverse environmental consequences of cement manufacturing, and developing green energy to create a sustainable, eco-friendly, and sustainable environment [1,2]. Pozzolanic substitute materials (fly ash, furnace slag, and silica fume) can be utilized as a partial substitute for regular Portland cement in mortar and concrete [3-5]. In cementitious materials using superplasticizers is one way to cut down on excessive water needed. The use of superplasticizers helps both to reduce water consumption, but also plays a decisive role in improving the characteristics of the materials.

In this work, the improvement of the mechanical characteristics of some materials in which the cement was partially replaced with fly ash and blast furnace slag was determined, the following superplasticizers being used to reduce water consumption: naphthalene formaldehyde sulfonates, melamine formaldehyde sulfonates, lignosulfonates and polycarboxylate ethers.

Characteristics such as compressive strength, bending strength, adhesion to the substrate were determined, and the influence of these additives on the water:binder ratio was also determined. By using superplasticizers, water consumption decreased, which had a positive effect on mechanical resistances: compressive strength increased by over 30%, while flexural strength increased by 15%.

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SECTION 3. NEW MATERIALS FOR ENVIRONMENTAL PROTECTION

DETECTION OF NITROPHENOLIC COMPOUNDS IN WATER USING A FIBER OPTIC PLASMONIC SENSOR

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The increasing presence of pesticide-related pollutants in aquatic environments has raised major concerns about water quality, ecosystem health, and public safety. Among these pollutants, nitrophenolic compounds such as 4-nitrophenol and 2,4-dinitrophenol are of particular importance due to their widespread use in pesticide synthesis and agricultural applications, as well as their persistence and high toxicity [1]. Traditional detection methods, while effective, often require complex sample preparation and sophisticated equipment and are not easily adaptable to on-site monitoring [2].

In this work, we present the design and use of a fiber optic plasmonic sensor for the quick, sensitive, and label-free detection of 4-nitrophenol and 2,4-dinitrophenol in water solutions [3]. The sensor utilizes the surface plasmon resonance (SPR) effect created by the gold thin film coated on the silica fiber surface, allowing real-time interaction between the evanescent field of guided light and analyte molecules in the solution. Experimental results demonstrate that the FO-SPR sensor can detect 4-nitrophenol and 2,4-dinitrophenol at environmentally relevant concentrations with high reproducibility and stability. Distinct resonance wavelength shifts that match different analyte concentrations verify the system's ability to perform quantitative analysis. Additionally, the fiber optic design offers inherent benefits such as being compact, resistant to electromagnetic interference, and suitable for remote or in-situ monitoring. The developed plasmonic sensor is a promising tool for real-time water quality assessment, providing a cost-effective and portable alternative to traditional laboratory methods.

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GREEN SYNTHESIS OF IRON OXIDE NANOPARTICLES USING DEEP EUTECTIC SOLVENTS AS A SUSTAINABLE NANOMATERIALS APPROACH

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The sustainable design of nanomaterials is a key priority in modern green chemistry, where the choice of solvent and synthesis pathway significantly influences both environmental impact and material performance [1]. Iron oxide nanoparticles (IONPs) are among the most extensively studied nanomaterials due to their unique magnetic, catalytic and electronic properties. These interesting properties recommend them in wide-ranging applications such as catalysis, energy storage, water purification and biomedicine [2]. Conventional synthetic routes often require toxic solvents, harsh surfactants, and high energy input, limiting their sustainability. In recent years, deep eutectic solvents (DESs), composed of a hydrogen bond donor and acceptor, have emerged as attractive alternatives, offering non-volatility, biodegradability, and low toxicity [3]. Apart from that, DESs influence also the nucleation, growth and morphology of the synthesized nanoparticles through a strong metal coordination process. In this study, the synthesis of γ-Fe_2O_3 nanoparticles, with particle sizes ranging from 3 to 10 nm, was achieved using choline chloride - based DES systems, under mild thermal conditions. The synthesized nanoparticles were in depth characterized using a series of complementary techniques (XPS, XRD, SEM, TEM, VSM), confirming the phase purity, nanoscale dimensions, surface functionality, and magnetic properties, respectively. Simultaneously purposes of DES, as no-aqueous solvent, stabilizer and templating agents, enables a precise control over particle size, phase and morphology. Overall, the use of DESs aligns strongly with the principles of green chemistry and offers a scalable pathway toward eco-friendly nanomaterial fabrication, bridging sustainability with technological performance.

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TiO_2-BASED HETEROSTRUCTURES FOR SENSING APPLICATIONS

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In recent years, sensors have played an important role in various aspects of our daily lives. For instance, chemical sensors serve as essential tools for capturing real-time chemical data from our environment. Such information can supply control systems with vital feedback across a wide range of chemical processes—including the detection of toxic substances and explosives, activation of safety alerts for gas appliances, protection mechanisms for workers exposed to chemical risks, environmental monitoring, regulation of the food supply chain, and even health monitoring [1]. UV sensors (photodetectors) are gaining increasing attention due to their relevance in everyday life, and lately the metal oxides materials are widely used in the development of UV sensors due to their wide bandgaps, high thermal and chemical stability, and photoconductivity under UV illumination [2]. As materials for sensors, numerous approaches have been used to study metal oxide material nanostructures from the perspectives of synthesis, structure, and properties. Among oxide materials, TiO_2 is a versatile compound known for its brightening and UV-absorbing properties, non-toxicity, and chemical stability.

For this study, the heterostructures based on $TiO_2/CuMnO_2$ and aero-TiO_2 materials were used for fabrication of UV photodetectors, and characterization under ultraviolet irradiation was assessed. The as-obtained composite materials were characterized by UV-Vis spectroscopy, Scanning Electron Microscopy (SEM), and X-ray diffraction (XRD) analysis. To prove the n-TiO_2/p-$CuMnO_2$ heterojunction, the Mott-Schottky measurement was performed. The UV sensing measurements were performed at ambient temperature in dark and under UV irradiation at $\lambda = 365$ nm and $\lambda = 395$ nm, using a commercial LED source. The *I-V* measurements of the n-TiO_2 nanolayer/p-$CuMnO_2$ thin film heterostructure confirm its diode characteristics under dark state, UV and visible illumination conditions [3].

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Terahertz Spectroscopic Analysis, Thermal Properties and Applications of Chitosan/PVP/PEO/PAA/AgNP composite hydrogels synthesized by e-beam cross-linking: A Comprehensive Study

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This study aims to combine THz Time Domain Spectroscopy and Thermal analysis to characterize biocompatible composite hydrogels with good elastic and antimicrobial properties. These hydrogels have been fabricated using chitosan and water-soluble polymers, along with commercial silver nanoparticles, through e-beam cross-linking. The optical parameters of the hydrogels have been investigated using Terahertz time-domain spectroscopy THz-TDS in the frequency range of 0.1 THz - 3.0 THz. It demonstrates how the THz-TDS system can identify any structural changes due to the incorporation of AgNP and the influence of electron beam radiation of a dose of 20 kGy, and respectively, 25kGy on the transmission coefficient of the hydrogels in the THz regime.
To the best of our knowledge, no combined studies of THz transmission and thermal analysis have been reported on composite hydrogels with good elastic and biological properties that have been fabricated by e-beam cross-linking using a complex polymer mixture based on CS(chitosan), PVP(polyvinylpyrrolidone), PAA(Polyacrylic acid), PEO(polyethylene oxide), and commercial AgNP.

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ENHANCEMENT OF THE TiO_2-AuQDs SENSOR FOR UV DETECTION

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Recently, photodetectors are gaining increasing attention due to their relevance in daily life, and especially metal oxides materials are widely used in the development of UV sensors due to their wide bandgaps, high thermal and chemical stability, and photoconductivity under UV illumination [1]. From metal oxide class as materials for sensors, numerous approaches have been used to study these nanostructures from the perspectives of synthesis, structure, and properties, and titanium dioxide (TiO_2) has become a versatile compound known for its brightening and UV-absorbing properties, non-toxicity, and chemical stability.

Within this study, the TiO_2 nanoparticles were obtained by synthesis in microwave-assisted hydrothermal conditions as an active material for ultraviolet (UV) light-sensing applications. Gold quantum dots (AuQDs) were uniformly applied to the TiO_2 surface to improve its sensing properties. For testing the sensing performances of TiO_2-AuQDs composite material, a commercial Au/Cr interdigitated electrode was used. Response and recovery times were threefold enhanced as a result of this functionalization, highlighting the function of AuQDs in promoting charge separation and lowering recombination processes at the semiconductor surface. The photoresponse of the TiO_2–AuQD system was evaluated at a bias voltage of 5 V using UV illumination with a wavelength of 365 nm and an incident power density of 28 $mW \cdot cm^{-2}$.The findings show that nanoparticles TiO_2 and AuQDs work in concert to create a promising platform for the creation of UV photodetectors with high sensitivity and quick response.

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Acknowledgements:

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ASSESSMENT OF RHUS TYPHINA L. LEAF EXTRACTS AS GREEN CORROSION INHIBITORS FOR BRASS ALLOYS IN ACIDIC MEDIA

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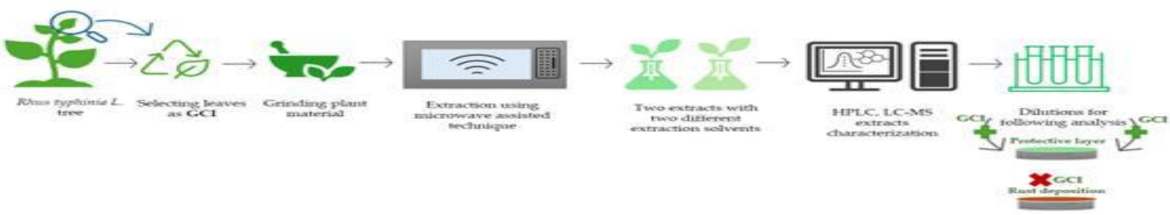
Leaves from *Rhus typhina* L. (RTLE, designated as P1 and P2) were used to create green inhibitor solutions. Two distinct extraction methods—methanolic (P1) and hydroalcoholic (P2) were employed to obtain the extracts. This process, known as microwave-assisted extraction, aimed to maximize the yield of beneficial compounds. The resulting extracts were then analyzed using high-performance liquid chromatography (HPLC) to determine their phytochemical composition. This characterization step is crucial for identifying the specific natural compounds present in the extracts that may be responsible for their inhibitory properties. The effect of various concentrations of these green inhibitors on brass alloys in acidic media was evaluated using potentiodynamic polarization and electrochemical impedance spectroscopy (EIS) methods. These techniques enabled the calculation of the inhibition efficiency (IE%) and corrosion rate. Additionally, the surface morphology and elemental composition were further examined using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX). The results showed that both P1 and P2 extracts significantly reduced the corrosion rate of brass alloys by forming a protective, inhibitive film on the surface. The adsorption of RTLE onto the substrate surface followed the Langmuir isotherm model. The negative Gibbs free energy of adsorption ($\Delta G_{ads}<0$), value indicates that the process is spontaneous. Overall, the RTLE green inhibitors demonstrated a significant protective effect, acting as mixed inhibitors. The electrochemical behavior of brass alloy substrates confirmed the strong inhibitory effect of RTLE extracts, with inhibition efficiencies exceeding 90% at higher concentrations (1000 ppm for P1 and 800–1000 ppm for P2). The smoother surface morphology in the presence of RTLE indicates physicochemical adsorption of active phytoconstituents, enhancing corrosion resistance.



Schematic representation of the extraction process, characterization, and application of RTLE as green corrosion inhibitors for brass.

TiO_2 THIN FILMS FABRICATED BY PLD IN VARIOUS ATMOSPHERES FOR EFFICIENT METHYLENE BLUE PHOTODEGRADATION

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The increasing use of dyes in industries such as textiles, tanning, paper manufacturing, printing and dyeing, food processing, and cosmetics leads to the contamination of environmental and water resources [1]. Due to its high water solubility and aromatic molecular structure, methylene blue dye can accumulate in ecosystems, posing a health hazard to humans and living organisms [2]. In this study, the photocatalytic degradation of methylene blue was investigated using TiO_2 thin films deposited by Pulsed Laser Deposition (PLD) under Ar, O_2, N_2, and He atmospheres, respectively. The degradation process was monitored by measuring the absorbance spectra with a UV-VIS spectrophotometer. The final dye concentrations were then determined using a calibration curve. Absorbance spectra of methylene blue at different UV exposure intervals, in the presence of the TiO_2 thin film (deposited in O_2 atmosphere), are presented in Fig.1. Hypsochromic and hypochromic effects can be observed at the maximum absorption wavelength of 662 nm, indicating the formation of intermediate degradation products. The photodegradation of methylene blue occurred in steps, via N-demethylation, as indicated by UV-Vis spectra. The reaction intermediates and final products of methylene blue were identified using high-performance liquid chromatography (HPLC-ESI-QTOF-MS). The results showed that the background gas used during TiO_2 thin film deposition significantly influenced its physico-chemical properties and photocatalytic activity. XRD and XPS were employed to determine the crystal structure and chemical composition of the films, while SEM was utilized to examine their morphology.

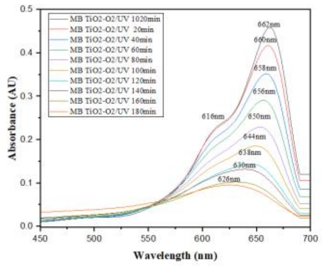

Fig.1. Evolution of methylene blue degradation under UV exposure in the presence of TiO_2 thin film deposited in O_2 atmosphere.

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Hydrothermal synthesis of REO- CNTs-doped TiO2 nanostructured powders for 3D printing applications in photocatalysis

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One of the problems facing the international community is the environmental pollution caused by the increase of the number of pollutants evacuated in the water. This requires the creation of a new / updated framework for regulation and control. Under the European Green Deal, the European Commission tabled a proposal for a recast of the Urban Wastewater Treatment Directive in October 2022. Wastewater treatment aims to reduce the pollutant load prior to discharge into the environment, typically rivers, lakes, and coastal zones.
In Europe, by 2023, industrial water treatment was estimated to increase water costs by up to 25% of total production cost and only about 50% of waste water will be purified. In the near future, the need for innovation in wastewater treatment technologies will grow significantly. In this context, photocatalytic technologies for wastewater treatment that use solar radiation as "green energy" with low impact on the environment must be considered from the perspective of environmental protection.
In this context, the paper presents the results on the development of nanocomposite structures based on TiO_2 doped with mixed rare earth oxides (REO) and functionalized with Carbon Nanotubes in controlled proportions, obtained by integrating hydrothermal green synthesis with additive manufacturing processes, to ensure a high photocatalytic efficiency and having spatial geometries designed for use in different configurations on wastewater decontamination installations.
The experiments carried out at IMNR were performed base on a factorial experimental plan to reduce the number of experiments and obtain mathematical correlations between the synthesis parameters and their BET specific surface and photocatalytic activity. The results show that nanostructured powders with 100% on TiO_2 anatase structure and high BET specific surface up to 285 m^2/g. Photocatalysis tests show a high level of decontamination efficiency for standard methyl orange, ranging between 89.64% and 95.23% and 88.98% to 98.00% for amoxicillin after 4 hours treatment, when using TiO_2 nanostructured powders doped with 1wt.% La2O3 and functionalized with 1 wt.% CNTs.
Works are in progress to obtain 3D printed ceramic structures with design geometry for pilot scale demonstration.

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NOVEL E-BEAM CROSS-LINKED HYDROGELS FOR SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL APPLICATIONS

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The growing challenges of drought, soil degradation, and water scarcity highlight the urgent need for advanced materials that support environmental protection and sustainable agriculture [1]. Superabsorbent hydrogels represent promising solutions owing to their high-water retention capacity, soil conditioning properties, and potential to reduce irrigation demands [2]. In this study, novel hydrogels composed of sodium alginate, acrylic acid, and polyethylene oxide were synthesized and cross-linked via electron beam (e-beam) irradiation, an emerging eco-friendly technology that eliminates the need for toxic chemical initiators. Their structural, swelling, and morphological properties were systematically investigated in aqueous environments with varying electrical conductivity, demonstrating pronounced sensitivity to water quality. FTIR spectroscopy and SEM analyses confirmed the formation of stable, interconnected porous networks that facilitate efficient water uptake and diffusion. These e-beam cross-linked hydrogels present a sustainable approach to soil enhancement and water management, offering significant potential for next-generation materials in environmental protection and sustainable agriculture.

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Electrochemical and Pharmacological analysis of Cu-Coumarin Complex

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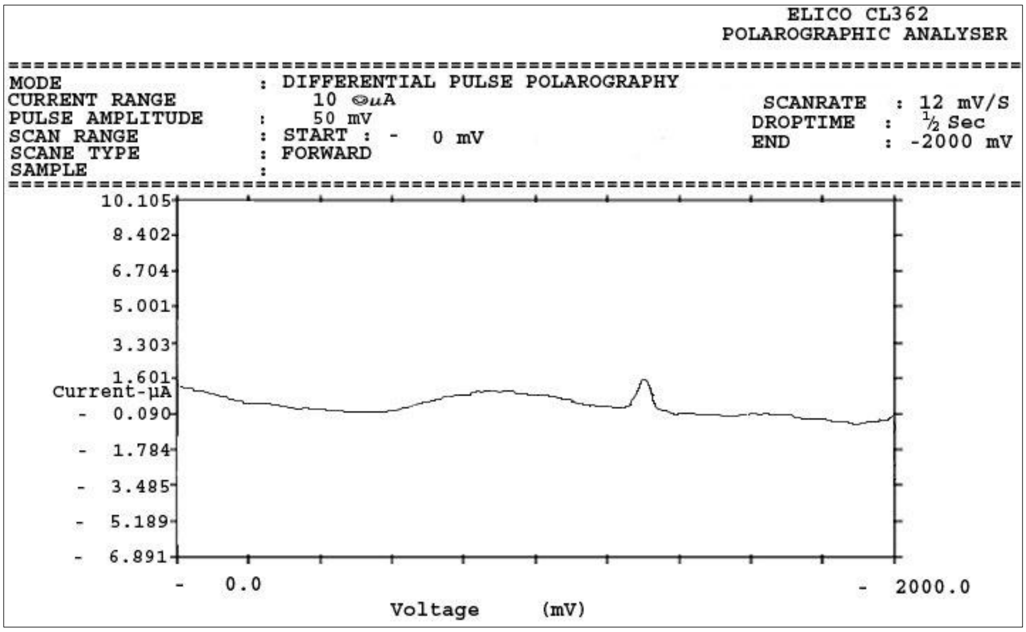
The drug coumarin is a potent anticoagulant. In the present study, the drug has been modified by complex formation with absolute methanol and concentrated sulphuric acid following standard procedures to increase its potency. To study the interaction between drugs and metal complexes, differential pulse polarography (DPP) has been used. In a pharmacological study, modified atropine showed an increased potency compared to its parent drug.

Keywords: Coumarin, DCP, DPP, anticoagulant, in vivo study.



From Fruit Waste to Functional Materials: Apple Pomace-Derived Carbons for Methane and CO_2 Mitigation

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Data from the United Nations states that livestock production accounts for 14.5% of the total global anthropogenic greenhouse gas emissions (GHG), emphasizing that 30% of the total global methane emitted comes from these sources, and two-thirds comes from cattle (mainly through eructation and exhalation). On the other hand, the food waste represents 33% of the total global food production, with fruits and vegetables comprising 22% of this amount. Apple is among the most widely consumed and processed fruits, with the industry generating approximately 4 million tons of apple pomace globally every year [1-3]. This study aims to valorize apple pomace to produce carbon structures with a high specific surface area for potential CH_4 and CO_2 adsorption. The residue was subjected to a pyrolysis between 700 and 800 ºC under N_2 atmosphere. Some of the biochar produced was further physically activated by a CO_2 or H_2O steam atmosphere (Figure 1), a more environmentally friendly approach than the chemical activation by acids or bases. The impact of temperature, activation time, and activating gas on the morphological and physicochemical properties of the carbonaceous materials was evaluated, along with their potential application as cattle feed supplements. Additionally, CH_4 and CO_2 adsorption tests were conducted to assess the potential of these materials for greenhouse gas mitigation. Results showed that the sample pyrolyzed at 800 °C for 1 h without activation exhibited a 72 m²/g BET surface area. This value increased significantly to 552 m²/g following CO_2 activation (150 mL/min, 1 h), and further to 682 m²/g when the activation time was extended to 2 h. These high surface areas highlight the promising potential of the produced materials for gas adsorption applications.

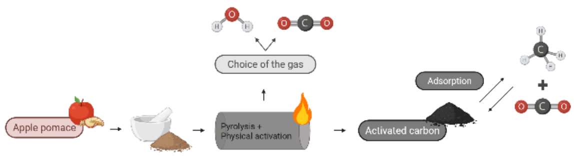

Figure 1: Schematic representation of the valorization of apple pomace via pyrolysis and activation (CO_2/H_2O steam) for the production of high surface area activated carbon materials for CH_4 and CO_2 adsorption.

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CHARACTERISTICS OF ZIRCONIUM-BASED HIGH ENTROPY ALLOY COATINGS DEPOSITED BY MAGNETRON SPUTTERING

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The present study investigates the structural, mechanical, and corrosion properties of thin film high-entropy alloys (HEAs), deposited by physical vapor deposition (PVD) magnetron sputtering, with emphasis on Zr-based multicomponent alloys. Two alloy systems were explored: **$Zr_{65.7}Cu_{15.6}Ni_{11.7}Al_{3.7}Ti_{3.3}$ (at.%)** and **$Zr_{48}Cu_{36}Al_{8}Ag_{8}$ (at.%)**, selected for their potential multifunctionality and relevance to protective coating applications. High-entropy alloy (HEA) coatings are increasingly important because they might combine superior hardness, wear and corrosion resistance, thermal stability, and diffusion barrier properties, making them excellent candidates for protecting materials in harsh or demanding service environments [1, 2]. Thin films were deposited from alloy targets, under identical sputtering conditions, with or without the addition of nitrogen as a reactive gas (with various flow rates). Substrate temperatures were maintained below 65 °C. The coatings were characterized in terms of **structural development, composition, mechanical properties, sheet resistance, and electrochemical stability.** Overall, the results highlight that careful compositional tuning of HEA thin films enables tailoring of hardness, adhesion, and corrosion resistance. It was observed that samples deposited with higher flows of nitrogen exhibit electropositive values in regard to the open circuit potential. Furthermore, depending on the nitrogen partial pressure, the sheet resistance values are several orders of magnitude apart. These findings provide guidelines for the design of multifunctional HEA coatings for environments requiring a balance between mechanical durability and corrosion protection.

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SUSTAINABLE MATERIALS TO REDUCE AIRCRAFT MRO COSTS

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The technique of laser cladding deposition of thermal barrier coatings has grown in recent years. Laser cladding deposition is an interdisciplinary sustainable technique that combines laser technology with computer-aided manufacturing and control systems. All these characteristics favour it to be included in sustainable additive manufacturing due to the automation of the deposition process, the reduction of dead times and the possibility of introducing the technology in the Internet of Things (IoT).[1]

In order to increase the sustainability and durability of aircraft engine components, there is a need to deposit a protective layer that reduces heat transfer inside the combustion chamber of the turbo engine. This extends the life of these metal components and increases the time between maintenance, thus reducing the costs necessary for aircraft repairs and maintenance, MRO (Maintenance, Repair and Overhaul) costs.

The current research shows the importance of selecting the optimal parameters depending on the deposition material and the support on which the deposition is made, so as to obtain the best possible adhesion of the two materials, and the efficiency of the deposition process to be maximum.

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DENSITIES, SPEEDS OF SOUND AND REFRACTIVE INDICES FOR BINARY MIXTURES OF ACETONITRILE + AROMATIC HYDROCARBONS, AT *T*= 298.15 K, WITH APPLICATIONS IN DECONTAMINATION PROCESSES

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The physico-chemical properties for the pure liquids of acetonitrile, and two aromatic hydrocarbons, namely: *n*-propylbenzene and *iso*-propylbenzene (cumene), as well as their binary mixtures of *n*-propylbenzene/ *iso*-propylbenzene + acetonitrile, have been measured at different temperatures, between T = (298.15 and 318.15) K and atmospheric pressure.

The excess and deviation quantities, have been calculated using the obtained experimental results of densities, speed of sound, and refractive indices, respectively. The thermodynamic properties reported in this work, at T = 298.15 K were: the excess molar volumes, deviation in speeds of sound, excess isentropic compressibilities, excess molar isentropic compressibilities, as well as the deviations in refractive indices, and excess molar refractions.

The experimental density data were used to calculate also the partial and apparent volumetric properties.

From the experimental refractive index data, some theoretical (n,ρ) mixing rules (Lorentz-Lorenz, Gladstone-Dale, Arago-Biot, Edwards and Eykman) usually used in predicting the refractive indexes were assessed.

These excess and deviation properties have been correlated by the Redlich-Kister type polynomial expression, with good accuracy.

The experimental and calculated results are discussed from the point of view of the molecular interactions between components of mixtures and their structural effects.

The study of the thermophysical properties for binary mixtures of acetonitrile with alkylbenzenes, has a significant relevance for environmental protection, in different decontamination processes.

The ability of acetonitrile to dissolve a wide range of organic compounds makes it an ideal solvent for the extraction and analysis of contaminants organic in glass manufacturing and processing. These contaminants, such as pesticides and phthalates, can have an important impact on the quality and safety of glass products.

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This contribution was carried out within the research programme “Chemical Thermodynamics and Kinetics. Quantum chemistry” of the “Ilie Murgulescu” Institute of Physical Chemistry, financed by the Romanian Academy (RA). The financial support of the EU (ERDF) and Romanian Government, for the acquisition of the research infrastructure under Project INFRANANOCHEM-Nr. 19/01.03.2009, is also gratefully acknowledged

HIGH-PERFORMANCE CORROSION INHIBITION OF CARBON STEEL IN 1.0 M HCL USING AN ECO-FRIENDLY CO-APATITE PHOSPHATE COMPOUND

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Carbon steel degradation in acidic environments, particularly in hydrochloric acid, presents serious challenges for the petrochemical, construction, and transportation industries. The development of effective and environmentally friendly inhibitors is therefore essential to enhance the durability of steel structures. In this study, a novel Co-Apatite Phosphate compound was investigated as a corrosion inhibitor for carbon steel in 1.0 M HCl solution. The material was synthesized through a simple, eco-friendly chemical route and characterized by FTIR spectroscopy, X-Ray diffraction and SEM/EDS analyses. Electrochemical techniques, including electrochemical impedance spectroscopy (EIS), potentiodynamic polarization (PDP), and cyclic voltammetry (CV), were employed to evaluate its anticorrosion performance. The compound exhibited excellent inhibition efficiency, achieving 96.4% at an optimal concentration of 50 ppm. Although a slight decrease in efficiency was observed with increasing temperature, the inhibitor maintained substantial protective capability. Polarization studies indicated its mixed-type inhibitory behavior, while surface analysis confirmed the formation of a dense and adherent protective film on the steel surface [1,2, 3]. These findings highlight the potential of phosphate material as a highly effective and eco-friendly inhibitor, offering strong protection for carbon steel under aggressive acidic conditions relevant to industrial practice.

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INTEGRATED BIOREMEDIATION AND MONITORING OF CHROMIUM-CONTAMINATED SOILS USING FUNGAL CONSORTIUM AND ELECTROCHEMICAL SENSORS

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Remediation of chromium-contaminated environments is a priority from both ecological and public health standpoints, as toxic hexavalent chromium (Cr^{6+}) is persistent, bio-accumulative, and associated with carcinogenic, mutagenic and teratogenic effects. Biological remediation using microorganisms and plants is emerging as a sustainable and efficient alternative to conventional methods by transforming or immobilizing toxic Cr species into less hazardous forms [1]. However, their effectiveness is difficult to evaluate without real-time monitoring of its content. The aim of our research is to develop a complex system consisting of a fungal consortium with improved Cr bioremediation efficiency and simultaneous monitoring using a portable electrochemical device based on nanomaterial-modified screen-printed sensors.
Indigenous filamentous fungi were isolated from highly Cr-contaminated soil in Bucharest and tested for their compatibility and tolerance to different concentrations up to 1 g/L of $K_2Cr_2O_7$ [2]. The most suitable strains were combined in equal proportions and inoculated into soils with various levels of chromium contamination. The reduction of Cr^{6+} concentration was monitored for 8 weeks in the soil solutions extracted with small-volume lysimeters by amperometric detection using screen-printed carbon-paste electrodes modified with different nanomaterials and redox mediator - Prussian blue. The differences in elemental composition of the soil samples were assessed by X-Ray Fluorescence at the end of the experimental period.
Three strains belonging to the genera *Trichoderma* and *Clonostachys* were selected to form the consortium. The reduction of Cr^{6+} concentration was highlighted by electrochemical studies and was observed to be complete after a period of 8 weeks. Bioleaching of Cr from soil particles was confirmed through XRF analysis, as a result of acidification by fungal metabolites. The developed electrochemical miniaturized sensors showed a high sensitivity of 584.99 $mA{\cdot}M^{-1}{\cdot}cm^{-2}$ and a detection limit of 1.2 μM for Cr^{6+} detection, allowing real-time monitoring of the bioremediation process.
Our study presents the successful development of a novel chromium-bioremediating consortium and of an electrochemical miniaturized and portable monitoring system, demonstrating synergistic efficiency in Cr^{6+} reduction, with concomitant in-situ monitoring. Studies will continue by evaluating the phytoextraction efficiency of hyperaccumulator plants for ecological restoration and recovery of chromium from contaminated soils.

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BENEFICIAL INFLUENCE OF DNA BIOPOLYMER ON OPTICAL LIMITING FUNCTIONALITY

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Optical limiting functionality is based on the nonlinear absorption process. In optical limiting the optical transmission of a material decreases when the incident laser intensity exceeds a threshold value [1-3]. It is used to protect the eyes and sensitive optical and optoelectronic devices from laser-induced damage. The optical limiting is of significant importance with the continuous development of increasingly powerful lasers. For an ideal optical limiter, the transmitted intensity linearly increases with incident intensity up to the optical limiting threshold, remaining constant at higher incident intensities. For a real optical limiter, the transmitted intensity depends nonlinearly on the incident one, being described by a saturation curve.

We present our recent results of the investigation of the optical limiting in a new class of nonlinear optical materials. They consist of deoxyribonucleic acid (DNA) biopolymer functionalized with natural dyes (e.g. turmeric) [4]. These materials are investigated by the Intensity-scan with femtosecond laser pulses at 1550 nm, which is an important telecommunication wavelength [5-7]. The optical limiting of the turmeric dye alone and of the DNA-turmeric compound are studied comparatively. The optical transmittance curves have been determined in both the linear and nonlinear transmittance regimes. From these curves, the linear transmittance, the optical limiting threshold and the saturation intensity have been determined. This comparative study revealed that the nonlinear optical absorption coefficient is higher and the saturation intensity is lower in the DNA-turmeric compound than in turmeric alone.

The obtained results demonstrate the favourable influence of DNA on optical limiting in turmeric dye. The investigated DNA biopolymer – turmeric compound, a novel material with applications in photonics, can serve as an ecological alternative to hard-to-degrade and highly polluting synthetic polymers and dyes.

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PHOTOCHEMICAL ACTIVITY OF FUNCTIONALIZED ZINC PHTHALOCYANINE-NATURAL POLYMERS SYSTEMS

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New photosensitizers based on tetracarboxy- and octacarboxy- zincphthalocyanines derivatives conjugated to some natural polymers for photodynamic therapy are investigated. The tetracarboxy- and octacarboxy- ZnPc powders prepared by the direct condensation and hydrolysis were conjugated to chitosan. The combination of valuable photophysical characteristics and their chemical stability allows us to obtain various optoelectronic devices based on phthalocyanines [1]. Electronic absorption and emission spectra were used in order to characterize the phthalocyanine derivatives. The red-shift of the absorbance in substituted $ZnPc(COOH)_4/Ch$ and $ZnPc(COOH)_8/Ch$ systems makes them attractive as potential photosensitizers in PDT as the Q absorption band is in the range of the optical window of 650–800 nm, providing deeper penetration of light into biological tissues.

Their photophysical properties including quantum yield, fluorescence lifetimes and phosphorescence were investigated. The time-resolved fluorescence decay of $ZnPc(COOH)_4/Ch$ is mono-exponential, while for $ZnPc(COOH)_8/Ch$ system is biexponential. This fact indicates that binding between the amine and carboxyl groups results in the formation of system with favorable self-healing properties. In the transient absorption map, these compounds displayed a ground state baseline at lower wavelengths and the excited states can occur. Also, the biological characteristics such as low dark and photoinduced toxicity, the ability to generate reactive oxygen species and storage stability were studied.

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BIOACTIVE WOUND DRESSINGS USING NEW MICROBIAL POLYSACCHARIDE CROSSLINKED HYDROGELS

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Natural resource-derived crosslinked hydrogels were thought to be a good substitute for conventional hydrogels made of synthetic polymers, the majority of which are non-biocompatible and non-biodegradable [1]. Natural polysaccharide-based hydrogels have a wide range of potential uses, including controlled medication release, tissue engineering, wastewater treatment, agriculture, sensors, and hygiene products. Hydrogels based on natural derivatives have inherent benefits such as easy availability, biocompatibility, non-toxicity, and biodegradability, but they also have drawbacks, including low water retention properties and poor mechanical stability.

Despite the benefits of natural derivatives, like their simple availability, biocompatibility, non-toxicity, and biodegradability, there are drawbacks as well, like reduced water retention properties and poor mechanical stability. Crosslinking hydrogels and/or adding strengthening inorganic fillers can help to mitigate these disadvantages. Hydrogel nanocomposites made with nanoclay particles have been the subject of much research in recent years for a variety of uses aimed at enhancing the hydrogel's mechanical strength and swelling characteristics. Taking these factors into account, the primary goal of this study is to synthesize and characterize a unique series of microbial polysaccharide crosslinked hydrogel nanocomposite materials that are produced by varying the quantity of natural clay.

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BIOINSPIRED SYNTHESIS OF MAGNESIUM ALUMINATE FOR APPLICATIONS IN ENVIRONMENTAL REMEDIATION

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Nowadays, the synthesis of materials used in environmental remediation is increasingly challenging. In this line, the involvement of waste from the food industry in the synthesis of mixed oxides represents a major component of the management of this type of waste and a solution to concerns about environmental toxicity. It has been demonstrated that magnesium aluminate ($MgAl_2O_4$) exhibits interesting photocatalytic properties, being efficient for the removal of cationic dye from wastewater [1].

This research study focused on the synthesis of $MgAl_2O_4$ by a green approach of combustion method using an aqueous extract of apple peel as a biological fuel. The phytochemicals present in the plant extract act as reducing, chelating and stabilizing agents in the formation of mixed oxides. The most of the bioactive phytochemicals from apple fruit are found in apple peel [2]. The final oxide was obtained after a thermal treatment at 700 °C/2h and was characterized by various techniques. The X-ray diffraction, infrared and Raman spectra proved the synthesized sample's spinel structure. SEM and EDX results reveal the formation of nanocrystalline $MgAl_2O_4$ powder with homogeneous microstructure and composition. The photocatalytic activity of the as-synthesized oxide was evaluated for methyl orange (MO) photodegradation under visible light irradiation. A high photocatalytic activity was retained over five cycles and no change in the structure of the tested sample was observed, confirming its reusability.

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TRIGAP-C —Climate-Responsive Cellulose–Nanoparticle Façade Skins

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Urban heat islands and climate variability pose significant challenges to sustainable construction in low- and middle-income countries (LMICs), where energy-efficient materials are essential for thermal regulation without mechanical systems. This work introduces an innovative concept for adaptive cellulose-nanoparticle composites as "smart skins" for building envelopes, engineered to respond dynamically to environmental stimuli such as humidity, temperature, and UV exposure. By functionalizing microcrystalline cellulose with TiO_2 (for photocatalytic self-cleaning and UV absorption), SiO_2 (for structural stability and hydrophilicity control), and ZnO (for thermal conductivity modulation and antimicrobial properties) at 5–15 wt% loadings, the composites form a responsive hydrogel network via eco-friendly cross-linkers like citric acid.

Under high humidity, the matrix swells to expose nanoparticles, enhancing evaporative cooling and self-cleaning through reactive oxygen species generation. Temperature rises trigger ZnO-mediated heat dissipation, while UV exposure induces surface charge shifts for dust repellency, mimicking natural plant cuticles. This synergy enables self-regulation: tight networks for insulation in low-stimuli conditions, and open pores for active response in harsh climates.

We outline a structured approach: (1) material design via sol-gel deposition and characterization (SEM, FTIR, contact angle); (2) multiphysics simulation in COMSOL to model diffusion, heat transfer, and photoexcitation; and (3) Bayesian optimization (using BoTorch) to refine nanoparticle ratios and cross-link densities, minimizing evaluations (20–50 iterations) for multi-objective targets like response time (<5 min) and durability (>85% retention after 100 cycles).

Applied to smart building envelopes, these composites could reduce urban cooling needs by 20–50%, mitigate UHI effects, and support environmental protection through biodegradable, low-carbon materials. Future pilots in LMIC testbeds will validate performance, advancing sustainable construction.

SUSTAINABLE ASSEMBLING TECHNOLOGIES FOR LIGHTWEIGHT TEXTILE AIRBORNE STRUCTURES

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Developing sustainable airborne systems requires innovative materials and assembling technologies that minimize environmental impact while ensuring high mechanical performance [1]. This work presents an environmentally friendly sewing-based assembling technology applied to advanced technical textiles designed for high-altitude aerial applications [2]. The technology was implemented in the development of a full-scale collapsible helicopter bucket prototype for vegetation fire suppression, demonstrating its applicability in real operational products [3]. The employed multilayer polyester composite, enhanced with waterproof and fire-retardant coatings, exhibits excellent tensile strength, tear and abrasion resistance, and hydrostatic impermeability exceeding 9999 mm H_2O, while maintaining dimensional stability under UV and chemical exposure [4], [5], [6]. The assembling technology employs optimized stitching patterns and high-tenacity threads to ensure seam durability under cyclic loading, repeated folding, and dynamic stresses typical of aerial operations, while replacing adhesive bonding, eliminating solvent emissions, avoiding thermal curing steps, and reducing both production cost and environmental impact. Following manufacturing, the prototype underwent a comprehensive ground testing program, including dimensional, gravimetric, and watertightness evaluations. It fulfilled all specified performance requirements, demonstrating operational readiness, while complementary EN/ISO laboratory evaluations confirmed that the sewn assemblies retained mechanical strength and functionality even after long-term storage.
This work demonstrates how combining advanced textile composites with sustainable assembling technologies can generate robust, eco-efficient solutions for next-generation airborne applications and support environmental protection through effective wildfire suppression.
Keywords: technical textiles, sustainable joints, collapsible bucket, environmental protection

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ADVANCED MULTIFUNCTIONAL NANOARCHITECTURES FOR OPTO-ELECTROCHEMICAL BIOSENSING IN FOOD AND ENVIRONMENTAL SAFETY MONITORING

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Keyword: Fullerenol, aptasensors, electrochemiluminescence, food safety, drug residues.

Even though nanotechnology has advanced so much that functional materials can be created on a scale invisible to the naked eye, having a huge impact on how essential compounds are detected and monitored, there is still emerging the development of new nanomaterials with enhanced opto-electrochemical properties. Application of nanotechnology in biosensing include food safety and agriculture, where portable biosensors and (nano)sensors are able to detect pathogens, allergens, biogenic amines and drug residues, and to monitor the soil health, to detect plant disease and optimal conditions for plant growth.

Innovative nanocomposite materials with improved characteristics have been developed based on crosslinked hydrogel networks doped with Fullerenol based nanomaterials [1], for sensing applications in food and environmental fields. By incorporation of specific bioreceptors, such as aptamers, into such conductive nanostructures were obtained biosensitive functional materials with unique characteristics and diverse functionalities.

The aptasensors developed by using these innovative nanomaterials were integrated in portable miniaturized opto-electrochemical tool allowing the sensitive and specific detection of histamine and histidine from food samples [2], and drug residues such as penicillin and tetracycline from aquatic environments using electrochemiluminescence (ECL) technique. After placing the aptasensors in the ECL cell, a volume of 300 µL of a mixture of 100 mM luminol and 10 mM H_2O_2 is deposited on their surface, and measurements are performed in ECL and linear sweep voltammetry (LSV).

The integration of advanced nanomaterials with microfabrication methods, IoT or AI technologies and wireless connectivity paves the way for smart devices, offering multifunctional solutions in the fields of healthcare, environmental protection and food quality control. In this context, engineered nanostructures play a critical role in advancing precision medicine, ensuring safer food chains, and strengthening sustainable practices that benefit both human well-being and ecosystem health.

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CNF-BASED FUNCTIONALIZED COMPOSITE AS AN EFFICIENT ADSORBENT FOR ANTIBIOTICS IN AQUEOUS SOLUTIONS

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The growth of the pharmaceutical industry has contributed to water pollution with various active pharmaceutical organic compounds. Among these, antibiotics are particularly concerning due to their ability to induce bacterial resistance. The presence of antibiotics in water has been associated with cytotoxicity, genotoxicity, and hepatotoxic effects, which highlights the importance of understanding the factors involved in their removal. Ceftriaxone is a third-generation cephalosporin, mostly eliminated unchanged from the body, making it a relevant target pollutant.

The adsorption process has increased popularity in wastewater treatment due to its efficiency, simplicity, and cost-effectiveness for removing ceftriaxone from water. In this study, the aim is to investigate the adsorption capacity of CNF/$Cu(OH)_2$/$Zn(OH)_2$ and the mechanisms involved in removing ceftriaxone from aqueous solutions. The synthesized CNF-based functionalized composites were characterized using Energy-dispersive X-ray spectroscopy (EDX), Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), and Differential Scanning Calorimetry (DSC). Batch adsorption experiments were carried out using the obtained nanomaterials as adsorbents. At an initial concentration of 10 mg/L ceftriaxone (CF), the removal rate was 54%. Adsorption isotherms were studied using different models, with Langmuir and Freundlich fitting the best experimental data, varying the adsorption conditions.

The synthesized nanoparticles exhibit excellent adsorption capacity for ceftriaxone removal. Improving the performance of these materials by increasing the active surface area or modifying the used CNF represents a future goal that could be achieved. Overall, the results demonstrate that the synthesized nanoparticles based on CNF represent an efficient adsorbent for pharmaceutical removal from aqueous solutions.

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OBTAINING A FRACTION ENRICHED IN (-) EPICATECHIN AND RUTIN FROM A SEA BUCKTHORN FRUITS EXTRACT

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The berries of *Hippophae rhamnoides* (*Elaeagnaceae* fam., Sea buckthorn) shrub are frequently used for their antioxidant activity, in hypo- and avitaminosis, in anemia and convalescence, for curing cough, improving blood circulation, skin wounds, etc. [1]. The berries are rich in phenolic compounds, especially: phenolic acids (hydroxybenzoic acids and hydroxycinnamic acid derivatives), flavonoids (isorhamnetin, quercetin), flavones, and tannins, but also vitamins (vitamin C, vitamin E), carotenoids (lycopene, β-carotene), carbohydrates (glucose, fructose) etc [1-3].

The main objective of this study was to obtain a fraction enriched in (-)epicatechin (E) and rutin (R) from a concentrated extract of sea buckthorn berries by a RP HPLC-PDA method [4].

An ethanolic extract, obtained from berries by the accelerated solvent extraction (ASE) method, was subjected to concentration by evaporation, and then sterilized by filtration. The separation was performed using a Flexar preparative HPLC system equipped with a manual injector with a 0.4 mL loop, and an fraction collector. Chromatography was performed using a YMC-Actus ODS-A HPLC column (300Å, 5 µm, 150 x 20.0 mm), set to 35 ºC. Mobile phase A was water with 0.1% formic acid (FA), B- methanol with 0.1% FA, and a gradient mobile phase of 5% - 70% B, 35 min, was applied. The eluent flow rate was 4.5 mL/min. The signals were monitored at 280 nm for E, and 380 nm for R. Analysis of the fractions of the processed sea buckthorn extract showed that it is rich in E and R.

The fraction, a valuable source of (-)epicatechin and rutin, can be used in the preparation of food supplements or pharmaceutical formula with topical administration.

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INFLUENCE OF MICROWAVE-ASSISTED SYNTHESIS ON THE MORPHOLOGY AND STRUCTURE OF NANOSTRUCTURED NIO

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The synthesis of oxide nanoparticles is an intensive research area due to its versatile electrical, mechanical, optical, thermal, magnetic properties [1] and various applications in fields such as electronics and biomedical [2]. Among them, nanostructured NiO has superior antibacterial properties, ideal for biomedical and water purification applications [3],[4]. This study investigates the influence of microwave-assisted synthesis at 1000W, 3 minutes, on the properties of nanostructured NiO, compared to the standard hydrolytic method. Both techniques use similar precursors, the introduction of microwave radiation being the distinguishing factor. SEM analysis demonstrated that the prepared powders are aggregates with irregular shape. Microwave-assisted synthesis resulted in more uniform particles. The crystallite size is influenced by the synthesis method. X-ray diffraction analyses identified an average crystallite size of 4.89 nm for NiO obtained by standard hydrolytic synthesis and 9.89 nm for NiO resulting from microwave-assisted synthesis.
The observed changes in morphology and optical properties suggest a direct influence on the average crystallite size that increases with the duration of microwave treatment. In contrast to the standard method, which resulted in a band gap energy (Eg) value of 5.26 eV, the microwave synthesized sample showed a reduced value of 4.96 eV. This decrease in band gap energy indicates changes in the electronic structure, influenced by the morphology and size of the crystallites.

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TAILORING FUNCTIONAL NANOHYBRIDS BY LASER ENGINEERING: DUAL APPLICATIONS IN ENERGY AND ENVIRONMENT

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Environmental deterioration and the **growing global energy demand** are two of the most pressing challenges of our time. Industrial activities continuously release hazardous organic pollutants such as synthetic dyes, pharmaceuticals, and microplastics into water sources, while at the same time energy consumption is increasing at an unprecedented rate. Developing **green multifunctional nanomaterials** able to simultaneously address environmental protection and energy conversion is therefore a priority for sustainable development.
In this work, we demonstrate a novel class of **laser-engineered nanohybrids** synthesized by **Matrix-Assisted Pulsed Laser Evaporation (MAPLE)**, an eco-friendly technique that enables precise material design without additional chemical treatments. The hybrid layers consist of graphene oxide (GO) and carbon nanotubes simultaneously doped with p-type (B) or n-type (N) species and decorated with NiO nanoparticles. This configuration provides synergistic functionalities: heteroatom doping modulates the band structure of the carbon framework, NiO facilitates efficient charge carrier generation, while the conductive carbon materials suppresses recombination losses.
The obtained nanohybrids reveal a clear dual role. On one side, they ensure **highly efficient photocatalytic removal of organic contaminants** under simulated sunlight, achieving up to 80% degradation of organic, methyl orange dye, the co-doping strategy reducing the band gap down to ~1.6 eV, extending light absorption into the visible region and opening opportunities for solar-driven energy harvesting. Reactive oxygen species trapping experiments confirmed that superoxide radicals ($O_2^{\bullet-}$) are the main active species, complemented by hydroxyl radicals and photogenerated holes. On the other side, the same structural and electronic features that enable water purification also render these hybrids suitable for energy-related devices such as supercapacitors. This study highlights the dual potential of laser-tailored functional nanohybrids integrating environmental remediation and energy storage into a single material platform. Such multifunctional systems represent a promising pathway toward next-generation green technologies, based on complex nanocomposite materials.

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PROMISING MATERIALS FOR POLLUTANT REMOVAL

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The European Environmental Regulations for Water Quality intend to strengthen water quality standards and reduce the contaminant concentration in urban wastewater management. Therefore, expectations for wastewater treatment will increase, and eco-friendly materials should be feasible options for pollutant removal. Current research and applied technologies for water treatment should be focused more towards greener and more sustainable approaches of environment remediation. In the last years, in wastewater treatment technologies, an increasing consideration has been given to advanced oxidation processes (AOPs) because they are effective in the removal of several emerging contaminants.

Photochromic properties of new spiropyrans functionalized nanomaterials offer an alternative method for the removal of pollutants from waters. After only 15 minutes of irradiation, photodegradation of selected pollutants in the presence of catalyst achieved an elimination rate of more than 85%. We proposed testing the catalytic activity of spiropyrans in the degradation of Bisphenol A (BPA), a model pollutant that is commonly found in food containers, water bottles, and even metal cans.

The Electron Spin Resonance (ESR) investigations revealed that the examined catalysts efficiently produced 1O2 in aqueous suspension. Thus, it was demonstrated that the presented catalysts are promising materials capable of providing feasible and useful solutions for the removal of micropollutants from contaminated wastewater.

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Fabrication and characterisation of Spiral Phase Plates generated by 3D Laser Lithography

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This paper investigates the 3D laser fabrication of spiral phase plates (SPPs) as diffractive micro-optic components for generating and controlling focused light beams with orbital angular momentum (OAM). Series of SPP microstructures, with diameters of tens of micrometers and thicknesses of a few micrometers, were fabricated in the photosensitive polymer IP-L using 3D laser lithography via two-photon photopolymerization. The processing time and microstructure geometry were optimized using a Python code developed to mathematically describe the laser scanning path. The beam wavefront modification induced by the fabricated SPPs was assessed using a collimated He-Ne laser beam in a Z-scan configuration by measuring the beam profile in the focal plane of a focusing lens. The transverse phase profile of the beam was also evaluated with a wavefront sensor. The results highlight the potential of Direct Laser Writing (DLW) for compact and customizable OAM beam-shaping devices, with applications in optical communications, quantum optics, and microscopy.

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INFLUENCE OF Ag ADDITION ON THE ELECTRICAL AND CATALYTIC PROPERTIES OF B-DOPED SnO_2

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Tin oxide (SnO_2) is recognized as a metal oxide semiconductor, which is extensively applied in a variety of fields due to its remarkable electrical and optical properties [1, 2]. In a previous study [3], we synthesized samples of SnO_2 and B-doped SnO_2 (with molar ratios of 2%, 5%, and 10%) through a simple sol-gel method. This research introduces the synthesis of silver (Ag) - modified SnO_2 and 2%B- SnO_2 using a straightforward impregnation technique to investigate the electrical and optical properties of the synthesized materials. Characterization methods, including XRD, UV-Vis, IR, and Electric Impedance Spectroscopy (EIS), were employed to examine the influence of Ag deposition on the structural, optical, and electrical properties of Ag/ SnO_2 and Ag/ 2%B-SnO_2. The XRD analysis revealed a tetragonal structure of Ag - modified SnO_2 and 2%B- SnO_2. The optical properties showed a decrease in bandgap energy with the addition of Ag. Moreover, the catalytic performance of the samples was assessed through the photocatalytic degradation of Brilliant Blue (BB) dye.

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LASER-INDUCED FORWARD TRANSFER OF CARBONIC MATERIALS FOR FLEXIBLE ELECTRONICS

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Enhancing the laser-induced forward transfer (LIFT) technique for electrode fabrication represents a critical phase in the development of flexible electronic systems. This research investigates the refinement of the carbon-based material transfer process via the LIFT technique, aiming to produce precise, consistent electrode structures compatible with sensor technologies. Due to their exceptional electrical properties and high surface area, graphene-derived materials are highly promising candidates for use in sensing platforms, particularly in the detection of gases and chemical compounds.

Nonetheless, the integration of graphene into functional sensor devices often faces limitations related to the accurate and scalable definition of electrode geometries. In this study, we systematically examine the influence of key LIFT parameters — including laser pulse duration (femtosecond vs. picosecond regimes), energy fluence, and repetition frequency — to enhance the resolution and fidelity of electrode patterning using carbon-based structures. The fabricated electrodes exhibit uniform morphology, strong substrate adherence, and favorable electrical characteristics.

Our findings contribute valuable insights into the processing conditions governing electrode fabrication in graphene-based sensors and demonstrate the viability of a low-cost, scalable strategy for manufacturing advanced sensing components. The outcomes support further progress in the implementation of graphene-based technologies for environmental sensing, industrial process monitoring, and wearable electronics.

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ENHANCED PHOTOCATALYTIC PERFORMANCE OF ELECTROSPUN RARE EARTH-DOPED ZnO NANOSTRUCTURES

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Zinc oxide (ZnO) is a widely studied photocatalytic material due to its high stability, non-toxicity, and strong oxidative characteristics. However, its relatively low efficiency under visible light limits its broader application in environmental and energy-related fields. To address this challenge, researchers have focused on modifying ZnO nanostructures through doping with rare earth elements, aiming to enhance their photocatalytic performance by extending light absorption into the visible range and improving charge separation. Rare earth elements (La, Er, Sm, Ce, Nd, Pr, etc) are known for their unique electronic configurations, which can tune the energy levels of the ZnO bandgap. This adjustment in the electronic structure enables better utilization of visible light, leading to enhanced photocatalytic activity. Additionally, rare earth doping can reduce the recombination rate of electron-hole pairs, further improving the efficiency of photogenerated charge carriers in redox reactions. Nanostructured oxide semiconductor materials have attracted considerable attention for their potential use in wastewater purification and environmental protection. This presentation will focus on the preparation of pure ZnO and rare earth (La, Er, Sm, Ce, Nd, Pr, etc) doped ZnO using the electrospinning-calcination method [1,2].
The synthesis, characterization, applications, and photocatalytic mechanisms of these semiconductor catalysts are detailed. Studies have confirmed that doping with different rare metals significantly improves the photocatalytic performance of these materials. Various investigations have demonstrated the effectiveness of metal oxide semiconductors doped with rare metals as photocatalysts in the degradation of various organic pollutants (dyes and drugs) under UV and visible light irradiation. In addition, the research provides an in-depth analysis of the kinetics governing the photodegradation process. The efficiency of the RE-doped materials was validated by evaluating the photocatalytic activity and rate constants ($10^{-2} \times min^{-1}$), highlighting the improved performance of these catalysts.
Moreover, the current study will highlight the synergistic impact of some key factors in photocatalytic processes, including the initial concentration of the pollutant (mg/L) and the catalyst dose (% w/v). Remarkably, the introduction of small amounts of rare earth dopants has been shown to achieve up to 100% pollutant removal efficiency. In addition, all photocatalysts exhibited excellent reusability, consistently maintaining their performance even after five cycles under identical experimental conditions.

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ULTRATHIN AG, ZN, AND AGZNO FILMS ON SI (001) FOR SURFACE PLASMON APPLICATIONS VIA RF MAGNETRON SPUTTERING

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We investigated the microstructure of silver (Ag) films deposited on Si (001) substrates via radio frequency (RF) magnetron sputtering using Varian equipment. Deposition was carried out under low active power (1–2 W) and negligible reactive power (~0 W), with argon as the working gas at a pressure of 3–4 × 10^{-4} torr for 2–3 minutes. This process yielded ultrathin, fine-grained Ag films with thicknesses of several nanometers. Morphological, structural, and compositional analyses were performed using atomic force microscopy (AFM), scanning electron microscopy (SEM) in both top-view and cross-section modes, and X-ray diffraction (XRD). AFM revealed surface roughness below 1 nm, while AFM and SEM confirmed the feasibility of producing highly homogeneous Ag ultrathin films when sputtered particle energy is minimized. XRD patterns characteristic of Ag were clearly identified. Optical properties were assessed via spectroscopic ellipsometry and UV-VIS reflectance, revealing refractive index values revealing refractive index values below 1 in the visible range and a distinct surface plasmon resonance peak near 450 nm. Mechanical properties, measured by nanoindentation, aligned well with existing literature data, further validating the quality of the deposited layers
Keywords: Epitaxial silver, RF magnetron sputtering, film morphology, chemical composition, optical properties, mechanical characterization

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GREEN BORON SILICA/CuO NANOPARTICLES COMPLEX: A HALOGEN-FREE FIRE RETARDANT FOR WOOD PROTECTION

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Human health and safety are greatly affected by building and construction material fire hazards. The study aimed to design and investigate a combination of a boron-silica complex and CuO nanoparticles (CuONPs) fire retardant that is halogen-free and environmentally friendly, applied onto pine wood. Wood-based materials are widely used for building elements, but due to their composition, they are susceptible to combustion if exposed to fire [1]. To mitigate this risk, a boron-silica complex was synthesized using a microwave-assisted process. CuONPs, at concentrations of 1% and 3%, were produced through a green chemistry approach utilizing Mentha piperita. These NPs were then combined with the boron-silica complex through a sonication process and applied to pine wood by immersion. The resulting boron-silica/CuO NPs complex was characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), thermal analysis (DTA/TG), and X-ray fluorescence (XRF) analyses. The SEM analysis, coupled with energy-dispersive X-ray spectroscopy (EDX), revealed a uniform coating on the wood surface and confirmed the presence of CuO NPs. Additionally, the antimicrobial activity and the preliminary fire-retardant performance of the treated wood samples using a vertical flame test were evaluated.

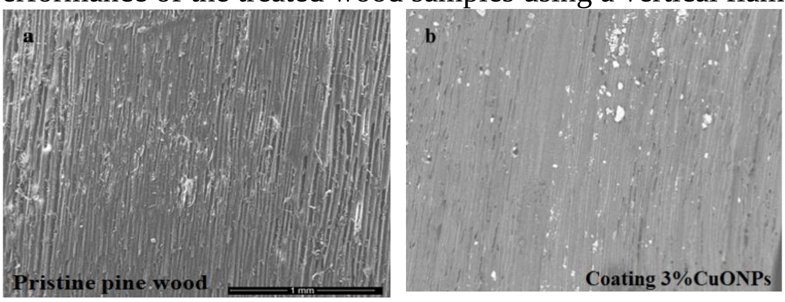

Fig. 1 SEM images of pristine pine wood and pine wood coated with the boron–silica/ 3% CuO NPs complex

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HONEY-DERIVED HYDROCHAR CONTAINING TEMPO FREE RADICAL FOR DEGRADATION OF AQUEOUS ORGANIC POLLUTANTS

†TEMPO=2,2,6,6-tetramethylpiperidine-1-oxyl

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The rational design and development of environmentally benign materials from biodegradable and renewable sources is a growing topic in various areas of environmental science and energy storage. Carbon materials from biomass and its derivatives are some of the most attractive resources for a sustainable future. [1] However, integrating these materials with stable free radicals remains challenging. This study presents a straightforward one-pot hydrothermal route using raw honey as the carbon source and 4-amino 2,2,6,6-tetramethylpiperidine-1-oxyl (4-amino-TEMPO) as the free radical.

The addition of TEMPO derivative initiates Maillard reactions between its amino group and the carbonyl groups of the carbohydrates in honey, resulting in the formation of a functionalized hydrochar with a spherical morphology (~8 µm). The presence of free radicals within the carbonaceous matrix was confirmed by e**lectron spin resonance spectroscopy,** supported by infrared spectroscopy, elemental analysis, thermal analysis, scanning electron microscopy, and **X-ray photo electron** spectroscopy.

The material effectively removed methylene blue, fluorescein, and doxorubicin from water in the presence of green oxidants like hydrogen peroxide and sodium hypochlorite. After 24 hours, removal efficiencies reached 92% for doxorubicin, 73% for methylene blue, and 23% for fluorescein. Moreover, the hydrochar demonstrated good regeneration capability, maintaining its dye removal efficiency over several cycles. [2]

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TITANIUM-MODIFIED ZEOLITE Y COMPOSITES FOR ADVANCED CO_2 ADSORPTION

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Carbon dioxide (CO_2), the main greenhouse gas from fossil fuel combustion, has risen by over 100 ppm in recent decades, driving increasingly severe climate events [1]. Mitigation strategies focus on carbon capture and storage (CCS) and carbon capture and utilization (CCU) [1, 2], with CCS regarded as particularly effective. Zeolite materials are promising adsorbents due to their microporous structure, high surface area, and acid–base properties that enhance CO_2 capture [2]. In the present study, zeolite Y - TiO_2 composite materials were synthesized for CO_2 capture. TiO_2 was incorporated either via impregnation (denoted "i") or through direct synthesis (denoted "d") within the zeolite Y framework at varying loadings. These composite materials offer the potential to bridge CCS and CCU approaches, as the photocatalytic activity of TiO_2 allows the adsorbed CO_2 to be converted into value-added products through redox reactions. The synthesized composites were characterized using X-ray diffraction (XRD), Raman spectroscopy, N_2 adsorption-desorption, and scanning electron microscopy (SEM). The CO_2 adsorption properties of the samples were evaluated using temperature-programmed desorption (CO_2-TPD) up to 600 °C.

The XRD patterns confirm that the crystalline structure of zeolite Y is preserved regardless of the TiO_2 incorporation method. TiO_2 concentration or loading approach had no significant effect, except for the sample synthesized by direct incorporation with 5% TiO_2, which also exhibited distinctive morphological features. Alongside the typical octahedral morphology of zeolite Y observed in all composites, spherical particles likely associated with amorphous TiO_2 were detected. This finding was further supported by Raman results that showed no distinct extraframework titania (anatase or rutile) bands. For the composites obtained by impregnation, Raman spectra revealed features of zeolite Y as well as rutile and anatase phases. Specific surface areas decreased with increasing TiO_2 content, with the most pronounced reduction in samples prepared by direct synthesis.

The CO_2 adsorption results show that the adsorption capacity increases with the TiO_2 content in the case of samples obtained by impregnation, with the highest capacity recorded for the material containing 20% TiO_2 (1722 µmol CO_2/g). In contrast, for samples obtained by direct synthesis, the CO_2 adsorption capacity decreases as the TiO_2 concentration increases. At the same TiO_2 loading of 5%, impregnation yielded an adsorption capacity of 914 µmol CO_2/g, compared to only 34.66 µmol CO_2/g for direct synthesis.

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NEW ANTIBACTERIAL AND ANTIVIRAL CARBOPOL BASED HYDROGELS FOR TREATMENT OF MINOR BURNS

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Carbopol based hydrogels with antibacterial activity are currently an innovative solution for treating wounds resulting from thermal or chemical burns [1, 2]. Dihydropyrimidine derivatives have many biological properties, such as: antimicrobial, antiviral, antitumour, anti-inflammatory, anti-Alzheimer's, antidiabetic activities etc [3, 4].

The purpose of this study is to create Carbopol based hydrogels, functionalized with ethyl 6-methyl-4-(naphthalen-2-yl)-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate and, respectively, *Mentha* essential oil. Their antimicrobial and antiviral properties were compared with the same biological activities of an hydrogel which contain bacitracin (a topical antibiotic commonly used for the treatment of burns and superficial wounds).

Hydrogels based on Carbopol 940, with triethanolamine and glycerol, were obtained by trituration. The dihydropyrimidine derivative was synthetized through a multi-component Biginelli reaction. Ethanolic solutions of this compound and the essential oil, as well as an aqueous antibiotic solution, were homogenized into the hydrogel base. Antimicrobial activity tests were performed using drawing lines of gel on seeded plates with the reference bacterial strains: *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, and *Pseudomonas aeruginosa* ATCC 27853. Antiviral activity screening was performed on HeLa cell line, using the adapted SR EN 14476+A2 standard. The MTT method and L929 fibroblast cell line from mouse were used for cell viability test of the hydrogels.

The tested hydrogels showed good cell viability, antibacterial and antiviral activities.

In vitro biological studies show that our Carbopol based hydrogels with antimicrobial activity can be included in wound healing dressings; they are recommended for regenerative medicine applications.

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MAGNETIC PROPERTIES OF Mn_2O_3 NANOPARTICLES FABRICATED VIA TWO-STEP THERMOLYSIS

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Manganese oxides (MnOx) are a highly complex system, due to the availability of several Mn states amenable to oxidation-reduction reaction, they can be present in several phases and various oxidation states of manganese (II, III, IV) such as MnO, MnO2, Mn2O3, Mn3O4, Mn5O8. Manganese oxides show an ubiquitous presence in the ocean floor, soils and sediments, and exhibit some important properties, like environmental benignity and also high cation exchange capacity. Because of their advantageous properties, manganese oxides are of increasing importance for a remarkable wide range of technical applications in catalysis, electrochemistry, sensing and electronics, for completely oxidizing various volatile organic substances or hydrocarbons and battery technologies, ion exchange, molecular adsorption, dry cells, varistors, high density magnetic storage media, solar energy conversion, due to their structural flexibility combined with novel chemical physical and magnetic properties [1, 2].
To the best of our knowledge, few works have been reported concerning morphology control of manganese oxides. The study of Mn2O3 nanocrystals has become a focus on our research. Here we have prepared manganese oxides at the nanoscale by a method of thermolysis and we have systematically studied the phase formation, morphology and magnetic properties.
SEM images were obtained with a microscope equipped with an energy dispersive X-ray spectroscopy (EDX) for elemental analysis, while TEM images were obtained on a transmission electron microscope using an accelerating voltage of 100 kV. Chemical purity and stoichiometry of the as-prepared Mn2O3 was tested by EDX measurements. Phase analysis was carried out by Raman analysis, complemented by the characteriation of the powders through X-ray diffraction and FTIR spectroscopy. The zero field cooling (ZFC)-field cooling (FC) magnetic properties were analyzed providing information on the magnetic phases existing in the samples, as several oxides could be formed, which may coexist or progressively change one into the other during the Mn oxidation process.

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DOPED TiO_2 NANOPOWDERS PREPARED BY SOL-GEL AND MICROWAVE-ASSISTED SOL-GEL METHODS

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The doped TiO_2 powders obtained by sol–gel and microwave-assisted sol–gel methods were investigated. In the case of the microwave assisted sol-gel method was synthesized under mild conditions of short time exposed to microwaves for 10 min at 200 W. Titanium (IV) butoxide was used as a TiO_2 precursor, with parental alcohol as a solvent and ammonia water as a catalyst. In the case of the dopants, the precursors were used in the amount of 2 mol % CuO, SnO_2, ZnO. Based on the TG/DTA results, the powders were thermally treated at 500 °C. The comparative investigation of the microstructure and morphology was performed by high-resolution transmission electron microscopy with selected area electron diffraction (HRTEM/SAED), scanning transmission electron microscopy (STEM) coupled with EDX mapping, Fourier transmission infrared (FTIR), X-ray diffraction (XRD), and X-ray florescence spectroscopy (XRF). The obtained materials were tested for the photocatalytic removal of methyl orange dye from aqueous solutions. It was observed that in the UV domain, the TiO_2-Cu SG sample, with crystallite size of 14 nm, presented the highest activity in photocatalytic degradation of MO, removing ~97% of the dye in 5h. By modification of TiO_2-Cu MW, it was possible to lower the band gap energy to 3.02 eV, which led to an increase of the photocatalytic performance in the visible range.

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CORROSION INHIBITION OF B66 BRONZE IN 3% NACL USING A 1,2,4-TRIAZOLE DERIVATIVE: COMBINED EXPERIMENTAL AND THEORETICAL INVESTIGATIONS

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In this work, a novel 1,2,4-triazole derivative (TSE) was investigated as a potential corrosion inhibitor for b66 bronze metal exposed in an aggressive 3% sodium chloride (NaCl) medium. The research aims to explore the inhibition efficiency in mitigating corrosion through a comprehensive approach, combining experimental investigations with advanced theoretical modeling [1,2]. Weight loss analysis, atomic absorption spectroscopy test, and electrochemical evaluations, namely electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization curves, showed that the presence of the compound markedly reduced the corrosion rate. At its optimal dosage of 10^{-2} M, the inhibitor achieved an efficiency of 93.75%, attributed to the development of a stable protective layer on the bronze surface. Electrochemical findings confirmed an anodic type inhibition mode, influencing metal dissolution reactions. Adsorption studies indicated compliance with the Langmuir isotherm, pointing toward monolayer adsorption of the molecules. Complementary surface characterization via scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) confirmed the protective film formation and reduced surface degradation. Furthermore, theoretical insights from density functional theory (DFT) calculations provided a deeper understanding of the inhibitor/metal interactions at the molecular scale.

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ACID VERSUS ALKALINE MODIFICATION OF CLINOPTILOLITE-RICH NATURAL ZEOLITES: A COMPARATIVE APPROACH

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Natural zeolites are cost-effective and widely available materials, occurring in numerous geological deposits worldwide. They exhibit excellent characteristics, including high mechanical and thermal stability, significant ion-exchange capacity, pH-buffering ability, high specific surface area and considerable adsorption potential [1,2]. The physicochemical and structural characteristics of natural zeolites can be tailored through thermal treatment and/ or chemical activation, allowing their potential applications across a wide range of fields [3]. This study presents a comparative evaluation of the structural and compositional modifications in clinoptilolite-rich natural zeolites subjected to various acid and alkaline treatments. Characterization of both natural zeolites (CNZ) and their chemically modified forms (CNZ-H and CNZ-Na) was performed using inductively coupled plasma optical emission spectrometry (ICP-OES), X-ray diffraction (XRD) and scanning electron microscopy (SEM). The efficiency of acid and alkaline treatments in tailoring the zeolite characteristics was influenced by reagent concentration, temperature and treatment duration. Acid treatment led to the removal of greater quantities of both major and trace elements compared to alkali treatment, reflecting the higher leaching capability under acidic conditions. The high cation exchange capacity (CEC) observed in the natural zeolites was attributed to the high clinoptilolite content (~65%), as confirmed through compositional analysis. XRD data revealed a high clinoptilolite content in the raw samples and showed that the primary crystalline framework remained largely intact following both acid and alkaline modifications. However, a noticeable decrease in crystallinity was observed in CNZ-H, consistent with partial dealumination of the clinoptilolite structure. SEM analysis revealed surface morphological changes in both CNZ-H and CNZ-Na samples, characterized by increased structural disorder and the formation of fine particle agglomerates, likely resulting from partial framework degradation and surface restructuring induced by the chemical treatments. These findings demonstrate that controlled acid and alkaline treatments modify the structural and compositional characteristics of natural zeolites, thereby enhancing their suitability for industrial, medical and environmental applications.

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DETERMINATION OF PB IN TABLE SALT USING DIFFUSIVE GRADIENTS IN THIN-FILM TECHNIQUE FOR PASSIVE SAMPLING PRIOR GFAAS ANALYSIS

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Lead (Pb) is a highly toxic element of which content needs to be controlled in table salt due to maximum levels established for this food constituent. Herein, we developed a sensitive and accurate analytical methodology based on Diffusive Gradients in Thin-film (DGT) technique for matrix separation and preconcentration of Pb from table salt solution prior their instrumental quantification using graphite furnace atomic absorption spectrometry (GFAAS). The analyte was collected from 1000 mL feed solution in which 5 grams of analysed salt were dissolved. DGT passive samplers with Chelex-100 resin gel and agarose crosslinked polyacrylamide diffusive gel were used for analytes uptake. The linear accumulation of Pb by DGT was evaluated for 48 hours passive samplers deployment period. The obtained determination coefficient was 0.973. The performance parameters of the developed methodology were discussed considering the requirements in the Commission Decision 2002/657/EC and Commission Regulations 2023/915/EU, 2011/836/EU and 2007/333/EC. The limit of detection in salt sample was 0.01 mg/kg , limit of quantification 0.03 mg/kg, trueness (91 % recovery in spiked sample), repeatability in terms of relative standard deviation (12 %) comply with the minimal criteria necessary to a method to be implemented in control laboratories for Pb determination in salt. The validated methodology was applied for analysis of seven salt samples commercially available on the market in Romania and two salt samples collected directly from two salt mines. The maximum admitted level of 1.0 mg/kg established for Pb in salt table by Commission Regulations 2023/915/E was exceeded in one sample.

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ZEOLITES IN MINING WASTEWATER TREATMENT: ADSORPTION OF TOXIC ELEMENTS

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Ore beneficiation produces high volumes of wastewater enriched in toxic elements, creating important environmental and health risks. Conventional treatment methods, though effective, are often costly and generate secondary waste. Zeolites offer a sustainable alternative for the treatment of mine effluents contaminated with toxic elements [1, 2]. In this study, the adsorption performance of natural zeolites was evaluated using synthetic mine water (50 and 500 ppb Ni, V, Co, Cd, Li, Cr, Cu, Zn, Pb, Cs, Ba) to assess its potential as a sustainable treatment alternative. Batch adsorption experiments revealed rapid initial uptake of multiple toxic elements (Cr, Cu, Zn, Pb, Cs, Ba), followed by gradual stabilization toward equilibrium. The zeolite demonstrated high affinity for Cu, Zn, Pb, Cs, Ba, consistent with recent findings on zeolite-based remediation systems [2]. These results underscore the viability of natural zeolites as low-cost, efficient sorbents for mine water treatment. The adoption of zeolite-based strategies could play a critical role in mitigating the long-term environmental impacts of mining operations while supporting safer and more sustainable water resource management.

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THE IMPACT OF THE INTERDIGITAL ELECTRODES ON THE NO_2 SENSITIVITY AT ROOM TEMPERATURE

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Decreasing the operating temperature for a metal oxide semiconductor (MOS) based gas sensor has received considerable attention within the field of gas sensing due to the low power consumption criteria. However, sensitivity and selectivity remain challenges today [1]. Herein, a novel system based on SnO_2 doped with 30% Mn was designed following a hydrothermal chemical route [2], enabling good-performance detection of nitrogen dioxide (NO_2) gas at room temperature in the presence of 50% relative humidity. Besides good selectivity against CH_4 and CO_2 and enhanced stability, the role of the Platinum interdigital electrodes with different aspect ratios was deeply analysed, describing the way in which enhancement in overall gas sensitivity can be modulated. We showed that the enhancement in the gas sensitivity of SnO_2:Mn 30% can be ascribed to the synergistic effects involved from the geometrical aspect ratio, charge transfer, equivalent resistance, and chemical aspects. Moreover, we proposed a series of equations of the basic sensing principles, aiming to decouple and to overcome the disadvantages which may occur within the gas sensor fabrication processes [3]. A comparison of wide and narrow interdigital electrodes (Fig.1) leads to some useful properties of the sensors, such as basic diagnostics of the involved gas sensitivity towards NO_2.

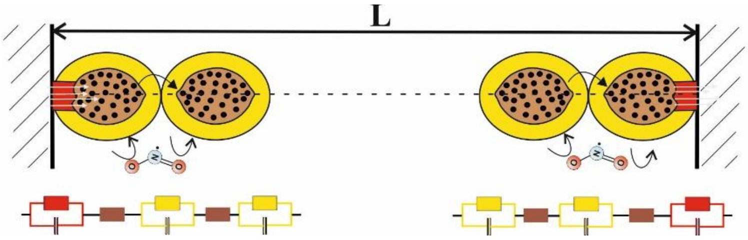

Figure 1. The model of grain-to-grain interconnected crystallites over a defined L interdigital distance and the equivalent electrical circuit.

This work provides a promising approach to the fabrication of SnO_2:Mn 30% based gas sensor for environmental monitoring at room temperature under in-field-like conditions (e.g. the presence of relative humidity, other potential interfering gases, dynamic gas flow).

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BIOSURFACTANTS AS SUSTAINABLE MATERIALS FOR INDUSTRIAL WASTEWATER TREATMENT

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Keywords: biosurfactants, industrial wastewater treatment, bioremediation, circular bioeconomy, sustainable materials.

Abstract: The increasing demand for environmentally sustainable approaches in industrial wastewater treatment has brought attention to microbial surfactants as green and functional materials. Produced by microorganisms using renewable and low-cost substrates, such as agro-industrial residues and waste oils, these biosurfactants provide a biodegradable and efficient alternative to traditional synthetic surfactants. Their amphiphilic properties allow them to solubilize hydrophobic organic pollutants, while also enhancing the availability of these contaminants for further microbial breakdown [1,2]. According to the literature, sophorolipids, rhamnolipids, and lipopeptides are highly effective in eliminating hydrocarbons, heavy metals, or dyes from water [3,4]. Additionally, biosurfactants maintain stability under a wide range of pH levels, salinities, and temperatures, making them suitable for diverse wastewater treatment applications [1]. This work underscores the potential of biosurfactants as eco-friendly materials that simultaneously support contaminant removal and environmental sustainability. By embedding microbial surfactant production within circular bioeconomy strategies, industrial waste streams can be valorized while being remediated, advancing both sustainable development objectives and the production of innovative green materials.

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DETERMINATION OF PLAIT POINT IN THE WATER-ACETONE-CHLOROFORM TERNARY SYSTEM AT 298.15 K WITH APPLICATIONS IN THE DESIGN OF INDUSTRIAL WASTEWATER TREATMENT PROCESSES

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The liquid-liquid extraction process is viewed from both the perspective of the fundamental chemical interactions and chemical process engineering. In the case of industrial wastewater treatment, a detailed knowledge of phase equilibria provides essential information for the design and optimization of these processes.

This paper presents a comparative approach for estimating the plait-point of the heterogeneous water-acetone-chloroform ternary system at 298.15 K and atmospheric pressure, using three complementary methods: the Othmer–Tobias and Hand consistency tests, and the geometric construction proposed by Coolidge.

The binodal data were processed in Roozeboom coordinates, and the binodal was represented by a fourth-order polynomial fit, which allowed the uniform application of the methods.

To highlight the procedures mentioned above, we prepared 3 heterogeneous water-acetone-chloroform mixtures, the water/chloroform ratio being 1:1. The mixtures were prepared by weighing using a 0.1 mg precision balance and a 40 cm3 cell, equipped with a thermostatic jacket maintained at 298.15 K.

In the case of determining the plait point in the first case, through consistency tests we take into account that the plait point can be viewed as the result of the merging of two conjugated homogeneous mixtures or as a limiting case of the situation in which a conode ends up being of zero length.

In the case of the Coolidge method, the point located relative to the center of the circle passing through the vertices of the equilateral triangles constructed on the last two conodes at a distance equal to the radius of this circle is sought on the binodal. It is taken into account that the center of this circle is located at the intersection of the last two conodes.

The results of the plait point coordinates obtained by the three methods showed a very good convergence confirming the experimental consistency, these being in accordance with the data in the literature.

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ECO-FRIENDLY PAPER COATINGS VIA VALORIZATION OF POTATO, ONION, AND GARLIC PROCESSING WASTE

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Plastics derived from fossil resources dominate the packaging industry but generate severe environmental burdens. Starch-based bioplastics are emerging as sustainable alternatives, offering biodegradability and flexibility. However, their limited mechanical performance and barrier properties remain critical drawbacks. Valorisation of agrifood by-products represents a promising strategy to overcome these limitations while advancing circular economy practices. In this study, starch was recovered from potato washing slurries and combined with powdered onion peels (OP) and garlic peels (GP) to produce thermoplastic starch-based bioplastics for paper coatings. The influence of OP and GP on chromatic features, mechanical properties [Young's modulus (YM), tensile strength (TS), elongation at break (EAB)], and water barrier performance [water vapor transmission rate (WVTR), wettability] was evaluated. Incorporation of OP and GP imparted distinct natural coloration (orange and brownish, respectively) while enhancing surface brightness. OP increased YM by up to 150%, whereas GP reduced it by up to 66%. Both OP and GP improved hydrophobicity (by up to 50% and 30%, respectively) and enabled strong adhesion of the coatings to paper substrates without compromising mechanical or barrier integrity. These results demonstrate the effective upcycling of potato starch-rich effluents and onion/garlic peels into functional, biodegradable paper coatings with enhanced performance. The approach highlights a sustainable route for waste valorisation, contributing to the replacement of conventional plastics in packaging applications.

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STRUCTURAL AND MORPHOLOGICAL CHARACTERIZATION OF ZNO PREPARED USING OVALBUMIN FROM FREE-RANGE CHICKEN EGGS

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A novelty in recent research is the production of oxide nanomaterials using green methods. The biogenic elaboration method has the advantage of producing nanomaterials with improved properties, such as greater stability, better dispersion, as well as improved purity [1]. One of the most researched nanomaterials is ZnO, due to its multiple uses, with applications in various fields such as ceramics industry [2], antibacterial [3] or skin treatment [4],[5].

This research presents characterizations of ZnO powders obtained through biogenic synthesis, using the precursors: zinc sulfate and ovalbumin from free-range chicken eggs. Ovalbumin has a globular structure, similar to proteins in the serpin superfamily, although it does not act as a serine protease inhibitor. The specific effects of egg white on ZnO elaboration depends on various factors, including the concentration of egg white, the type of proteins present, the pH of the solution, and the processing conditions.

Structural characterization was performed using XRD, which determined pure zincite phase and crystallite sizes of 44.1 and 47.4 nm, depending on sulfate concentration. Morphological characterization was performed using SEM-EDS. SEM micrographs reveal different morphologies of the asymmetric particles, depending on the zinc salt concentration. The size distribution histograms put in evidence the fact that the prepared powder is homogeneous and uniform in terms of size. The quantitative analysis by EDS reveals Zn, O, Ti, Na, Si, P impurity, due to the poulty food or from substances used for disinfection.

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ENHANCED PHOTOCATALYTIC ACTIVITY OF MN-DOPED ZNO NANOPOWDERS SYNTHESIZED BY CONVENTIONAL AND MICROWAVE-ASSISTED SOL–GEL METHODS

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The design of functional ceramic nanomaterials with tunable properties is central to advancing sustainable technologies. In this work, manganese-doped zinc oxide (ZnO) nanopowders were synthesized by both conventional sol–gel (SG) and microwave-assisted sol–gel (MW) methods to investigate how synthesis route influences their structural, morphological, and photocatalytic properties. ZnO, a multifunctional oxide ceramic, offers wide tunability through dopant incorporation and morphology control, enabling the development of next-generation photocatalysts.
Comprehensive characterization (DTA/TGA, FTIR, XRD, SEM, UV–Vis, and photoluminescence) revealed distinct differences between the two synthesis methods. MW-derived powders exhibited higher crystallinity, well-faceted morphologies, and stronger UV light absorption. In contrast, SG-synthesized powders displayed a slightly reduced bandgap and fewer charge recombination centers, as indicated by photoluminescence quenching. Both materials generated reactive oxygen species (ROS) under simulated solar irradiation, confirming photocatalytic activity toward oxalic acid mineralization. Notably, SG-derived samples demonstrated superior stability and higher CO_2 yields.
These findings highlight Mn-doped ZnO as a cost-effective photocatalyst and underscore the critical role of synthesis control in tailoring oxide ceramics for environmental remediation and energy-efficient catalytic applications.

FUNCTIONAL CONDUCTIVE MXENES AS VERSATILE SUPPORTS FOR BIORECEPTOR INTEGRATION IN BIOSENSING APPLICATIONS

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Keywords: MXene, peptide, cancer biomarkers, saliva.

MXenes are a recently developed class of two-dimensional (2D) transition metal carbides with unique physicochemical properties that make them promising transducer materials for biosensor applications. Their intrinsic hydrophilicity, high electrical conductivity, large surface area, and biocompatibility [1] have been exploited to enhance (bio)sensing interfaces, improving electron transfer kinetics, sensitivity, active surface area, and stability [2].

In this work, titanium carbide ($Ti_3C_2T_x$) MXenes were synthesized by selective etching of MAX phase precursors with hydrofluoric acid, followed by DMSO-assisted delamination to obtain thin, conductive flakes. The MXene materials were subsequently deposited on carbon paste screen-printed electrodes (SPEs). Successful synthesis and delamination of the MXene flakes were confirmed using FTIR spectroscopy, SEM and TGA. The electrocatalytic performance of the MXene-modified electrodes was evaluated through cyclic voltammetry (CV), amperometry and electrochemical impedance spectroscopy (EIS), while their opto-electrochemical behavior was assessed via electrochemiluminescence (ECL).

Furthermore, the MXene flakes will be functionalized with amino groups to enable covalent immobilization of ferrocenyl-labeled peptide receptors, paving the way for the development of opto-electrochemical biosensors targeting carcinoembryonic antigen (CEA) and epidermal growth factor receptor (EGFR) cancer biomarkers in saliva [2].

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SECTION 4. MATERIALS MODELLING AND SIMULATION

CAPACITY BUILDING IN THE FIELD OF VET FOR TEXTILE INDUSTRY IN MOLDOVA AND UKRAINE

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This paper presents the aspects related to VET capacity building in Moldova and Ukraine through Smart Labs aimed at enhancing digital skills in the textile sectors. With the pressing need for modernization, the initiative incorporates digitalization into vocational education curricula, exemplified by using 3D prototyping for smart textiles in personal protective equipment (PPE). This approach enriches education and equips students with hands-on skills essential for the tech-driven job market. It also enhances existing employees' capabilities in optimization and prototyping, improving the quality of technical textiles. The paper discusses challenges in integrating smart features into protective clothing, highlighting the need for thorough material behavior analysis under mechanical loads for effective sensor placement. Overall, the adoption of smart wearable technologies positions Moldova and Ukraine as competitive players in the global textile industry, promoting innovation and sustainability. Studies reviewing VET curricula on smart technologies [1, 2,] point out gaps in technology integration and provide recommendations for adaptation to industrial changes [3].

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TUNABLE 2D PHOTONIC CRYSTALS IN As_2S_3

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Photonic crystals (PhCs) are optical structures with a periodic refractive index variation (modulation) at a scale of the order of the light wavelength. PhCs can control the propagation of the light due to their photonic band gap, which is dependent on the geometry of the structure and on the refractive index contrast. PhCs have extensive applications in photonics, including optical filters, switches, waveguides, logic gates, ring resonators, sensors etc. [1-3]. Usually, once the designed periodic structure (e.g. air hole lattice) is imprinted in a specific material, the photonic band gap cannot be further modified. As the geometry of a fabricated photonic crystal cannot be changed, band gap tuning can only be achieved by modifying the refractive index contrast between the optical material and the air holes.

In this work, we report the design of an all-optical tunable two-dimensional (2D) photonic crystal imprinted in an As_2S_3 film. As_2S_3 chalcogenide glass is a highly transparent material in the near infrared (NIR) spectral domain, with a high linear refractive index (n_{As2S3}=2.42) and with a large optical nonlinearity [4]. The refractive index of As_2S_3 can be substantially modified by light of wavelength at the band gap energy or shorter [5], property that makes this material appropriate for all-optical tunable PhCs.

A 2D PhC consisting in a hexagonal lattice of holes in an As_2S_3 film, has been numerically modelled in order to exhibit the photonic band gap in the NIR domain, important for optical communications. The possibility to tune the photonic band gap of a PhC already patterned in an As_2S_3 film by the light-induced change in the refractive index of the material has been demonstrated by numerical simulations. Changes of the spectral position of the band gap and of its width have been computed for light-induced modifications of the refractive index of As_2S_3 up to 0.09, a value already experimentally demonstrated [5, 6]. At this value of the refractive index change, an important shift of ~ 40nm of the central wavelength of the band gap has been achieved [7]. Our results are of interest in photonics revealing the possibility to produce tunable PhCs in nonlinear optical materials with light-sensitive refractive index.

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FROM VISION AND VISIBILITY TO OVERVIEW

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The vision belongs to the observer, while visibility is shaped by the environment; their integration enables an overview of the scene. With optoelectronic devices, human vision extends beyond its natural limits—accessing spectral domains from microwaves to UV, reaching below the diffraction limit, resolving ultrafast optical events, detecting photons individually, and functioning under poor visibility (night, fog, smoke).

In this broader picture, regeneration of the human eye is considered through coherent biophotons within torsion fields generated by metasurfaces. Alexander Gurwitsch described ultraweak photon emission (UPE) from tissues as "mitogenetic rays," linked to embryonic development [2]. In the eye, the oxidative metabolism of rods and cones makes photoreceptors strong UPE sources [1]. UPE levels reflect cellular state, with melanin-producing cells in the uvea protecting tissues and regulating oxidative stress. DNA is now seen as the source of biophotons, whose spectral distribution is tied to oxidative processes and cellular communication [2]. Coherent left-handed circularly polarized photons can reduce oxidative stress and regenerate tissues.

Our work models metasurfaces—2D arrays of nanoantennas—that generate vortex beams for tissue regeneration under artificial light. Metaoptics enables subwavelength control of light, including left-handed circularly polarized fields resonant with biophoton emission. Such torsional optical fields act as subtle organizing forces, supporting negentropic effects and potential eye regeneration [1,3,4,5].

Keywords: biophotons, metasurface, regeneration, metaoptics.

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NUMERICAL MODELLING OF DC SPUTTERING CASE STUDY ON AN AL–FE–NI–CU ALLOY

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This research presents a comprehensive computational framework for modeling the direct current sputtering deposition of the quaternary high-entropy alloy $Al_5Fe_{48}Ni_{33}Cu_{14}$ on to a substrate of Fe(001). High-entropy alloys are generally defined as alloys containing five or more principal elements in near-equiatomic proportions [1]. They exhibit outstanding properties, including exceptional wear resistance, enhanced corrosion resistance, and a favorable balance of strength and ductility—characteristics that are preserved even when fabricated as thin films. The MATLAB-based model simulates deposition at a substrate temperature of 1000 K, incoming particle energy of 1 eV at normal incidence [2]. The approach assumes a constant atomic flux and incorporates composition-dependent deposition rates, following methodologies commonly employed for modeling magnetron sputtering. The framework integrates simulation strategies across multiple spatial and temporal scales, combining atomistic and microscopic approaches to provide a detailed description of the deposition process.

At the microscopic scale, the model predicts deposition rates (nm/s), adatom diffusion governed by Arrhenius kinetics, root mean square (RMS) surface roughness, and compositional gradients across the film thickness. The results indicate that higher substrate temperatures enhance atomic mobility, thereby reducing roughness and promoting layer-by-layer growth, consistent with experimental findings. Moreover, the simulated average film composition closely matches that of the incident flux. Complementary atomistic simulations performed with MedeA/LAMMPS confirm the formation of a solid solution, bridging the essential connection between phase structure and chemical composition [3].

This numerical approach substantially reduces the cost and time associated with experimental screening of numerous potential HEA compositions. The MATLAB model thus provides a transparent and extensible platform for optimizing deposition conditions—including particle energy, angle of incidence, and working gas pressure—while achieving a level of predictive capability comparable to other computation-based techniques for high-entropy alloy thin-film fabrication.

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Design of Advanced Multicomponent Alloys via Direct Energy Deposition Technology for High-Performance Industrial Applications

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Multicomponent alloys fabricated via additive manufacturing using the Direct Energy Deposition (DED) technique constitute a novel class of advanced materials, distinguished by superior mechanical properties, excellent formability, and structural adaptability. The inherent flexibility of the DED process allows for microstructural customization, enabling enhanced performance in critical applications across aerospace, biomedical, and automotive sectors.

This technology facilitates the controlled, layer-by-layer deposition of metallic powders such as titanium, nickel-based alloys, and aluminum matrix composites onto predefined substrates. The process involves selective activation of the powder using optimized parameters (laser power, scanning/printing speed, inert gas flow, powder feed rate, etc.), allowing for the fabrication of complex geometries with advanced functional characteristics.

Materials selected for this additive manufacturing approach exhibit exceptional oxidation resistance, creep resistance, high hardness, compressive strength, and tensile strength. Post-heat treatments are effectively integrated into the deposited layers, further enhancing structural integrity.

The development of 3D compositions using DED technology with powders such as Inconel 718, H13 tool steel, and 316L stainless steel showcases the versatility of the process in generating functional structures tailored to the demands of advanced applications. Precise control over deposition parameters has enabled the realization of complex geometries and optimized microstructures, underscoring the potential of additive manufacturing in producing layered materials with outstanding mechanical and thermal performance.

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DETERMINATION OF THE COLOR OF PIGMENTS BASED ON METAL OXIDES

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Metal oxides are important inorganic pigments due to their stability and optical properties. Iron oxides (Fe_2O_3, Fe_3O_4) are widely used as red and black pigments thanks to their chemical stability [1]. Chromium oxide (Cr_2O_3) provides a highly stable green shade that withstands high temperatures [1]. Titanium dioxide (TiO_2) is the most significant white pigment because of its high refractive index and strong light-scattering ability, making it essential in paints, plastics, and coatings [1]. Cobalt oxides (Co_2O_3) are valued for their intense blue coloration, commonly applied in ceramics and glass [1]. In addition, zinc oxide (ZnO) is employed not only as a white pigment but also in modern applications such as photocatalysis, optoelectronics, and nanotechnology [2].

The color determination was carried out using a dedicated software application. The purpose of the application is to accurately obtain color codes (RGB/HEX) from photographs by eliminating errors introduced by the camera (such as the sensor's spectral response, white balance, and JPEG processing). The process begins with camera calibration: three reference images (R.jpg, G.jpg, B.jpg) are compared with the same three images photographed using the camera to be calibrated (R1.jpg, G1.jpg, B1.jpg). From this comparison, a 3×3 correction matrix of the new camera is computed. This matrix is subsequently applied to any photograph taken with that camera, and the color codes extracted from the corrected image represent the "true"/corrected values, with camera-related errors minimized [3].

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SPATIAL AND TEMPORAL DYNAMICS OF ULTRA-INTENSE FEMTOSECOND LASER BEAMS IN DISPERSIVE MEDIA

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A two-dimensional finite-difference time-domain (FDTD) model has been elaborated to analyse the equivalence between spatio-temporal characteristics and the intensity evolution of a focused laser beam propagating through micro-structured dispersive materials in the few-cycle regime. In addition to field enhancement studies, a spatio-temporal analysis of the electromagnetic field at the focal point is performed as a function of the relative spatial extent of the pulse as related in [1], offering a comprehensive description of the underlying dynamics (Fig.1). The numerical simulations demonstrate that shorter and more intense pulses can be achieved under well-defined conditions. Moreover, the results further emphasize the critical roles of the input beam profile, numerical aperture, and dispersive material properties in determining focal intensity enhancement. The proposed numerical approach is intended to advance focal intensity studies in ultra-intense regimes providing essential aspects for laser field enhancement beyond the current spatial and temporal constraints using tightly focused laser pulses. These results are expected to be broadly relevant for forthcoming high-power laser-matter interaction experiments envisioned at petawatt-class laser facilities [2,3,4].

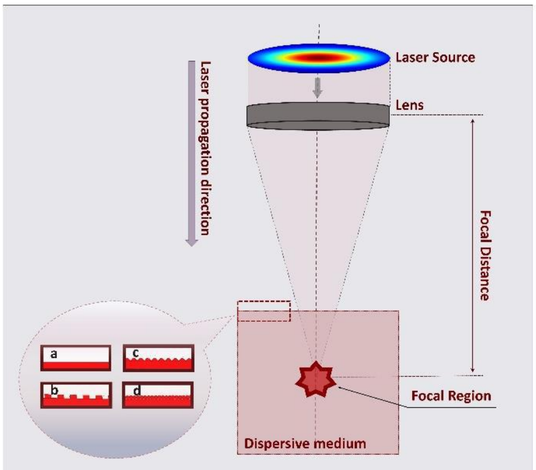

Figure 1. Sketch of the optical setup for the tightly focused femtosecond laser pulses in dispersive media with distinct micro-structured profiles (no-structure (a), step (b), sine (c), and one-layer spheres (d)).

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Extended Bioheat Modeling with Thermal Relaxation Effects for High-Intensity Pulsed Laser Treatment of Brain Cancer

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Modeling heat transfer in laser-irradiated biological tissues is a significant challenge for optimizing minimally invasive oncological interventions. Classical Pennes Bioheat Equation models predict instantaneous heat diffusion, and the accuracy of predictions is restrictive for the treatment of brain cancer by pulsed laser sources of significant intensity [2, 3]. This paper generalizes the Pennes model by introducing thermal relaxation terms according to the Cattaneo-Vernotte formulation [1, 3]. The new aspect is the simultaneous combination of thermal relaxation parameters and tissue optical properties calculated by Monte Carlo simulations within a general modeling approach. The temperature distribution in space more realistically accounts for the interaction between localized laser radiation absorption and thermal inertia. Comparisons of classical and new model predictions exhibit marked differences at short times of exposure to laser irradiation with the most significant differences occurring at peri-tumoral distances from the tumor site [2]. Relaxation phenomena there give rise to thermal peak suppression and realistic redistributions of temperature gradients, thus affecting thermal dose control and reducing damage to healthy tissue. Thermal relaxation parameters facilitate model calibration according to experimental evidence [1], thus increasing the robustness of clinical predictions. This extended bioheat model offers a precise tool for laser treatment planning in brain cancer therapy.

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MULSCALE MODELLING OF A NON-ENZYMATIC GLUCOSE DETECTOR

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Multiscale modelling represents an essential approach in the development of glucose detectors, facilitating the understanding of processes at atomic, molecular, and detector level, correlating biochemical parameters to sensor response. This type of modelling allows us to develop detectors with higher sensibility, being adaptable to individual physiological parameters [1]. In case of non-enzymatic detection, multiscale modelling offers key perspectives in detection mechanism, such as mass transport, and direct glucose oxidation. Thus, it allows us to select and optimize the materials used in the development of such detectors [2], [3].

The aim of this study is to model a multilayered non-enzymatic glucose detector and predict the way it will interact with glucose and different interferents. To do this, we studied a NiO-based detector with ferroelectric and piezoelectric components. We modelled the detector at different levels (atomic, molecular, and bulk) and created correlations between material properties and detector functional properties (sensitivity, linearity domain, selectivity, limit of detection, time of response).

Preliminary data showed that the properties of such detector are comparable with commercial enzymatic detectors. This proves that non-enzymatic detectors have a promising future, and that multiscale modelling will be a centre piece in their development. The next step is the production of the detector and comparison with experimental data.

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TEMPERATURE CONTROL IN THE REACTOR OF THE METHANOL OBTAINING PROCESS BY REDUCING CARBON DIOXIDE USING THE COPPER-BASED CATALYST

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Carbon dioxide (CO_2), a major greenhouse gas, is significantly responsible for global warming (greenhouse effect) and climate change in recent decades [1]. The increase in the level of CO_2 emissions in the air leads to global warming and a lot of ecological problems [2]. The use of pure CO_2 as feedstock provides an alternative solution for CO_2 emissions and facilitates a simpler and more efficient separation process [3]. The Cu-based catalyst is the most widely used catalyst in methanol synthesis.

To see the influence of varying temperature and pressure on resultant CO2 conversion, several experiments at different temperatures are performed by reacting CO2 with H2 in an adiabatic equilibrium reactor.

In regulating the temperatures (T1, T2 and T3) on the reactor in the case of the CO2 hydrogenation experiment, the P-type regulator was chosen.

The regulation law for a P-type regulator is of the form: $u(t)=Kp\ \varepsilon(t)+u_0$, where: K_p = amplification factor. (In the case of the experiment, the amplification factor was denoted by K_c).

This control law can be given in the form: $u(t)=1/B_p \cdot \varepsilon(t)$, where: B_p % = Proportionality band, given by the relation: $B_p\%=100/K_p$ (domain u(t))/(domain ε(t)) [4].

If , u(t) and ε(t) have the same variation range, then: $B_p\%=100/K_p$

For a unitary step variation of the deviation $\varepsilon(t)=1(t)$, the command quantity is: $u(t)=K_p\ 1(t)=K_p$, $t\geq 0$.

In temperature control, the PID Setpoint Profile VI sub-modules were used (which generates the setpoint values over time, in a control loop for ramp control application types) and the PID VI from the LabView software.

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DFT STUDY OF P-BLOC ELEMENTS ADSORPTION ON PAHs SURFACE: IMPLICATIONS FOR CLUSTER DESORPTION AND TEMPLATE-DIRECTED ASSEMBLY

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Density Functional Theory (DFT) calculations have been carried out to investigate the adsorption of metal and metalloids onto the polycyclic aromatic hydrocarbons (PAHs) surface and desorption of formed clusters from the surface of PAHs (phenanthrene - Phe and pyrene). DFT study of desorption of p-block metals and metalloids from PAHs (example in Fig. 1 – Left panel) is important for develop new applications in nanotechnology, environmental science, and materials engineering [1]. The simulations shown that desorption enables template-directed assembly of clusters and the larger element "aggregates" may slightly distort the PAH's planarity. These leverage the controlled release of metals from aromatic scaffolds, capitalize PAHs' stability and leaves the PAH intact.

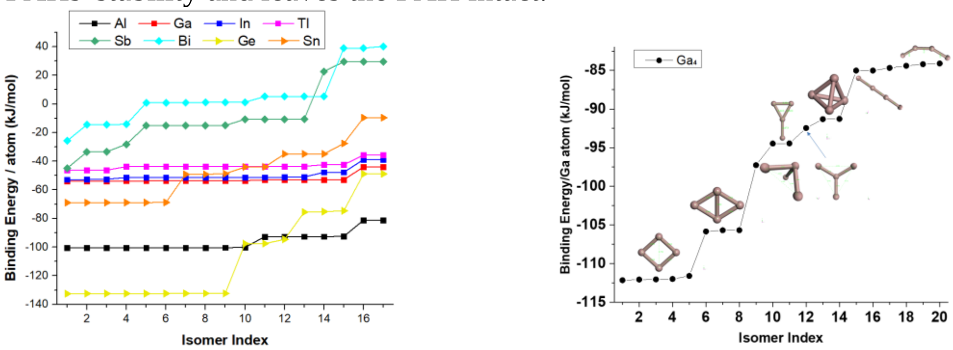

Figure 1. Left panel - Example of binding energy of one atom of some p-block elements onto Phe surface, calculated from DFT simulations. Right panel - binding energy per Ga atom of desorbed clusters of 4 Ga atoms from the surface of Phe.

In Fig. 1 - Right panel, Ga clusters of 4 Ga atoms initially physisorb onto Phe via weak intermolecular forces. On Phe's surface, Ga prefers edge or bay sites due to higher electron density, thus the clusters align with Phe's planar structure through induced dipoles and π-electron overlaps. For catacondensed PAHs like Phe, simulations highlight preferential binding at angular sites, contrasting with more uniform stacking on pericondensed PAHs like pyrene.

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ENERGETIC AND ELECTRONIC PROPERTIES OF Mg-BASED INTERFACES FOR HYDROGEN STORAGE: A DFT APPROACH

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Magnesium and its hydrides are considered highly attractive for solid-state hydrogen storage because of their high capacity and natural abundance. However, their use is limited by slow reaction kinetics and the high stability of MgH_2. Increasing evidence shows that interfaces can decisively influence these properties by altering how hydrogen atoms are bonded, transported, and released. In this study, density functional theory (DFT) calculations were carried out to examine two representative systems: the Mg/MgH_2 phase boundary and the interface between the α and γ polymorphs of MgH_2. The results show that interfacial regions present distinct energetic landscapes compared to the bulk, lowering the barriers for hydrogen incorporation and release. At the same time, charge redistribution at the interfaces modifies the local electronic structure, weakening Mg–H interactions and facilitating hydrogen mobility. These findings highlight the role of interfaces as active regions that can enhance performance, and point to interface engineering as a promising strategy for improving the kinetics and thermodynamics of Mg-based hydrogen storage materials.

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EXPLORING THE POTENTIAL OF PROMPT ENGINEERING IN ATOMIC-SCALE MODEL CALCULATIONS

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Prompt engineering is leveraging natural language processing to request various operations powered by artificial intelligence (AI). In this demonstrative work, Copilot was used in different roles for High Entropy Alloy (HEA) modelling: i) to assist with data extraction and formatting; ii) to perform modelling tasks that support alloy design; iii) to analyse modelling data and provide visualizations; iv) to generate code for expert-level applications. Thus, as data curator (i), Copilot was asked to provide formatted tables with various parameters that serve as input data for thermodynamic models like Miedema's regular-solution approach. It performed based on the inbuilt literature data and served complex compilations of data as tables, together with the references. Then, as calculation agent (ii), it requested the correct inputs (like alloy composition) to calculate thermodynamic parameters that are specific to Miedema's model. Assessing the significance of the results and comparison with experimental data is a process that has to be performed by experienced researchers. Nevertheless, their work can benefit from Copilot assistance (iii), which is capable to generate visualizations such as bar charts and diagrams to help interpret atomic trends, mixing capabilities or mechanical properties of the proposed alloy. As a specialized coding assistant (iv), Copilot was capable of generating small applications to perform the mathematical calculations of the HEA model on a rigorous algorithmic basis, without using the heuristic simplifications of AI performing mathematics. In conclusion, prompt engineering is a powerful technique for creating or modernizing custom made HEA modelling applications and computing workflows by generating code for expert-calculations, implementation of specific user interfaces, scripting, data preprocessing, and creating input files formatted and curated for specific modelling goals.

MODELING THERMAL BEHAVIOR IN ANISOTROPIC FEMTOSECOND LASER–DNA INTERACTIONS: A HERMITE POLYNOMIAL APPROACH

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This study introduces a novel analytical framework based on the bioheat equation to model the interaction between femtosecond laser pulses and DNA strands. The model incorporates laser intensity and interaction time as key input parameters and simulates the resulting thermal distribution by decomposing the laser beam into transverse Hermite–Gauss modes. A consistent mathematical framework was developed to model the thermal distribution in irradiated DNA strands, achieved by decomposing the laser beam into transverse Hermite–Gauss modes.
Simulations were conducted for 100 fs pulse durations, where the formation of a minimal heat-affected zone is expected—an outcome that enhances both the stability and repeatability of the technique. Results reveal that the spatial intensity profile of the laser beam plays a critical role in shaping the thermal field at the junction of irradiated DNA strands.
This model offers valuable insights for laser-based applications under variable intensity conditions, with two primary areas of relevance: (i) DNA elongation without compromising genetic integrity, achievable with temperature variations below 10 K (e.g., H[1,y] mode), and (ii) Targeted cancer therapy, particularly for skin tissue, where controlled heating between 10 K and 30 K (e.g., H[2,y], H[4,y] modes) can selectively eradicate diseased cells while preserving healthy tissue [1]. These results offer valuable insights for advancing laser-based medical technologies, paving the way for more precise, efficient, and patient-tailored therapeutic approaches.

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DESIGN AND EXPERIMENTAL VALIDATION OF ZnO HETEROSTRUCTURES

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This work demonstrates an effective strategy to combine simulation-driven design with an optimized fabrication process for advanced photonic and optoelectronic applications. We present a comprehensive approach that combines numerical simulations of angular reflectance spectra with experimental measurements to investigate the optical response of ZnO heterostructures. The transfer-matrix method was employed to model reflectance spectra by describing light propagation through the multilayer optical system, with each layer represented by its characteristic matrix[1]. Optimized designs were developed to enhance two distinct resonances[2], one photonic and the other excitonic, originating from the ZnO active region. The fabricated ZnO heterostructures were subsequently characterized using an angle-resolved (AR) spectroscopy setup, and the measured spectra were correlated with the simulations, confirming the accuracy of the design process. The results highlight the potential of engineering the optical performance of ZnO-based heterostructures through precise control of fabrication parameters[3].

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MODELLING OF THE HOLOGRAPHIC RECORDING PROCESS IN THIN FILMS OF As_2S_3

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The amorphous chalcogenide semiconductor As_2S_3 is a promising nonlinear optical material with various applications in photonics (optical recording, optical guiding, image processing, optical communications, sensing etc.) [1,2]. Many of its photonic functionalities are based on the light-induced periodic structures recorded in As_2S_3 [2-6].

We report the holographic recording in As_2S_3 thin films using green laser light (λ = 514.5 nm, Ar laser) at the As_2S_3 bandgap energy and the modelling of the recording process. The recording of the periodic structure induced in the film during its evolution is monitored by the diffraction of a laser beam at λ = 632.8 nm (He-Ne laser) on it. The periodic light pattern with λ = 514.5nm, incident on the As_2S_3 film, correspondingly modifies its absorption coefficient, refractive index, and local thickness of the film. Thus, a mixed amplitude-phase grating, with two components of the phase grating (refractive index, relief), is induced in As_2S_3.

This complex recording process is modelled considering the Raman-Nath diffraction theory on thin gratings and a simplified model of the energy-band structure of As_2S_3 [7,8].

Important parameters of light-induced gratings in As_2S_3 films, as the amplitudes of the modulation of the absorption coefficient, refractive index, surface relief and also the time constants of the recording process, have been determined by analysing the experimental data in the frame of the introduced model.

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QUANTUM SPECTRAL-MODEL AND THE HYDROGEN I SPECTRUM

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Starting from the quantum model of the Hydrogen atom, we calculate and tabulate the peaks of α *Humphreys*-multiplet in fine-structure approximation (*fs*-approximation) [1,2]. We determine the spectral line peaks of this multiplet using a new *MaximumLocalisation*-spectral-Model which is based on some several spectroscopic and statistical hypotheses [2-4]. By statistical analysis of the NIST and ACE data, we evaluate the parameters of the regression curves for the multiples of *Lyman..Pfund* and *Humphreys* spectral series (Fig.1). Furthermore, an algorithm for the quantum spectral reconstruction of multiplets in *fs*-approximation for any *Sn* spectral series of H-I is provided, *n* being the order of the spectral series. A plot representation is used to give a statistical global view of the first six series of H-I spectrum. The results confirm the measurements provided of the solar data from ACE mission [5].

Key words: Hydrogen, astrophysics, NIST, spectral model, algorithm, statistics-regression.

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THE PULSATORY LIPOSOME FUNCTIONS AS A PERCEPTRON

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In this paper we consider an unilamellar liposome (lipid vesicle) filled with aqueous solution of osmotic solute. This liposome is introduced in a hypotonic aqueous medium of large dimensions. Due to the osmosis process the liposome swells to a critical size, when a transbilayer pore suddenly appears. Some of the internal solution leaks through this pore and the liposome relaxes and returns to its initial size. The swelling starts again and the liposome begins a new cycle and so on. The evolution of the liposome is a dynamic and cyclical process. The swelling of the liposome is described by a differential equation. The appearance of the pore changes the evolution of the liposome. The internal solution comes out through the pore and the liposome starts its deflation (relaxation) and reaches to its initial size. All the processes which contribute to the liposome relaxing and its coming back to the initial size (pore evolution and internal solution delivery) are described by three differential equations. This system of differential equations describes the evolution of the pulsatory liposome during a cycle and can be integrated using numerical methods. After performing a number of cycles, the pulsatory liposome stops. It can be assimilated to a intelligent biophysical engine and a neural network. A neural layer corresponds to a cycle. A neural layer corresponds to a cycle. Each neuronal layer learns to solve the equations that describe the evolution of the liposome during a cycle. So, a pulsed liposome works according to its own program that can be learned by a neural network.
Key words: Pulsatory liposome, intelligent biophysical engine, neuronal network

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MONTE CARLO SIMULATION OF ELECTRON INTERACTION VOLUMES IN THIN FILM COATINGS

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The reliable characterization of thin films is often limited by the difficulty of separating coating signals from substrate contributions during electron microscopy analysis. In this work, Monte Carlo simulations were performed with the CASINO software to study how accelerating voltage and material properties influence electron scattering in simple coated systems[1]. The model consisted of 1 layers of C, Mg, Ti, Zn, Zr, Ag, W and Pb deposited on Si substrates. Beam energies between 5 and 30 kV were applied, and the number of simulated electron trajectories was varied to examine the effect of statistical sampling on the definition of the interaction volume[2][3].
The simulations confirm a strong correlation between atomic number and electron behavior. Low atomic number layers such as C and Mg allowed electrons to penetrate deeply and scatter broadly, while high atomic number materials such as W and Pb confined electrons near the surface and produced intense backscattering[4][5]. For Zn on Si, clear boundary effects were visible, with changes in scattering behavior at the interface.
These results underline the importance of carefully selecting beam parameters to optimize thin film analysis in electron microscopy. Monte Carlo modelling thus provides a valuable predictive tool for planning experiments and optimizing analysis strategies in electron microscopy of coated systems. The approach provides a predictive basis for extending simulations toward multilayer systems.

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SURFACTANTS FOR STABLE NANOCOLLOIDS: AN EXPERIMENTAL APPROACH

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Nanofluids, defined as suspensions of nanoparticles in a base fluid, have attracted growing interest due to their enhanced thermophysical properties. A key challenge is the tendency of nanoparticles to agglomerate because of Van der Waals forces and high surface energy, which leads to sedimentation, viscosity changes, and reduced performance. Thus, to improve nanofluids stability, surfactants are widely employed. These amphiphilic molecules, with hydrophilic and hydrophobic parts, adsorb at the nanoparticle–fluid interface, lowering surface tension and creating electrostatic or steric barriers that prevent aggregation. Surfactants are typically classified as anionic (e.g., SDS), cationic (e.g., CTAB), non-ionic (e.g., Tween 80), or zwitterionic. Their selection depends on nanoparticle type and base fluid. For example, SDS is often used for metallic nanoparticles, CTAB for metal oxides, while non-ionic surfactants are preferred in biomedical contexts due to their lower toxicity.
The main benefits of surfactants in nanofluids are:

- improved colloidal stability,
- uniform nanoparticle dispersion,
- optimized thermal conductivity and viscosity,
- enhanced chemical compatibility with the base fluid.

Therefore, surfactants are essential for the synthesis and stabilization of nanofluids, ensuring durable and efficient systems. Nevertheless, the main disadvantage of adding surfactants is the foaming effect, excessive viscosity increase or chemical interactions and their negative influence on thermal conductivity. Current research trends focus on optimizing the type and concentration of surfactants to minimize undesired effects while achieving long-term stability of nanofluids with special focus on applications in heat transfer, renewable energy systems, and biomedicine.

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IMPACT OF THERMAL RELAXATION TIME ON GENERALIZED BIOHEAT EQUATION: A COMPARATIVE STUDY OF ANALYTICAL AND NUMERICAL MODELS

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The Pennes bioheat equation is a widely used model for simulating heat transfer in biological tissues during thermal exposure. Based on Fourier's law, it describes energy exchange between blood vessels and surrounding tissue. While numerical solutions are common, analytical models remain limited.
This study introduces a 3D analytical model developed in MATHEMATICA and validated through COMSOL simulations to analyze laser-induced heating under therapeutic conditions. Key innovations include: (a) a non-Fourier formulation accounting for thermal relaxation time, (b) integration of Dirac functions and the telegraph equation to simulate localized heating, and (c) closed-form solutions for both classical and modified bioheat equations.
A key focus of this work the relationship between the relaxation time parameter in the telegraph equation and the thermal relaxation time used in bioheat modelling. Based on simulation results, the optimal thermal relaxation time was determined to be 1.16 seconds, with thermal exposure durations ranging from 0.01 to 120 seconds [1].
By incorporating spatial temperature non-uniformities and refining the heat exchange dynamics between tissue and blood flow, this generalized model offers a more realistic representation of biological thermal behaviour. Notably, a strong correlation was observed between the analytical results from MATHEMATICA and the numerical outcomes from COMSOL, reinforcing the model's validity [1]. These findings contribute to the advancement of laser-based medical procedures and thermal therapies, supporting the development of more effective and personalized treatment strategies.

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THE IMPACT OF PLASMA TREATMENT ON THE PRINTABILITY OF COMMERCIAL-GRADE POLYMERS USED IN ADDITIVE MANUFACTURING

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For biomedical applications, polymer surface modifications are essential because they improve the overall surface adhesion, or its chemical characteristics, changing its wetting, and biological interactions. For the processing of biomaterials, atmospheric pressure plasma jets work well, especially those that run in argon and helium [1-3]. In this work, we performed optical emission spectroscopy and electrical diagnosis in order to characterize a dielectric barrier atmospheric pressure plasma jet. Polymers like polylactic acid, acrylonitrile butadiene styrene as well as polyethylene terephthalate were exposed for 180 s to plasma. AFM, SEM, FTIR, XPS, XRD, and contact angle measurements were the surface analysis methods that showed notable alterations. Water adhesion work was increased by plasma treatment, which increased surface hydrophilicity by up to 70% for ABS and 50% for PLA. The water work of adhesion for PETG, for example, increased from 71 mN/m to 131 mN/m. A smoother surface with less root mean square roughness was shown by morphological studies. Both XRD and FTIR spectroscopy verified the advantageous plasma contact, and tensile testing revealed increased strain in the polymers treated with plasma. This study demonstrated proper operating parameters for successful surface treatment by establishing a correlation between plasma parameters, treatment duration, and the ensuing morphological and chemical changes. These plasma-treated polymers are appropriate for biomedical applications such as coatings for prosthetic devices because of their smoothed surfaces and uniformly distributed nanometric formations, which indicate enhanced surface adhesion and interlayer bonding.

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High-Entropy Alloys – The Next Generation in Corrosion Protection

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Developing effective corrosion protection strategies remains a critical challenge in many industrial sectors. High entropy alloys (HEAs) represent an innovative class of metallic materials designed by combining five or more main elements in nearly equimolar proportions [1].

Their main effects—high configurational entropy, slow diffusion, crystal lattice distortion, and cocktail effects—contribute to superior mechanical strength, thermal stability, and improved corrosion resistance compared to conventional alloys. This unconventional approach generates unique microstructures and synergistic effects — high configurational entropy, slow diffusion, crystal lattice distortion, and cocktail effects — that improve mechanical, thermal, and electrochemical performance [2].

Recent research shows that HEAs exhibit superior corrosion resistance in aggressive environments such as chloride-rich solutions, acidic environments, and marine conditions. The reported studies suggest that HEAs can significantly outperform traditional stainless steels and superalloys, making them a promising path toward next-generation corrosion-resistant materials for aerospace, marine, energy, and biomedical applications. The formation of stable and adherent passive films, together with the synergistic role of several alloying elements, ensures long-term durability [3, 4].

This work highlights HEA as a new generation of materials for anti-corrosion applications, offering promising solutions for marine sectors where corrosion critically limits the service life of components.

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