Book of Abstracts

EUROINVENT
ICIR 2026

International Conference on Innovative Research

May 28th to 29th, 2026
Iasi – Romania

Organized by:

- **Romanian Inventors Forum**
- **Faculty of Materials Science and Engineering, The "Gheorghe Asachi" Technical University of Iasi, Romania**
- **ARHEOINVEST Platform, Alexandru Ioan Cuza University of Iasi**
- **Centre of Excellence Geopolymer and Green Technology CEGeoGTech), Universiti Malaysia Perlis (UniMAP)**
- **Department of Physics, Czestochowa University of Technology, Częstochowa, Poland**

With support of:

- **National Institute for Research and Development in Environmental Protection INCPDM**
- **International Federation of Inventors' Associations - IFIA**
- **World Invention Intellectual Property Associations – WIIPA**

Editors:
Andrei Victor SANDU, Mohd Mustafa Al Bakri ABDULLAH,
Petrică VIZUREANU, Marcin NABIALEK, Ion SANDU

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EUROPEAN EXHIBITION OF CREATIVITY AND INNOVATION

EUROINVENT

IAŞI – ROMANIA

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Euroinvent is a Festival of innovation, a joint event promoting creativity in European context, by displaying the contributions of consecrated schools from higher education and academic research and also of individual inventors & researchers.

Under the auspices of EUROINVENT we organize:

1. **Inventions and Research Exhibition**

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2. **International Conference on Innovative Research**

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3. **Technical-Scientifical, Artistic and Literary Book Salon**

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Event purposes:

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- partnerships and agreements;
- Creating and developing new research ideas;
- Technology transfer;
- Implementation of inventions,
- Scientific recognition.

The exhibition welcomes you to display inventions (patented in the last 7 years or have patent application number). A special section is held for innovative projects.

EUROINVENT International Conference on Innovative Research (ICIR) will bring together leading researchers, engineers and scientists will present actual research results in the field of Materials Science and Engineering.

euroinvent@yahoo.com

Foreword

This volume comprises the abstracts of the EUROINVENT International Conference on Innovative Research (ICIR) 2026. The ICIR Conference is held under the auspices of EUROINVENT, a comprehensive event dedicated to fostering creativity within a European framework by showcasing contributions from established academic institutions, higher education entities, as well as independent inventors and researchers.

The ICIR Conference serves as a distinguished platform for leading researchers, engineers, and scientists to present recent advancements and research findings in the field of Materials Science and Engineering. Its primary objective is to facilitate a high-level international forum for the dissemination and exchange of innovative ideas, techniques, and developments within the discipline.

This event encompasses a broad spectrum of topics in materials science, ranging from the synthesis and characterization of materials to engineering processes, technological innovations, applications, and interdisciplinary links to the life sciences. Each contribution has undergone a rigorous peer-review process by at least two experts in the respective subject areas, with selection based on scientific merit and relevance to the conference themes.

The editors hope that this volume will offer readers a comprehensive insight into current trends and emerging directions in materials science and engineering. It is intended to serve as a valuable reference for ongoing and future research endeavors.

We extend our sincere gratitude to all members of the ICIR 2026 Scientific and Organizing Committees for their outstanding dedication and effort. We also acknowledge the support of the publishers in facilitating the dissemination of the full articles. Finally, we express our heartfelt thanks to all contributing authors for their significant scholarly input to this volume.

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Program of EUROINVENT ICIR Conference
ORAL PRESENTATION

*Palace of Culture Iasi – **Voievozilor Hall***

DAY 1 – THURSDAY MAY 28 2026	
9.00	Participants registration
11.00	**EUROINVENT Opening Ceremony**
12.00	**ICIR Opening Ceremony**
12.15	**Session 1** Chairman: Prof. Dr. Petrică VIZUREANU Prof. Dr. Alexandru PASCU Prof. Dr. Bogdan Viorel NEAMTU
12.15	**Plenary Speaker – Julia MIRZA-ROSCA** *Exciting and Promising New Class of Materials for the Future: High Entropy Alloys*
12.45	**Plenary Speaker – Marcelo PRADO** *The Story Behind the Conversion of Monetite to Hidroxyapatite*
13.15	**Plenary Speaker – Iulian ANTONIAC** *Magnesium-Based Alloys for Medical Applications: Where Are We Now ?*
14.00	***Snacks & Refreshments Break***
15.00	**Session 2** Chairman: Prof. Dr. Marcelo PRADO Prof. Dr. Camilo ZAMORA-LEDEZMA Prof. Dr. Andriana SURLEVA Prof. Dr. Iulian ANTONIAC
15.00	**Keynote Speaker – Suriani MAT JUSOH** *Development of Green Hybrid Composite Autonomous Surface Vehicle Searching Boat*
15.30	**Keynote Speaker – Cristina-Ileana COVALIU-MIERLA** *Nanotechnologies and Nanomaterials with Potential Applications in Industrial Wastewater Treatment*
16.00	**Natalia Lorela PAUL** - *Decoding Magnetic Signatures in Magnetotactic Bacteria through Comparative Magnetometric Analysis*
16.15	**Niki Vlad MANCASI** - *Offset vs. non-Offset 3D Warp Interlock Structures: A comparative Analysis of Geometrical Parameters in Para-Aramid Fabrics*
16.30	**Cristina JIMÉNEZ-MARCOS** - *Microstructural, Electrochemical and Mechanical Characterization of Novel Ti–Mo–Zr–Ta Alloys Manufactured Using SLM*
16.45	**Andra Teodora Anastasia MAN -** *Solid-state synthesis of Ni50Mn20Sn30 Heusler type alloy and the impact of low temperature annealing on phase formation*
17.00	**Sofia SAKR-NASSEF** - *Evaluation of Electrochemical properties of two CRT-D samples in simulated body fluid*
17.15	**Yulia IVASHKO -** *Preservation and Conservation Issues of the Salesian Monastery Façade in Oświęcim: Lessons from Ukrainian Practice*
17.30	**Francisco M. SÁNCHEZ SOSA** - *Service behavior of novel biodegradable Mg-Zn alloys for biomedical applications*
17.45	**Karol WYSZNACKI** - *Integrating Heritage Conservation and Contemporary Architecture: Renovation and Modernization of the Terrace at Uniejów Castle*
18.00	**Nina BOGDAN-GOLUBI** - *Biosynthetic Activity of Rhodotorula gracilis CNMN-YS-03 and Rhodotorula glutinis CNMN-YS-08 After Preservation and Long-Term Storage*
18.15	**Cristina PASCAL** - *Antifungal Effects of Essential Oils for Preservation of Natural Cotton Textiles*
	Posters evaluation: 15:00 - 17:00
18.30	**End of Conference Day**

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ORAL PRESENTATION

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DAY 2 – FRIDAY MAY 29 2026	
9.00	**Session 3** Chairman: Prof. Dr. Dimka FACHIKOVA Prof. Dr. Julia MIRZA-ROSCA Prof. Dr. Catalin POPA Prof. Dr. Suriani MAT JUSOH
9.00	**Keynote Speaker – Norina Consuela FORNA** *Advanced Biomaterials in Implant-Prosthetic Therapy: Innovations and Clinical Implications*
9.30	**Invited Speaker – Nermin DEMIRKOL** *The Circular Raw Material Potential of Izmit Gulf Bottom Sediment: Ceramics, Glass and Enamel Applications*
10.00	**Invited Speaker – Anca Daniela RAICIU** *Liposomal Microbial Inulinase for Controlled Release and Metabolic Health Applications*
10.30	**Alexandra HARABAGIU** - *Assessing water and sediment quality for Black Sea Romanian tributaries and coastal lagoons in the context of armed conflict*
10.45	**George Laurentiu ARDELEAN** - *Laser Welding of Titanium Grade 2*
11.00	**Camilo ZAMORA-LEDEZMA** - *Architecture Controlled PAN–Collagen–Dexamethasone Electrospun Scaffolds for Mesenchymal Stem Cell Culture*
11.15	**Alexandra Diana CHIRESCU** - *Mapping Structural Heterogeneity for Nature-Based Solutions in the Lower Danube*
11.30	**Elango JEEVITHAN** - *Biofabrication of a High-Fidelity In Vitro Blood-Brain Barrier Model Using Decellularized Squid Mantle Scaffolds*
11.45	**Siti Hawa SALLEH** - *Effect of Hydroxyapatite Concentration on the Temporal Corrosion Kinetics of AZ31 Alloy: Establishing a Foundation for Biomimetic Coatings*
12.00	**Mikheil TABATADZE** - *Effect of Mechanical Activation on the Sintering process of Fe–Cu–Ni–Sn Powder Mixtures during Hot Pressing*
12.15	**Alberto Daniel RICO-CANO** - *Influence of Graphene Nanoplatelets Doping on the Corrosion Behavior of Ultra-High Temperature Ceramics in Artificial Sea Water*
12.30	**Hamzah FANSURI** - *Metakaolin-Derived Geopolymer Photocatalyst Membranes for Synthetic Textile Dye Waste Reduction: Performance Comparison of TiO_2, ZnO, and NiO*
12.45	**Ioana-Corina MOGA** - *Advanced Treatment of Recalcitrant Industrial Wastewater: Validation of a Tri-component System Using Ligninolytic Fungi and Hybrid MBBR Technology*
13.00	**Diana-Petronela BURDUHOS-NERGIS** - *Effect of Immersion Time on the Corrosion Behaviour of Ca-Zn-Mg Phosphate Conversion Coating Deposited on Ti6Al4V*
	Posters evaluation: 10:00 - 12:00
13.30	**Awards Ceremony and Conference Closure**
18.00	**Cocktail dinner - Restaurant – HOTEL CIRIC**

Program of EUROINVENT ICIR Conference

POSTER PRESENTATION

*Palace of Culture Iasi - **Voievozilor Hall***

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P2.	Evgeni LANDO et al., Techno-Economic Evaluation of Reconstruction Projects for Damaged Residential Structures
P3.	Izabela ADAMCZYK et al., Historical Outline and Modernization the Neo-Baroque with Neo-Renaissance Elements of the Częstochowa Sanctuary
P4.	Damian JONCZYK et al., Conservation Monitoring of the Historic St. Valentine Church in Konopiska Using 3D Scanning as a Supporting Documentation Tool
P5.	Przemysław PALACZ et al., The use of Point Clouds for Developing a BIM Model in Conservation Documentation: A Case Study of a Historic Sacred Structure
P6.	Aleksandra REPELEWICZ et al., The Need for Conservation of Filial Churches as Exemplified by the Częstochowa Pastoral District
P7.	Jacek NAWROT et al., Assessment of Urban-Architectural Coherence in Historic Urban Fabric: A Case Study of Aleja Najswietszej Maryi Panny in Czestochowa
P8.	Aleksandra KUSMIERSKA et al., Impact of Thermal Modernization Strategies and Heating Systems on the Energy Performance of a Historic Building
P9.	Nina SOŁKIEWICZ-KOS et al., Conservation and Adaptation of Historic Tenement Houses as a Tool for Shaping Urban Identity: The Case of Częstochowa
P10.	Przemysław KASZA et al., Assessment of the Technical Condition of the Historic Underground Complex in Będzin
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P12.	Mihai Alin POP et al., Acoustic Performance of Recycled Polymer Panels Manufactured by Fused Granular Fabrication
P13.	Tudor BRANIŞTE et al., UV-Assisted CO_2 Sensing Using Au-Functionalized TiO_2 Nanoparticles
P14.	Tatiana GALATONOVA et al., Influence of Gold Functionalization on the Alcohol Sensing Properties of TiO2
P15.	Emilia VISILEANU et al., Performance Improvement of Hygienic and Olfactory Properties in Military Base Layer Textiles
P16.	Ștefania Andreea BITU et al., Adaptive Methodologies and Digital Implementations with the Aim of Reducing the School Dropout Risk
P17.	Florin POPA et al., Low Milling Time Alloying of Ni, Mn, Sn Elemental Powders Using Different Milling Energy
P18.	Mariana BUȘILĂ et al., Organosilane Functionalization of ZnO Quntum Dots: A Versatile Platform for Antitumor Applications
P19.	Dimka FACHIKOVA et al., Restoration and Conservation of a Personal Document with a Metal Object from the Cover
P20.	Nona SHIVACHEVA et al., Electrochemical Characterization and Corrosion Resistance of Ti-Mo-Nb-Sn Alloys for Biomedical Applications
P21.	Viktor BILICHENKO et al., Modeling and Dynamic Analysis of Synchronized Hydraulic Drives of an Automatic Machine for Forming Ceramic Blanks from Plastic Ceramic Mass
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P25.	Lakshmi Jeevithan et al., Recombinant Humanized Type Iii Collagen Peptide-Rgd Functionalized Alginate Hydrogels Enhance Msc, Hfob, and Fibroblast Proliferation via Integrin A5β1 Activation
P26.	Eliana Díaz-Cruces et al., Translating 3D Bioprinting Research, Development and Innovation into Marketable Patients Products: Legal, Corporate Sustainability and Governance Challenges.
P27.	Alexandra Virginia Bounegru et al., Electrochemical Sensor Based on a Copper(i) Complex for the Simultaneous Detection of Phenolic Pollutants in Water
P28.	Aurel ȚĂBĂCARU et al., New Hybrid Antitumor Systems Based on Lanthanide-Functionalized Zinc Oxide Nanoparticles
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P30.	Anca Daniela RAICIU et al., Liposomal Microbial Inulinase for Controlled Release and Metabolic Health Applications
P31.	Siseerot KETKAEW et al., Innovation of Eliminate Toxic Gases in Industrial Factory by Applying High Intensity Ozonation Electrical System
P32.	Siseerot KETKAEW et al., Research and Construction of Innovation to Reduce Air Humidity by Appling Electric Field Intensity Energy
P33.	Ionela Luminita CANUTA (BUCUROIU) et al., Innovative Management Aspects Necessary for Efficient Education Specificity of Materials Science
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P35.	Cristina-Alexandra HAIVAS et al., A Chemical-Mechanical Treatment Solution for a Zootechnical Farm Effluent: Coagulation-Flocculation-Sedimentation Using Hybrid Polymeric Materials
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P41.	Darya ILIEVA et al., Approaches for Evaluating Methods for the Quantitative Determination of Titanium in Simulated Human Fluids
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Program of EUROINVENT ICIR Conference
POSTER PRESENTATION

*Palace of Culture Iasi - **Voievozilor Hall***

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P53.	Anca CAZAC et al., Phosphate Conversion Coatings for Medical Applications – A Brief Review
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P56.	Tina TASHEVA et al., Physicochemical Tuning of Multicomponent Oxide Glasses for Optical Applications
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P63.	Bianca SOPRON et al., 3D-Printed Resin Orthodontic Brackets: A Systematic Review of Mechanical Performance
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P67.	Tina TASHEVA et al., Correlation between Structure and Electrical Behavior in ZnO–Containing Vanadate Glasses
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P70.	Mohammad Tamizi SELIMIN et al., Fly Ash-Based Geopolymer-Coated Lightweight Expanded Clay Aggregate (Leca) for Structural Applications: A Review.
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P88.	Joanna BARTKIEWICZ et al., Issues Related to the Protection of Cultural Heritage in a Small Historic Town, Using the Example of Sokołów Małopolski
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P92.	Iryna KOROTUN et al., Documentation and Reproduction of the Frescoes in the Bukovina and Dalmatia Metropolitans' Residence (Now – The Yuriy Fedkovych Chernivtsi National University Building)
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THE „GHEORGHE ASACHI" TECHNICAL UNIVERSITY OF IASI
Faculty of Materials Science and Engineering

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ROMANIAN INVENTORS FORUM

Romanian Inventors Forum (FIR), as a professional association of dialog and representation, has the purpose to support, stimulate, develop and valorize the scientifically, technically and artistically creativity. Under the aegis of FIR, Romanian Inventors have participated at more than 50 World Invention Exhibitions, where their creations have been awarded with orders, prizes and medals. The performance of Romanian inventics is renowned in the whole world, that is the reason why FIR became member in different international clubs, associations and federations, with special contributions.

Contact:
Str. Sf. P.Movila 3, L11, III/3
RO - 700089, Iaşi, România
Tel: +40.745.438604,
e-mail: euroinvent@yahoo.com
web: www.afir.org.ro

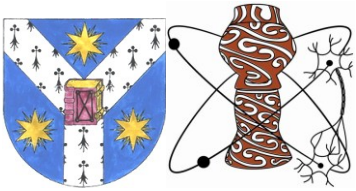
Universiti Malaysia Perlis (UniMAP) is Malaysia's 17th public institution of higher learning. It was approved by the Malaysian Cabinet on May 2001. Originally known as Kolej Universiti Kejuruteraa Utara Malaysia (KUKUM), or Northern Malaysia University College of Engineering, it was renamed as Universiti Malaysia Perlis (UniMAP) in February 2007. The first intake consisted of 116 engineering students who started classes on June 2002. Currently, UniMAP has approximately 14,000 students and a workforce of more than 2,100 academic and non-academic staff members. Universiti Malaysia Perlis (UniMAP) offers 14 programs of Bachelor in Engineering, 13 programs of Bachelor Engineering Technology, 6 programs of Bachelor Technology, 2 Bachelor in Business programs, 1 Bachelor in New Media Communication program and 6 Diploma level and over than 50 postgraduate programs that lead to the Master of Science in Engineering and PhD degrees.

Center of Excellence Geopolymer & Green Technology (CEGeoGTech) lead by Vice Chancellor Universiti Malaysia Perlis (UniMAP), Professor. Dr. Kamarudin Hussin. CEGeoGTech located at the School of Materials Engineering, Kompleks Pusat Pengajian Jejawi 2, Taman Muhibbah, 02600 Arau, Perlis. CEGeoGTech has been established on July 2011 with the intention to induce innovation in green material technology among researchers in Universiti Malaysia Perlis. CEGeoGTech are able combining their expertise and skills in various fields to support the academic structure in the generation of human capital that contributes to the development of high quality research. This center also can become a pillar of academic activities, especially regarding research, development and innovation. CEGeoGTech have 8 fields of research includes:

- ✓ Geopolymer
- ✓ Polymer Recycling
- ✓ Electronic Materials
- ✓ Ceramic
- ✓ Electrochemistry Materials & Metallurgy
- ✓ Environmental
- ✓ Manufacturing and Design
- ✓ Green ICT

Laboratory of Scientific Investigation and Cultural Heritage Conservation
ARHEOINVEST Platform, Alexandru Ioan Cuza University of Iasi

The Alexandru Ioan Cuza University of Iași is the oldest higher education institution in Romania. Since 1860, the university has been carrying on a tradition of excellence and innovation in the fields of education and research. With over 38.000 students and 800 academic staff, the university enjoys a high prestige at national and international level and cooperates with over 250 universities world-wide. The Alexandru Ioan Cuza University became the first student-centered university in Romania, once the Bologna Process was put into practice. Research at our university is top level. For the second year in a row, the University is placed first in the national research ranking. Striving for excellence, the university takes unique initiatives to stimulate research quality, to encourage dynamic and creative education and to attract the best students to academic life.



Contact:
Blvd. Carol I no. 11,
Corp G demisol
RO - 700506, Iaşi, România
e-mail: ion.sandu@uaic.ro
web: www.uaic.ro

Czestochowa University of Technology, Częstochowa, Poland
Department of Physics

Czestochowa University of Technology (CUT) is the largest state university in the region funded in the 40's last century. It is also the only one having full academic rights, i.e. it has the right to confer the title of doctor and university professor (habilitated doctor). During its scientific and educational activities, it has become an inherent part of Poland's history and tradition, of Czestochowa region and the city itself. In nationwide rankings of the state institutions of higher education, we are among the top universities in Poland of a similar profile.

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CUT has a reputation for being a modern and well-equipped school which offers a wide range of courses and a high level of education. The excellent quality of our teaching and research and the unrivalled academic knowledge and experience of our academic staff make studying at CUT a stimulating and invaluable experience. The University also prides itself on having good student infrastructure, a wide range of high-standard laboratories and lecture rooms to support research and teaching as well as three halls of residence, its own publisher and a modern main library and faculty libraries.

All accepted papers, after the peer review, from EUROINVENT 2026 International Conference on Innovative Research will be published in:

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European Journal of Materials Science and Engineering (Indexed by DOAJ, Chemical Abstracts, CiteFactor, indexed by Web of Science)

International Journal of Conservation Science (Indexed by Web of Science and Elsevier SCOPUS, IF 0.8)

Plenary Speaker

Marcelo PRADO, PhD

Professor
Materials Science and Engineering Graduate Programme
Military Instityute of Engineering, IME
Rio de Janeiro, R.J., BRAZIL

Marcelo Prado is a metallurgical engineer, M.Sc. and Ph.D. on Metallurgical and Materials Science Engineering from the Federal University of Rio de Janeiro (UFRJ, Brazil). Part of the Ph.D. was performed in the Interdisciplinary Research Centre in Biomedical Materials (IRC, Queen Mary and Westfield College, University of London) and developed Post doctoral research on porous bioceramics and composites performed at INEB – University of Oporto (2000-2001). Marcelo Prado is currently a Full Professor in the Military Institute of Engineering (IME, Brazil), being also in chief of the Electron Microscopy Laboratory and Ceramic Materials Laboratory. Prof. Marcelo Prado develops researches on bioceramics synthesis and processing, bioactive glasses and composites and is involved in related researches as supervisor, member of scientific committee of conferences, referee of scientific journals, and international societies. He was the President of the International Society for Ceramics in Medicine (ISCM) in 2008 and 2025.

THE STORY BEHIND THE CONVERSION OF MONETITE TO HIDROXYAPATITE

Hydroxyapatite is a well-known bioactive bioceramic used as scaffold for bone repair/regeneration and as bioactive coating on biocompatible metals and alloys like titanium and titanium alloys. The coating method has a strong influence on the adhesion to the metallic substrate and on the coating bioactivity and stability in the physiological medium.

This talk will tell the story of the publication of the article entitled “Transformation of monetite to hydroxyapatite in bioactive coatings on titanium” (Surf. Coat. Technol. 2001, 137, 270–276, https://doi.org/10.1016/S0257-8972(00)01125-7). The developed coating method is based on the conversion of an acidic calcium phosphate, monetite, Ca.HPO4, to hydroxyapatite, Ca10(PO4)6(OH)2. The development of this coating method gave rise to other routes for producing scaffolds and partially-substitute hydroxyapatite coatings.

Plenary Speaker

Julia MIRZA-ROSCA, PhD

Professor
Department of Mechanical Engineering,
University of Las Palmas de Gran Canaria, SPAIN

Julia Mirza-Rosca is Professor in the Mechanical Engineering Department of Las Palmas de Gran Canaria Universit, Canary Islands, Spain. She is the Head of Nanoscience and Nanomaterials Laboratory, Director of Nanomaterials and Corrosion Research Group and Director of IPCC company. Co-author of more than 100 publications with around 1500 citations. Her research interests are in the field of the materials science, corrosion of all types of materials, microstructure and biocompatibility of new materials, nanomechanical testing and surface treatments of materials.

EXCITING AND PROMISING NEW CLASS OF MATERIALS FOR THE FUTURE: HIGH ENTROPY ALLOYS

In the current context of rapid technological advances and growing industrial challenges, the development of advanced materials has become a fundamental pillar for scientific and economic progress. Among these innovations, high entropy alloys (HEAs) represent one of the most disruptive and promising proposals in contemporary materials science. Unlike conventional alloys, which are based on one or two main elements, HEAs are composed of multiple elements in near-equiatomic proportions, resulting in highly disordered atomic configurations and unique emergent properties. This new paradigm in materials design has opened up unprecedented opportunities to overcome traditional limitations in mechanical strength, thermal stability, corrosion resistance and behavior in extreme environments. This phenomenon challenges the classical principles of metallurgy and raises new fundamental questions about the relationship between composition, microstructure and properties. Exploring the advances, challenges and future prospects of high-entropy alloys allows us not only to better understand these materials of the future, but also to foster the interdisciplinary collaboration necessary to bring these innovations from the laboratory to real-world applications.

Plenary Speaker

Iulian ANTONIAC, PhD

Professor
Department of Materials Science and Physical Metallurgy, Faculty of Materials Science and Engineering,
National University of Science and Technology POLITEHNICA Bucharest, ROMANIA

Iulian Antoniac is Full Professor in Materials Engineering and Biomaterials, Habil in Materials Engineering, Member of the Academy of Romanian Scientist, Member of American Romanian Academy of Art and Sciences, Past President of the International Society for Ceramics in Medicine (ISCM) and President of the Romanian Society for Biomaterials. He is author of over 300 publications with more than 6500 citations (Hirsh Index 46 in GScholar, 40 in Scopus, 34 in WoS). He was recognized as Fellow of Biomaterials Science and Engineering (FBSE) for his worldwide contribution in biomaterials field. Prof. Antoniac was listed in Stanford/Elsevier Top 2% Scientist for last 3 consecutive years. His research interests are in the field of materials science and engineering, especially biomaterials; biodegradable metals; coatings; surface characterization; medical devices.

MAGNESIUM-BASED ALLOYS FOR MEDICAL APPLICATIONS: WHERE WE ARE NOW ?

The article provides a comprehensive overview of the applications made by Mg-based alloys across different medical specializations: cardiovascular, orthopedics, stomatology, general surgery, and neurosurgery. The main Mg-based alloys will be presented from fundamental aspects to experimental characterization and testing methods, following key aspects like alloying, fabrication techniques, surface modifications, testing media, implant design, animal testing. Experimental results obtained after using different characterization methods will be shown, from microstructural features to biocompatibility evaluation. Also, the challenges and prospects of biodegradable Mg-based implants will be discussed.

Keynote Speaker

Norina Consuela FORNA, PhD

Professor
Faculty of Medicine and Pharmacy,
Grigore T. Popa University of Medicine and Pharmacy,
Iasi, Romania

Forna Norina is currently a Full Professor, and Ph.D. on. Faculty of Medicine and Pharmacy, University of Medicine and Pharmacy „Grigore T.Popa" din Iasi (Romania). Professor Norina Forna conducts advanced research in the fields of dental prosthetics, complex oral rehabilitation, and implantology. She is actively involved in related research activities as a coordinator, member of scientific committees for international conferences, reviewer for specialized journals, and leader within global scientific societies. She has served as President of the European Prosthodontic Association (EPA) and currently holds the position of President of the Romanian Society for Oral Rehabilitation (ASRO) and the Romanian Dental Association for Education (ADRE). She is also a full member of the Academy of Medical Sciences and the Academy of Romanian Scientists.

ADVANCED BIOMATERIALS IN IMPLANT-PROSTHETIC THERAPY: INNOVATIONS AND CLINICAL IMPLICATIONS

Recent developments in biomaterial science have significantly increased the predictability of implant-supported rehabilitations. High-strength ceramics such as zirconia, surface-modified titanium, bioactive coatings, and hybrid composite materials contribute to improved osseointegration, mechanical resistance, and aesthetic outcomes. Particular attention is given to the interaction between biomaterials and peri-implant tissues, including aspects related to biocompatibility, surface micro- and nanotopography, and bacterial adhesion. The integration of digital workflows, including CAD/CAM technologies, enables precise fabrication of customized prosthetic components using advanced materials adapted to individual clinical scenarios. Key clinical considerations such as load distribution, wear resistance, and soft tissue stability are closely linked to material selection. In addition, emerging directions—such as nanostructured surfaces, biofunctionalization, and smart biomaterials—are analyzed for their potential to enhance tissue regeneration and reduce biological and mechanical complications. Evidence from recent clinical studies supports the development of optimized treatment protocols based on advanced biomaterials. In conclusion, the selection and appropriate use of advanced biomaterials remain essential for achieving functional, aesthetic, and long-term success in implant-prosthetic rehabilitation.

Keynote Speaker

Cristina-Ileana COVALIU-MIERLA, PhD

Professor
National University of Science and Technology POLITEHNICA
Bucharest, Romania

Cristina-Ileana Covaliu-Mierlă, PhD, at the National University of Science and Technology POLITEHNICA Bucharest, with a distinguished activity in the field of environmental engineering and biotechnologies. She currently serves as Director of the Doctoral School of Biotechnical Systems Engineering, playing a key role in coordinating doctoral programs and ensuring the quality of education and research processes. Scientifically, she has developed a strong research profile in wastewater treatment, nanomaterials, and sustainable technologies, being the author and co-author of more than 100 ISI scientific papers published in prestigious journals, as well as specialized books. Her contributions have been recognized through multiple awards and medals obtained at international invention exhibitions. She has coordinated, till the present, three knowledge transfer projects with industry partners (Pilot flotation plant using eco-friendly hybrid nanomaterials for wastewater treatment, Installation for removal of organic pollutants from wastewater using photocatalysis and biological processes, two SEE-funded projects, and one project aimed at supporting early-stage doctoral researchers.

NANOTECHNOLOGIES AND NANOMATERIALS WITH POTENTIAL APPLICATIONS IN INDUSTRIAL WASTEWATER TREATMENT

The removal of pollutants from wastewater to prevent their release into the environment has been extensively studied. Various types of nanomaterials with potential for removing toxic contaminants, such as heavy metals and pharmaceuticals, from wastewater are still studied. The materials discussed include carbon nanotubes, zeolites, magnetic oxides, hybrid nanomaterials, and composite materials. Furthermore, the correlation between material properties and their performance in wastewater treatment technologies is highlighted. Nanomaterials have the ability to function either as adsorbents, flotation adjuvants, or as catalysts in industrial wastewater treatment technologies.The performance of these nanomaterials was systematically investigated from the perspective of adsorption or catalys kinetics.

Keynote Speaker

Suriani MAT JUSOH, PhD

Associate Professor Dr. Eng.
Head of Programme, Maritime Technology and Naval Architecture
Faculty of Ocean Engineering Technology, Universiti Malaysia Teregganu, MALAYSIA

M.J. Suriani is an Associate Professor in composite materials at Universiti Malaysia Terengganu (UMT), Malaysia. She obtained her B.Eng. (2001), MSc (2007), and PhD in Materials Engineering (2012) from Universiti Putra Malaysia (UPM). Her research focuses on natural fibre composites, delamination and manufacturing defects, hybrid composites, materials selection, and corrosion inhibition using natural compounds. She has published extensively in international journals, books, and conference proceedings, particularly on defects in natural fibre composites. Dr. Suriani is a registered Professional Engineer (Ir.) with the Board of Engineers Malaysia (BEM) and a Professional Technologist with the Malaysian Board of Technologists (MBOT). She has over 20 years of teaching experience, applying modern pedagogical approaches aligned with 21st-century and Industry 4.0 education. She received the UMT Excellent Teaching and Learning Award (Engineering & Technology Cluster) in 2017 and 2019. She is actively involved in innovation exhibitions, receiving Gold Medals and Special Awards (2013–2025), serves as a reviewer for Q1 Scopus-indexed journals and conferences, and has been Content Editor of the UMT Journal of Undergraduate Research since 2018. She is an active researcher, leading and contributing to multiple funded projects.

DEVELOPMENT OF GREEN HYBRID COMPOSITE AUTONOMOUS SURFACE VEHICLE SEARCHING BOAT

Environmental awareness is increasingly shaping the composite boat industry, driving the adoption of sustainable materials such as Woven Kenaf hybrid composites to replace non-biodegradable, costly synthetics and improve energy and resource efficiency. This shift supports green manufacturing while addressing broader challenges like climate change and its impact on aquatic ecosystems. Conventional environmental monitoring methods remain limited, expensive, and sometimes hazardous. Autonomous Surface Vehicles (ASVs) offer a cost-effective and safe alternative for continuous data collection. This research proposes a local Unmanned Surface Vehicle (USV) prototype using Woven Kenaf hybrid composites, bridging technological innovation with environmental stewardship and expanding ASV applications beyond military and maritime domains. The autonomous boat enhances safety, reduces human error and operational costs, and improves fuel and space efficiency. The study pursues three objectives: developing a high-speed Woven Kenaf hybrid composite hull, constructing an ASV prototype, and evaluating system integration and performance.

Invited Speaker

Nermin DEMIRKOL, PhD

Associate Professor PhD
Department of Ceramics, Faculty of Fine Arts, Kocaeli University, TÜRKIYE

Nermin Demirkol received her B.Sc. in Ceramic Engineering from Dumlupınar University (2001), M.Sc. from Gebze Institute of Technology (2004), and Ph.D. from İstanbul Technical University (2013), Türkiye. Since 2004, she has widely presented and published on the production and characterization of ceramic materials across numerous countries. She has an extensive record of SCI-indexed publications and received a Scientific Achievement Award from Kocaeli University in 2011. Her biography was included among World Successful Scientists (Marquis Who's Who, UK, 2014), and she was listed in the TOP 100 Engineers by a UK-based biography center in 2015. She is a board member of the Biomaterials and Tissue Engineering Society (BTES) and the Clay Sciences Society, and a member of several professional organizations, including the Turkish Ceramic Society, European Ceramic Society (ECerS), International Society for Ceramics in Medicine (ISCM), and the European Society for Biomaterials (ESB). She has served as chair and scientific committee member in numerous international events. Her research focuses on traditional ceramics, bioceramic composites, 3D printing, waste reutilization in ceramics, and glazes. She is actively involved in national and international projects and is currently Associate Professor at Kocaeli University, Faculty of Fine Arts, Department of Ceramics.

THE CIRCULAR RAW MATERIAL POTENTIAL OF IZMIT GULF BOTTOM SEDIMENT : CERAMICS, GLASS AND ENAMEL APPLICATIONS

Seabed sediments accumulated from industrial and urban activities pose environmental risks but also offer potential as secondary raw materials. This invited talk explores the use of İzmit Gulf bottom sediments as substitutes for ceramic, glass, and enamel applications within a circular economy framework. Mineralogical and chemical analyses reveal clays, silica, feldspars, and metal oxides, highlighting their suitability for ceramic bodies, glass formulations, and enamel coatings. The presentation examines shaping behavior, firing performance, and mechanical properties of sediment-based ceramics, along with melting behavior, coloration, and surface characteristics in glass and enamel systems. Overall, the results show that İzmit Gulf sediments can be converted into value-added materials through proper pre-treatment and formulation, supporting both environmental remediation and local circular raw material supply chains.

Invited Speaker

Anca Daniela RAICIU, PhD

Assoc. Prof. PhD Pharm
Faculty of Pharmacy Titu Maiorescu University, Bucharest, ROMANIA

Anca Daniela Raiciu, chemist and pharmacist, is a tenured faculty member at the Faculty of Pharmacy, Titu Maiorescu University, where she teaches courses in pharmacognosy, phytochemistry, phytotherapy, dermatopharmacy, cosmetology, pharmaceutical marketing and management, as well as ethics and academic integrity. She holds a PhD in Pharmaceutical Sciences and has an outstanding academic and research activity, being the author of numerous scientific papers in the fields of pharmacognosy and phytotherapy. She has participated in multiple national and international conferences and has supervised 89 undergraduate theses in her areas of expertise. She is the author of several invention patents and has been responsible for numerous research projects in the field of natural products and medicinal plants. Professionally, she serves as Logistics & Sales Director at Hofigal Export-Import S.A. and is President of the Planta Romanica Employers' Association. She is also a member of the Technical Committee for Medicinal and Aromatic Plants and Beekeeping Products within the Ministry of Agriculture and Rural Development (MADR). She has completed hospital management training and is a TÜV-certified GMP auditor, actively contributing to quality assurance standards in the pharmaceutical field. She is also involved in scientific editorial activity, serving as Guest Editor for the journal Gels (MDPI).

LIPOSOMAL MICROBIAL INULINASE FOR CONTROLLED RELEASE AND METABOLIC HEALTH APPLICATIONS

Advanced liposomal nanosystems incorporating microbial inulinase are increasingly explored as platforms for preventing and managing metabolic disorders. Inulinase (EC 3.2.1.7) hydrolyzes β-2,1 fructan linkages in inulin, producing fructose and fructooligosaccharides with recognized prebiotic and metabolic benefits. Microbial sources such as Kluyveromyces, Aspergillus, and Penicillium exhibit high enzymatic efficiency under optimized fermentation conditions, influenced by aeration, agitation, and substrate composition. Advances in pharmaceutical nanotechnology highlight liposomes and hydrogels as complementary delivery systems that enhance stability, bioavailability, and controlled release of bioactives. Hybrid liposome–hydrogel platforms further improve intestinal permeability, reduce burst release, and increase systemic exposure. The integration of enzymatic biotechnology with nanostructured delivery systems thus represents a promising strategy for functional nutraceuticals targeting metabolic balance and personalized therapies.


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SECTION 1

SYNTHESIS AND CHARACTERIZATION OF MATERIALS

New Hybrid Antitumor Systems Based on Lanthanide-Functionalized Zinc Oxide Nanoparticles

Aurel TABACARU[1,*], Mariana BUSILA[1], Mihaela DRAGOI CUDALBEANU[2], Ionela AVRAM[3], Ana-Maria MOROSANU[4], Sergiu SHOVA[5]

[1]„Dunărea de Jos" University of Galați, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
[3]University of Bucharest, Romania
[4]Institute of Biology, Romanian Academy, Bucharest, Romania
[5]„Petru Poni" Institute of Macromolecular Chemistry, Iasi, Romania

[*]aurel.tabacaru@ugal.ro

Abstract. Zinc oxide nanoparticles (ZnO NPs) have attracted increasing attention due to their intrinsic cytotoxicity toward tumor cells, reactive oxygen species (ROS) generation capability and favorable biocompatibility profile. However, their therapeutic performance can be further enhanced through rational surface functionalization. This work reports the synthesis, physicochemical characterization and antitumor properties of new hybrid systems based on ZnO NPs functionalized with selected lanthanide complexes. Preliminary biological studies suggest that such hybrid systems exhibit enhanced cytotoxicity against lung (A549), prostate (PC3), liver (HEP-G2) and cervical (HeLa) tumoral cell lines. The results highlight the potential of lanthanide-functionalized ZnO NPs as versatile platforms for the development of next-generation antitumor nanomaterials. The study provides a solid foundation for further biological evaluation and optimization of hybrid inorganic–organic systems for oncological applications.

Keywords: zinc oxide nanoparticles, lanthanide complexes, hybrid nanomaterials, surface functionalization, antitumor systems.

Acknowledgments: This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS – UEFISCDI, project number PN-IV-P2-2.1-TE-2023-1242, within PNCDI IV, contract no. 100TE/03.01.2025.

Antifungal Effects of Essential Oils for Preservation of Natural Cotton Textiles

Cristina PASCAL[1,*], Sergiu SCUTARU[2], Irina-Niculina CRISTIAN[1]

[1]„Gheorghe Asachi" Technical University of Iași, Faculty of Industrial Design and Business Management, 29 Dimitrie Mangeron Blv, RO-700050, Iași, Romania
[2]Moldova National Museum Complex of Iași, 1 Ștefan cel Mare și Sfânt Square, RO-700028, Iași, Romania

[*]cristina.pascal@student.tuiasi.ro

Abstract. This research investigates the antifungal activity of oregano (Origanum vulgare), basil (Ocimum basilicum), and rosemary (Rosmarinus officinalis) vapors of essential oils on cotton fabrics. Cotton testing material, was initially contaminated with fungal proliferation and covered at a certain distance with polyester fabric sprayed with 1 ml essential oils. The samples were exposed to a microclimate similar to that in museums (temperature 18-220C, relative humidity 45-65%) and inspected at regular intervals. After a period of 16 days, oregano oil developed the most extensive fungal inhibition zone, acting on the samples exclusively through gradual evaporation. The samples were washed, dried and stored in boxes with identical cover (polyester fabric sprayed with 2 ml essential oil) as in the previous step. After 7 months, the effect of essential oil vapors on the samples was evaluated using microscopy analysis which confirmed the absence of fungi on samples stored in continuous exposure to oregano oil vapors. The results provide a scientific foundation for the development of a functional multilayer fabric intended for making covers for storing cloth on hangers. Such textile covers with a middle layer impregnated with oregano essential oil could ensure long-term antifungal protection, with direct applications in preventive conservation systems for textile artifacts, representing a viable, safe, and sustainable alternative to conventional chemical treatments.

Keywords: textile conservation, essential oils, cotton fabric, textile artifact.

References:

[1] K. Matusiak, W. Machnowski, H. Wrzosek, J. Polak, K. Rajkowska, K. Smigielski, A. Kunicka-Styczynska. Application of Cinnamomum zeylanicum essential oil in vapour phase for heritage textiles disinfection. International Biodeterioration & Biodegradation 131 (2018) 88-96.

Biosynthetic Activity of Rhodotorula Gracilis CNMN-YS-03 and Rhodotorula Glutinis CNMN-YS-08 after Preservation and Long-Term Storage

Ludmila BALAN[1,*], Nina BOGDAN-GOLUBI[1]

[1]Institute of Microbiology and Biotechnology of Technical University of Moldova, 3/3 Academiei Street, MD-2028 Chisinau, Republic of Moldova

[*]ludmila.balan@imb.utm.md

Abstract. Carotenoids are natural pigments with extensive applications in the chemical, pharmaceutical, and food industries due to their antioxidant properties and their role as precursors of vitamin A. In the context of the increasing demand for natural and sustainable compounds, the biotechnological production of carotenoids has attracted considerable interest. Pigmented yeasts belonging to the genus Rhodotorula represent promising microbial platforms for carotenoid biosynthesis, while strain stability and the maintenance of biosynthetic capacity during preservation are critical aspects for the development of stable and reproducible industrial processes. To optimize the biotechnological production of carotenoids and other biochemical components, the strains R. gracilis CNMN-YS-03 and R. glutinis CNMN-YS-08 were reactivated after lyophilization and prolonged storage using different mannoprotein extracts – obtained from yeast residual biomass derived from beer and wine production processes. The reactivation of pigmented yeasts using mannoproteic extracts in the rehydration medium results in a significant increase in biomass productivity (by 10–40%) as well as in biosynthetic activity. These effects depend on the type and concentration of the extract used, as well as the characteristics of the strain analyzed. Under these conditions, carotenoid biosynthesis can increase by up to 45%. Furthermore, the carbohydrate content, particularly in the biomass of the R. gracilis CNMN-YS-03 strain, increases by 37.5%, and the protein content in the biomass of the R. glutinis CNMN-YS-08 strain increases by 29.4% compared to the control sample.

Keywords: conservation, Rhodotorula, biosynthetic activity, reactivation after lyophilization.

Acknowledgments: This study was supported by the research project for young researchers 25.80012.7007.16TC „Viability and productive potential of pigmented yeasts of the genus Rhodotorula – carotenoid producers, after long-term preservation", funded by National Agency for Research and Development.

Comparative Study of AlTiN and AlTiCrN Coatings Deposited by High-Power Impulse Magnetron Sputtering

Teodor Cezar CODAU[1,*], Jorge SANTOS[1], Ana V. GIRÃO[1], Daniel FIGUEIREDO[3], Cristina M. FERNANDES[3], Bruno GUIMARÃES[3], Filipe J. OLIVEIRA[1]

[1]CICECO, Universidade de Aveiro, Portugal,
[2]R&D Department, Palbit S.A., 3850-582 Branca, Albergaria-a-Velha, Portugal

[*]codau.teodor@ua.pt

Abstract. High-Power Impulse Magnetron Sputtering (HiPIMS) is a Physical Vapor Deposition (PVD) technique characterized by a highly ionized metal flux, enabling the deposition of dense, smooth, and well-adhered hard ceramic coatings. In this work, AlTiN and AlTiCrN coatings deposited by HiPIMS-PVD on WC–Co carbide substrates were comparatively investigated. SEM–EDS analysis confirmed the elemental composition and revealed continuous, dense microstructures free of visible pores or cracks in both coatings. These structural features resulted in high microhardness values (HV0.01 of 3316 for AlTiN and 3171 for AlTiCrN). XRD analysis revealed a dominant FCC B1 nitride phase with a strong {111} preferred orientation in both coatings, with texture coefficients of 1.96 for AlTiCrN and 1.70 for AlTiN. Surface topography and SEM morphology showed that AlTiCrN coatings were markedly smoother than AlTiN, exhibiting less extreme areal height distribution parameters. Under dry conditions, AlTiN exhibited lower friction but resulted in higher wear of the steel counterbody, whereas AlTiCrN formed compact, plate-like tribolayers with a central groove. Under lubricated conditions, both coatings exhibited a significant reduction in the friction coefficient and a transition to mixed lubrication after the running-in stage. However, AlTiCrN showed smoother stabilization and significantly reduced counterbody wear.

Keywords: HiPIMS-PVD, ceramic hard coatings, tribology.

Acknowledgments: This study was funded by the PRR – Plano de Recuperação e Resiliência and by the NextGenerationEU funds at Universidade de Aveiro, through the scope of the Mobilizing Project of the Innovation Green Agendas “Hi-rEV – Recuperação do Setor de Componentes Automóveis” (Project nº 64 with the application number C644864375-00000002) and within the scope of the project CICECO-Aveiro Institute of Materials, UID/50011 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC).

Corrosion Resistance of Titanium Implants under Redox Conditions in the Human Body

Luydmila ANGELOVA[1,*], Andriana SURLEVA[1], Darya ILIEVA[1], Dimka FACHIKOVA[1]

[1]University of Chemical Technology and Metallurgy, 8 "st. Kl. Ohridski" blvd., 1756 Sofia, Bulgaria

[*]lyudmila@uctm.edu

Abstract. Model studies on the corrosion resistance of metallic biocompatible implants include a series of analyses, part of which are related to the investigation of the implant surface, and another part to the quantitative determination of titanium in media simulating the conditions in the human body. Titanium alloys possess crystalline structures (α-Ti alloys and β-Ti alloys. However, since their surface is readily covered by a thin (a few nanometers) layer of TiO_2, which is predominantly amorphous or contains nanocrystalline inclusions of TiO_2, the implants remain chemically stable and highly corrosion resistant. Because implants are used in a relatively non-aggressive environment with pH around 7.5, and under inflammatory conditions at approximately pH=5–6, the standard reduction potential of the couple $TiO_2+2H^+ + 4e^- \rightleftharpoons Ti^{2+} + 2H_2O$ ($E°=-0.502V$) decreases with increasing pH from 5 to 7, leading to an increase in reducing ability. The corrosion of titanium alloys depends not only on pH, but also on the presence of oxidizing agents (H_2O_2, O_2^-, $OH\cdot$, HOCl) and reducing agents (vitamin C, cysteine, histidine, proteins such as albumin, NADH/NADPH), which can alter the redox potential of the surface layer and lead to an increased dissolution rate. In biological fluids of the human body, a dynamic redox balance exists, which determines the stability of the passive layer on the implant, the corrosion rate, and the release of metal ions. Therefore, it is important to investigate the reduction processes of the oxide layer.

Keywords: chemical analysis, corrosion, Ti alloys, redox reactions, biofluids.

Acknowledgments: The financial support of the Bulgarian National Science Fund throughout the project KP06 DO 02/7 dated on 14.12.2023 Cool&SmartTit" A new generation of metallic biomaterials as health solution for a sustainable life" in the frame of the ERANET, ERA-Mine3 program of EU is highly acknowledged.

Approaches for Evaluating Methods for the Quantitative Determination of Titanium in Simulated Human Fluids

Darya ILIEVA[1,*], Andriana SURLEVA[1],
Luydmila ANGELOVA[1], Dimka FACHIKOVA[1]

[1]University of Chemical Technology and Metallurgy, 8 "st. Kl. Ohridski" blvd., 1756 Sofia, Bulgaria

[*]ilieva_cnil@uctm.edu

Abstract. The investigation of the corrosion resistance of biocompatible metallic implants is a key aspect of their applicability. The quantitative determination of metals released from implants is mainly carried out using ICP-MS, ICP-OES, and UV–Vis spectrometric techniques, the latter being the least frequently used due to its higher limits of quantification, interference from other metal ions, and more complex sample preparation. Since the primary cause of corrosion in metallic implants is the redox environment, testing is typically conducted in media containing oxidizing or reducing agents at concentrations up to approximately 1 mM. The release of metal ions from titanium alloys strongly depends on pH, as well as on the presence of H_2O_2, fluorides, and proteins. Due to the varying matrix composition of model fluids simulating human body fluids and the low concentrations of released metals, it is important to evaluate and verify the limits of detection and quantification using methodological blank samples. It is also necessary to select an appropriate calibration model, to assess measurement precision in different matrices, and to determine the analytical recovery, to ensure comparability of results obtained from different model systems. Based on quantitative determinations over extended periods, an empirical relationship between concentration and time can be derived for each type of implant.

Keywords: instrumental analysis, verification of detection limits, matrix matching, Ti alloys, corrosion.

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Offset vs. Non-Offset 3D Warp Interlock Structures: A comparative Analysis of Geometrical Parameters in Para-Aramid Fabrics

Niki Vlad MANCASI[1,*], Irina Niculina CRISTIAN[1,*]

[1]Faculty of Industrial Design and Business Management, "Gheorghe Asachi" Technical University of Iasi, Blvd. Profesor Dimitrie Mageron no.29, 700050 Iasi Romania

[*]niki-vlad.mancasi@academic.tuiasi.ro; [*]irina-niculina.cristian@academic.tuiasi.ro

Abstract. In the global defense sector, the requirement for high-performance ballistic plates and body armor necessitates textile reinforcements that maximize energy absordption and dissipation while minimizing bulk. 3D warp interlock fabrics have become essential for these applications due to their integrated through-the-thickness binder yarns, which provide superior structural integrity. While the mechanical properties of para-aramid fibers are established, the internal geometric arrangementremains a critical, yet under-explored, variable in optimizing protective systems. This research presents a comparative structural analysis of six 3D A-TT (angle - through the thickness) warp interlock woven fabrics, focusing on the morphological differentiation between offset and non-offset positioning of the weft yarns inside the 3D structure. To ensure experimental precision, all samples were manufactured on a rapier loom using 1680 dTex (1000 filaments) para-aramid yarn in both directions (warp and weft). A constant warp density of 12 yarns/cm and a weft density of 28 yarns/cm were maintained across all variants. The study evaluates how the basic parameters of the 3D weave structures influence fundamental physical parameters like yarn ondulation degree, mass per unit area and the thickness of the woven fabrics. Structural characterization demonstrates that the offset architecture significantly enhances the nesting capability of the weft yarns, particularly when paired with an irregular Satin weave for warp binding, which acts as a "tongs-like" mechanism. This led to a marked reduction in fabric thickness, ranging from 1.26 mm in stacked structures down to 0.97 mm in offset variants. Additionally, warp crimp values were identified primarily between 4% and 5%, with specific stacked configurations allowing for values as low as 2.73%. These findings highlight the offset configuration as a superior design choice for engineering high-density, streamlined para-aramid preforms for advanced ballistic protection.

Keywords: 3D angle interlock, para-aramid, ballistic fabrics, offset vs non-offset 3D structure.

Influence of Synthesis Parameters on Structural and Antibacterial Properties of ZnO–Chitosan Nanocomposites

Miruna-Adriana IOTA[1,2,*], Madalina Laura URSARU[1], Ioan Albert TUDOR[1], Ana Maria MOCIOIU[1], Adriana-Gabriela SCHIOPU[2,3]

[1]National Research & Development Institute for Nonferrous and Rare Metals-IMNR, Biruintei Blvd. 178-184, Pantelimon, 077145 Ilfov, Romania
[2]Doctoral School Materials Science and Engineering, National University of Science and Technology POLITEHNICA Bucharest, Splaiul Independentei No. 313, Sector 6, 060042 Bucharest, Romania
[3]Faculty of Mechanics and Technology, Pitesti University Centre, National University of Science and Technology Politehnica Bucharest, 110040 Pitesti, Romania

[*]ilieva_cnil@uctm.edu

Abstract. ZnO–chitosan nanocomposites were synthesized using a hydrothermal method by varying the ZnO/chitosan mass ratio and treatment time, while maintaining constant temperature and pressure conditions. This approach enabled the investigation of the influence of synthesis parameters on the structural and functional properties of the materials. FTIR analysis revealed interactions between ZnO particles and the functional groups of chitosan, while XRD confirmed the formation of crystalline ZnO within the polymer matrix. The antibacterial activity was evaluated against selected microbial strains, showing enhanced performance for ZnO–chitosan composites. The results indicate that the variation of ZnO content and treatment time significantly influences both the structural characteristics and antimicrobial efficiency. These findings suggest that ZnO–chitosan nanocomposites are promising materials for applications in antimicrobial coatings and biomedical systems.

Keywords: ZnO, chitosan, nanocomposites, antibacterial activity, FTIR, XRD.

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Soft Magnetic Composite Based on Fe and NiFeMo Fibers with Ferrite-enhanced Dielectric Coatings

Bogdan Viorel NEAMŢU[1,2,*], Leó-Ede MÁRTON[1,2], Traian Florin MARINCA[1,2], Florin POPA[1,2], Calin Virgiliu PRICA[1,2], Ionel CHICINAS[1,2]

[1]Technical University of Cluj-Napoca, Materials Science and Engineering Department, 103-105, Muncii Avenue, 400641, Cluj-Napoca, Romania
[2]EUT+ Institute of Nanomaterials and Nanotechnologies-EUTINN, European University of Technology, European Union

[*]bogdan.neamtu@stm.utcluj.ro

Abstract. This research investigates the development and characterization of soft magnetic composite cores based on Fe and NiFeMo fibers, optimized for high-frequency applications. Magnetic cores were fabricated using polymeric matrices, with and without the addition of $FeMnZnO_4$ ferrite nanoparticles, and were subjected to dielectric coating and polymerization treatments. Static and dynamic magnetic measurements (up to 10 kHz) were performed using Remagraph-Remacomp equipment. Results show that Fe-based composites exhibit higher saturation induction, reaching $B_s \approx 1.68$ T and relative permeability $\mu_r \approx 1160$, compared to $B_s \approx 0.59$ T and $\mu_r \approx 593$ for NiFeMo-based composites. However, NiFeMo fibers, due to their higher intrinsic resistivity, maintain stable permeability up to 10 kHz, whereas Fe-based cores show a significant drop above 2 kHz due to eddy currents. Ferrite addition reduces dynamic losses (e.g., from 125 W/kg to 95 W/kg at 5 kHz for Fe-based samples) by improving inter-fiber insulation, though it slightly increases hysteresis losses. The findings demonstrate that NiFeMo-based composites are better suited for high-frequency applications, while Fe-based composites offer higher initial magnetic permeability and induction. The results highlight the influence of dielectric coatings and fiber composition on the performance of advanced magnetic composites.

Keywords: soft magnetic composite, fibres-based, Fe fibres, NiFeMo fibres, magnetic properties.

Microstructure–Electrochemical Correlation of Corrosion Behavior in AISI 316 and Duplex 2205 Stainless Steels in 3.5 wt.% NaCl Solution

Juan Carlos LOZANO-MEDINA[1,*], Carlos Jesús SANCHEZ-MORALES[1], Cristina JIMENEZ-MARCOS[2], Julia Claudia MIRZA-ROSCA[2]

[1]Department of Processing Engineering, University of Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain
[2] Department of Mechanical Engineering, University of Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain

[*]juancarlos.lozano@ulpgc.es

Abstract. The increasing demand for corrosion-resistant materials in desalination systems requires a deeper understanding of passive film stability in chloride-rich environments [1]. This study analyzes the microstructure–electrochemical correlation between AISI 316 and duplex 2205 stainless steels in a 3.5 wt.% NaCl solution using microstructural characterization, Vickers microhardness, and electrochemical techniques (OCP, polarization, and EIS). Results show that duplex 2205 exhibits higher hardness due to its ferrite–austenite structure, resulting in enhanced passive film stability. It presents more noble corrosion potentials, lower corrosion current densities, and higher charge-transfer resistance, indicating superior corrosion resistance. In contrast, AISI 316 shows localized degradation after polarization. This improved performance is attributed to the optimized duplex microstructure and the formation of a more stable and protective passive film. These results provide valuable insight into the structure–property relationship governing corrosion resistance, supporting the selection of duplex 2205 for desalination applications.

Keywords: duplex stainless steel, AISI 316, corrosion behavior, EIS, passive film, NaCl solution.

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Evaluation of Electrochemical Properties of Two CRT-D Samples in Simulated Body Fluid

Sofia SAKR-NASSEF[1,*], Diana TINT[2], Julia Claudia MIRZA-ROSCA[1,3], Juan Carlos LOZANO-MEDINA[4]

[1]Department of Mechanical Engineering, University of Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain
[2] Department of Surgical and Medical Specialties, Transilvania University of Brasov, Brasov, Romania
[3] Department of Materials Engineering and Welding, Transilvania University of Brasov, Brasov, Romania
[4] Department of Processing Engineering, University of Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain

[*]sofia.sakr101@alu.ulpgc.es

Abstract. A Cardiac Resynchronization Therapy Defibrillator (CRT-D) is designed for patients with heart failure who are at risk of sudden cardiac death. It functions both as a pacemaker and as a device that synchronizes ventricular contractions. The long-term performance and material characterization of such implantable devices are critical for ensuring their safety and compatibility. In this study, two explanted CRT-D devices made of commercially pure titanium, were analyzed after eight years of implantation. Using a portable XRF analyzer, the frames were determined to be made of commercially pure titanium and electrochemical testing in simulated body fluid assessed corrosion behavior. The results indicated a tendency toward passivation in both devices, demonstrating high electrochemical stability. Electrochemical impedance spectroscopy revealed a duplex passive layer, indicating effective corrosion protection. These findings underscore the durability of commercially pure titanium in cardiac implants and the importance of post-extraction electrochemical assessments in evaluating material performance over time.

Keywords: cardiac resynchronisation therapy defibrillator (CRT-D), corrosion, biomaterials, titanium.

UV-Assisted CO_2 Sensing Using Au-Functionalized TiO_2 Nanoparticles

Tudor BRANIȘTE[1,*], Tatiana GALATONOVA[1], Mircea NICOLAESCU[2], Carmen LAZAU[2], Cornelia BANDAS[2]

[1]National Center for Materials Study and Testing (CNSTM), Technical University of Moldova, 168 Ștefan cel Mare Blvd., Chișinău, MD-2004, Republic of Moldova
[2]National Institute of Research and Development for Electrochemistry and Condensed Matter (INCEMC), Str. Dr. A. Păunescu Podeanu, nr.144, Timişoara, Romania

[*]tudor.braniste@cnstm.utm.md

Abstract. The development of highly sensitive CO_2 sensors operating at low temperatures remains an important goal in gas detection research. In this work, the influence of UV illumination on the CO_2 sensing performance of undoped TiO_2 and Au-doped TiO_2 is investigated. Electrical measurements were performed under controlled exposure to CO_2 at room temperature under dark and UV illumination conditions. In the absence of UV light, undoped and Au-doped TiO_2 show negligible response, indicating limited surface reactivity at room temperature. Upon UV activation, undoped TiO_2 shows a response reaching 100 nA, with a slow response time. However, Au-doped TiO_2 demonstrates significantly improved sensing performance under UV illumination, with a CO_2 response of 175 nA and a significantly faster response time. The improvement is attributed to the synergistic effect between the UV-induced photogeneration of electron-hole pairs and the catalytic role of Au nanoparticles, which promote charge separation and facilitate surface redox reactions with CO_2 molecules. Overall, the results highlight the critical role of noble metal doping and UV activation in enhancing the sensitivity and dynamic response of TiO_2-based CO_2 sensors, enabling improved performance at low operating temperatures.

Keywords: TiO_2- AuQD, porous structure, CO_2 sensor.

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Influence of Gold Functionalization on the Alcohol Sensing Properties of TiO_2

Tatiana GALATONOVA[1,*], Mircea NICOLAESCU[2], Tudor BRANIȘTE[1], Carmen LAZAU[2], Cornelia BANDAS[2]

[1]National Center for Materials Study and Testing (CNSTM), Technical University of Moldova, 168 Stefan cel Mare Blvd., Chisinau, MD-2004, Republic of Moldova
[2]National Institute of Research and Development for Electrochemistry and Condensed Matter (INCEMC), Str. Dr. A. Paunescu Podeanu, nr.144, Timisoara, Romania

[*]galatonova.tatiana@cnstm.utm.md

Abstract. Titanium dioxide (TiO_2) is a promising material for gas sensing applications, although its sensitivity to ethanol at room temperature is limited. In this study, the sensing performance of pure and Au functionalized TiO_2 was comparatively evaluated under ambient conditions, with and without UV illumination. Undoped TiO_2 exhibits a weak response to ethanol at room temperature, characterized by a decrease in current upon exposure and incomplete recovery to the initial value, indicating limited sensitivity and poor reversibility. Under UV illumination, the sensor response improves, demonstrating improved current modulation, but unstable cyclic behavior, highlighting the role of photoactivation in promoting surface reactions. A significantly improved sensing performance is observed for Au functionalized TiO_2 under UV irradiation, with a larger response amplitude, faster response-recovery dynamics, and improved repeatability over successive ethanol exposure cycles. This improvement is attributed to the synergistic effect between UV-induced charge carrier generation and the catalytic activity of Au nanoparticles, which facilitate charge separation and enhance the ethanol adsorption and oxidation processes.

Keywords: TiO_2- Au, porous structure, alcohol sensor.

Acknowledgments: This research was funded by a grant from the Ministry of Research, Innovation and Digitization, project number PN-IV-P8-8.3-ROMD-2023-0227 within PNCDI IV.

Analysis of Surface Mechanical Properties Applied to Cobalt-based Biomaterials

Mirabela Georgiana MINCIUNA[1,2],
Petrica VIZUREANU[1,2*], Vlad CÂRLESCU[1],
Ioan Gabriel SANDU[1]

[1]"Gheorghe Asachi" Technical University of Iasi, Blvd. Mangeron, No. 51, 700050, Iasi, Romania
[2]Center of Excellence, Geopolymer & Green Technology (CeGeoGTech), School of Material Engineering, Universiti Malaysia Perlis (UniMAP), Perlis, Malaysia

[*]peviz2002@yahoo.ro

Abstract. This research presents the analysis of the surface mechanical properties applied to alloys from the CoCrMo system used in medical applications. The experimental evaluation was carried out by applying hardness and scratch tests, important methods for characterizing the contact behavior, considering the domain of use. Hardness determinations highlighted the resistance of biomaterials to local plastic deformation, and scratch tests allowed the investigation of the resistance to scratching, wear and progressive damage of the surface. The study confirms the importance of surface characterization in the selection and design process of modern biomaterials.

Keywords: CoCrMo alloys, hardness, scratch tests, medical applications.

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Microstructural Characterization of a Novel EAS Cu–Fe-based Composite Coatings Reinforced with WC and TiC - Obtained by EAS

Codrin-Dumitru CIRLAN[1], Edmond LEVARDA[1], Ana Alina MUNCILA[1]*, Eduard Ionut BAHNAREANU[2], Daniela-Lucia CHICET[1], Corneliu MUNTEANU[3], Stefan Lucian TOMA[1]

[1]"Gheorghe Asachi" Technical University of Iasi, Materials Engineering and Industrial Safety Department, No. 67 Prof. D. Mangeron Blvd., 700050, Iasi, Romania
[2] Nation University of Science and Technology POLITEHNICA Bucharest
[1]"Gheorghe Asachi" Technical University of Iasi, Faculty of Mechanics, No. 61–63 Prof. D. Mangeron Blvd., 700050, Iasi, Romania

*stefan-lucian.toma@academic.tuiasi.ro

Abstract. This study investigates the microstructural and mechanical properties of Cu–Fe-based composite coatings reinforced with WC and TiC particles and alloyed with Cr, Ni, B and Si, deposited on steel substrates by electric arc spraying (EAS). The coatings were characterized using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) to evaluate morphology, phase distribution and elemental composition. SEM observations revealed a typical lamellar structure with partially melted carbide particles uniformly distributed within the metallic matrix. EDS mapping confirmed the presence and distribution of Cu-, Fe-rich phases and carbide reinforcements, along with alloying elements. The microhardness of the coatings ranged between 384 - 862 HV0.1, depending on local composition and carbide concentration. Adhesion strength, assessed by pull-off, showed values of 38±14 MPa, indicating good bonding to the substrate. The porosity level, determined by image analysis, was found to be 8.5-12.2 %, consistent with typical arc-sprayed coatings. The results highlight the influence of carbide reinforcements and multicomponent alloying on the structural integrity and mechanical performance of the coatings. These composite layers show potential for applications requiring enhanced wear resistance and moderate antifriction behavior.

Keywords: arc spraying process, composites, adhesion.

Phosphate Conversion Coatings for Medical Applications – A Brief Review

Anca CAZAC[1], Diana-Petronela BURDUHOS-NERGIS[1], Alin-Marian CAZAC[1,*], Andreea BRIE[1], Andrei-Victor SANDU[1], Costica Bejinariu[1,2]

[1]Faculty of Materials Science and Engineering, Gheorghe Asachi Technical University of Iasi, 67 Dimitrie Mangeron str., 700050 Iasi, Romania
[2]Academy of Romanian Scientists, Ilfov 3, 050044, Bucharest, Romania

[*]alin-marian.cazac@academic.tuiasi.ro

Abstract. Phosphate chemical conversion (PCC) coatings have gained significant attention over the last decade as a versatile and efficient method for the surface modification of metallic implants, particularly magnesium (Mg), titanium (Ti), and their alloys. This paper provides a synthetic overview of recent progress in PCC coatings for medical applications, focusing on systems based on zinc (hopeite), calcium (brushite, hydroxyapatite), and emerging strontium-doped variants. The major interest in PCCs within the biomedical field stems from their demonstrated ability to control the rapid degradation rate of magnesium in body fluids, thereby preventing subcutaneous hydrogen gas accumulation and ensuring necessary mechanical support during the bone healing process. In the case of titanium, these coatings transform a bio-inert surface into a bioactive one, facilitating rapid osseointegration. Analysis of the deposition mechanisms highlights the critical role of process parameters—such as bath temperature, pH, and surface pretreatment—in controlling crystal morphology, crystallinity, and the density of the protective layer. As a simple, and cost-effective method, the phosphating process represents a superior alternative to toxic chromate treatments. In conclusion, while PCCs offer superior biocompatibility and adherence properties, future research must focus on long-term clinical studies to validate the stability and safety of these biomaterials in complex physiological environments.

Keywords: conversion coatings, chemical phosphating, implants, biocompatibility, osseointegration.

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Influence of Tantalum Content on the Biocompatibility of SLM-Processed Ti–Mo–Zr–Ta Alloys

Mădălina Simona BALTATU[1], Andrei PRUTEANU[1], Andrei Victor SANDU[1,2], Petrică VIZUREANU [1,2,*], Dragos Cristian ACHITEI [1], Manuela Cristina PERJU [1], Dumitru Doru BURDUHOS-NERGIS[1]

[1]"Gheorghe Asachi" Technical University of Iasi-Romania, Faculty of Science and Material Engineering, 41 Prof. D. Mangeron Blvd., 700050, Iasi, Romania
[2]Academy of Romanian Scientists, 54 Splaiul Independentei St., Sect. 5, 050094 Bucharest, Romania

[*]petrica.vizureanu@academic.tuiasi.ro

Abstract. Titanium-based alloys are extensively employed in orthopedic applications due to their excellent corrosion resistance, mechanical strength, and intrinsic biocompatibility. This study investigates the biocompatibility of three novel β-type titanium alloys—Ti15Mo7Zr5Ta, Ti15Mo7Zr10Ta, and Ti15Mo7Zr15Ta, fabricated using Selective Laser Melting (SLM). The use of SLM enables precise control over microstructure and porosity, which are critical factors in enhancing osseointegration. Microstructural analysis revealed a predominantly β-phase structure with refined grains, favorable for reducing the elastic modulus and improving cellular response. The presence of non-toxic β-stabilizing elements such as molybdenum, zirconium, and tantalum contributes to enhanced cytocompatibility and corrosion resistance. In vitro biocompatibility assessment indicated good cell adhesion, proliferation, and viability on all alloy surfaces, with improved biological performance observed for higher tantalum content. Additionally, the reduced elastic modulus (43–76 GPa) minimizes stress shielding effects, promoting better bone remodeling.

Keywords: titanium alloys, selective laser melting, biocompatibility, β-type titanium alloys, osseointegration, orthopedic implants.

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Preliminary Investigations on Biomedical Ti-Mo-Nb-Sn Alloys with Low Elastic Modulus

Petrică VIZUREANU[1,2,*], Madalina Simona BALTATU[1], Andrei PRUTEANU[1], Andrei Victor SANDU[1,2], Dragos Cristian ACHITEI[1], Manuela Cristina PERJU[1], Dumitru Doru BURDUHOS-NERGIS[1]

[1]"Gheorghe Asachi" Technical University of Iasi-Romania, Faculty of Science and Material Engineering, 41 Prof. D. Mangeron Blvd., 700050, Iasi, Romania
[2] Academy of Romanian Scientists, 54 Splaiul Independentei St., Sect. 5, 050094 Bucharest, Romania

[*]petrica.vizureanu@academic.tuiasi.ro

Abstract. Titanium alloys are employed in various industries, notably the medical industry, for which their low elastic modulus, excellent strength-to-weight ratio, and biocompatible nature make them promising candidates. The role of alloying elements in stabilizing the β-phase and suppressing the formation of brittle phases is discussed. The results indicated that the increase of Nb and Sn enhances β-phase stability with the inhibition of the formation of brittle α″ and ω phases, improving ductility and lowering the elastic modulus, while Mo contents act as another phase stabilizing element that improves biocompatibility and corrosion resistance. Preliminary biocompatibility considerations, as seen from complementary studies on Ti alloys containing a combination of Mo, Nb, Sn, or other elements, showcase potential suitability for biomedical applications, especially thanks to the absence of cytotoxic elements and favorable surface characteristics. Mechanical compatibility is also improved in comparison to conventional Ti alloys containing Al and V, retaining yield strength while offering a lower elastic modulus.

Keywords: titanium alloys, biomedical implants, mechanical properties, biocompatibility.

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Morphological, Structural, and Topographical Characterization of TiO_2 Thin Films Deposited on PET Substrates

Tatiana USATII[1], Marius PETCU[1,*],
Elena MATCOVSCHI[1], Vasile TIRON[2],
Mihai BERNEVIG[1], Monica LOHAN[1],
Gheorghe BADARAU[1], Ștefan Lucian TOMA[1]

[1]"Gheorghe Asachi" Technical University of Iasi, Materials Engineering and Industrial Safety Department, No. 67 Prof. D. Mangeron Blvd., 700050, Iasi, Romania

[*]stefan-lucian.toma@academic.tuiasi.ro

Abstract. Thin TiO_2 films decorated with Ag nanoparticles have attracted increasing attention due to their tunable surface properties and potential applications in surface engineering and functional coatings. In this study, the morphological, structural, and compositional characteristics of Ag-decorated TiO_2 thin films were systematically investigated using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), atomic force microscopy (AFM), X-ray diffraction (XRD), and profilometry. SEM analysis revealed a relatively uniform TiO_2 matrix with dispersed nanoscale features attributed to Ag nanoparticles. EDS mapping confirmed the presence and spatial distribution of Ti, O, and Ag, indicating a heterogeneous dispersion of silver at the surface. XRD results indicated the predominance of the anatase phase, with no distinct Ag-related peaks, suggesting a fine dispersion and/or low concentration of Ag nanoparticles. AFM investigations showed that the incorporation of Ag significantly influences surface topography, leading to an increase in surface roughness (Sa = 18-37nm), associated with nanoparticle density and distribution. Profilometric measurements indicated a film thickness in the range of 60 -180 nm, with good uniformity across the analyzed area. The combined results highlight that Ag nanoparticle decoration modifies the surface texture and microstructural organization of TiO_2 thin films. These findings provide insight into the structure–surface relationship in TiO_2/Ag systems and support their optimization for advanced functional applications.

Keywords: TiO_2/Ag, nanoparticles, functional coatings.

Advanced Biomaterials in Implant-Prosthetic Therapy: Innovations and Clinical Implications

Norina Consuela FORNA[1,*], Doriana AGOP-FORNA[1]

[1]Prof. Univ.Dr. Faculty of Dental Medicine, University of Medicine and Pharmacy "Grigore T. Popa", Iasi, Romania

[*]profforna@gmail.com

Abstract. Recent developments in biomaterial science have significantly increased the predictability of implant-supported rehabilitations. High-strength ceramics such as zirconia, surface-modified titanium, bioactive coatings, and hybrid composite materials contribute to improved osseointegration, mechanical resistance, and aesthetic outcomes. Particular attention is given to the interaction between biomaterials and peri-implant tissues, including aspects related to biocompatibility, surface micro- and nanotopography, and bacterial adhesion. The integration of digital workflows, including CAD/CAM technologies, enables precise fabrication of customized prosthetic components using advanced materials adapted to individual clinical scenarios. Key clinical considerations such as load distribution, wear resistance, and soft tissue stability are closely linked to material selection. In addition, emerging directions—such as nanostructured surfaces, biofunctionalization, and smart biomaterials—are analyzed for their potential to enhance tissue regeneration and reduce biological and mechanical complications. Evidence from recent clinical studies supports the development of optimized treatment protocols based on advanced biomaterials. In conclusion, the selection and appropriate use of advanced biomaterials remain essential for achieving functional, aesthetic, and long-term success in implant-prosthetic rehabilitation.

Keywords: biomaterials, implantology, prosthetics, biological, biomechanical.

Wear Resistance of Low-E Glass Coatings

Daniela Lucia CHICET[1], Vlad CARLESCU[2,*], Marcelin BENCHEA[2], Gelu IANUS[2], Ana TUFESCU[2,*], Rodica-Mihaela BALAN[2]

[1]"Gheorghe Asachi" Technical University of Iasi, Faculty of Materials Science and Engineering, Blvd. Mangeron, No. 41,700050, Iasi, Romania
[2]"Gheorghe Asachi" Technical University of Iasi, Faculty of Mechanical Engineering, Blvd. Mangeron, No. 61, 700050, Iasi, Romania

[*]vlad.carlescu@academic.tuiasi.ro; [*]ana.tufescu@academic.tuiasi.ro

Abstract. Low-emissivity (low-E) coatings based on ultra-thin layers embedded in dielectric multilayer stacks are widely used in energy-efficient architectural glazing. Although these coatings are typically protected within insulating glass units, they remain susceptible to surface damage during handling, edge-processing and routine cleaning operations involving textile materials. This paper investigates the wear behaviour of the thin functional layers deposited on three commercial Ag-based low-E glasses (F9, V1 and V5) subjected to dry linear friction using a microtribometer and five different textile counter-surfaces: a rough sponge (A), a felt cloth (B), a microfibre cloth (C), a velvet fabric (D) and a professional window-cleaning cloth (E). The textile abrasives were selected to represent a range of surface roughness and asperity characteristics encountered in practical cleaning scenarios. All tests were performed without lubrication, under controlled normal load and sliding conditions. The resulting wear tracks were systematically examined by optical stereomicroscopy using a NexiusZoom instrument at 55x magnification to characterize the nature, extent and morphology of surface damage. Results reveal that the degree of coating degradation is strongly dependent on both the textile abrasive type and the specific low-E product, with the rough sponge (A) inducing the most severe damage and the microfibre (C) and velvet (D) producing comparatively minor surface alterations. Among the three glass samples, F9 consistently exhibits the highest resistance to surface degradation across all textile types, while V1 shows the greatest susceptibility to wear, in agreement with the adhesion hierarchy previously established by micro-scratch testing. The findings provide practical guidance for the selection of appropriate cleaning materials for low-E glazing and highlight the importance of textile surface texture in determining coating durability under realistic service conditions.

Keywords: Low-E glass, thin films, linear friction, textile abrasives, wear, optical microscopy, cleaning.

Influence of Substrate Type on the Quality of Layers Obtained by LIPPS

Madalin FARCAS[1], Daniela Lucia CHICET[2,*], Daniel CRISTISOR[1], Fabian LUPU[1], Bogdan ISTRATE[1], Corneliu MUNTEANU[1,3,*]

[1]"Gheorghe Asachi" Technical University of Iasi, Faculty of Mechanical Engineering, Blvd. Mangeron, No. 61, 700050, Iasi, Romania
[2]"Gheorghe Asachi" Technical University of Iasi, Faculty of Materials Science and Engineering, Blvd. Mangeron, No. 41, 700050, Iasi, Romania
[3]Technical Sciences Academy of Romania, 26 Dacia Blvd, Bucharest, 030167, Romania

[*]daniela-lucia.chicet@academic.tuiasi.ro

Abstract. The research investigates the influence of polymer substrate type on the quality of layers obtained by LIPPS (Laser-Induced Powder Polymer Surface impregnation), a innovative technique based on laser-assisted superficial impregnation of ceramic and metallic powders. The experimental set included polymer substrates made of PLA, ABS, PET-G and PA6 (printed both at 0° and 45°), coated with chromium oxide (Cr_2O_3) ceramic powder and NiCr metallic powder. The powders were applied onto the polymer surface and subsequently processed by localized laser-induced superficial melting, using the laser module of a Snapmaker 2.0 Modular 3-in-1 A250T system. The quality of the obtained layers was evaluated by macroscopic (Nexius Zoom Stereomicroscope) and microscopic analysis (Quattro C FE-SEM), considering the degree of surface coverage, layer continuity, impregnation uniformity and the aspect of contact between powder particle and substrate. The results showed a surface coverage degree above 80% for the investigated experimental variants. However, the samples impregnated with ceramic powder showed local fixing difficulties, especially on PET-G and PA6 substrates, where isolated uncovered or insufficiently impregnated areas were observed. In contrast, NiCr powder led to more uniform and continuous layers on the analyzed polymer substrates. The comparison between samples printed at 0° and 45° did not indicate significant differences in the impregnation degree or in the general appearance of the layers. The results indicate that substrate type influences the local quality and continuity of the surface layer.

Keywords: LIPPS, polymer substrates, superficial impregnation, laser-assisted superficial melting, Cr_2O_3 powder, NiCr powder, surface coverage.

Current Trends in 3D-Printed Dental Crown Frameworks

Gabriela NASTASACHE (STAN)[1], Daniela Lucia CHICET[2,*], Petru TRIFAUTANU[1], Bogdan ISTRATE[1], Corneliu MUNTEANU[1,3]

[1]"Gheorghe Asachi" Technical University of Iasi, Faculty of Mechanical Engineering, Blvd. Mangeron, No. 61, 700050, Iasi, Romania
[2]"Gheorghe Asachi" Technical University of Iasi, Faculty of Materials Science and Engineering, Blvd. Mangeron, No. 41, 700050, Iasi, Romania
[3]Technical Sciences Academy of Romania, 26 Dacia Blvd, Bucharest, 030167, Romania

[*]daniela-lucia.chicet@academic.tuiasi.ro

Abstract. The research reviews the current state of 3D-printed materials used for dental crown frameworks, with emphasis on their clinical relevance, manufacturing accuracy and mechanical performance. Additive manufacturing has become an important component of digital prosthetic dentistry, offering a personalized and efficient alternative to conventional lost-wax casting and subtractive CAD/CAM milling. The review analyzes polymeric materials such as PMMA and PEEK, ceramic materials such as zirconia and lithium disilicate, and metallic materials including Co-Cr alloys and titanium. These materials are processed through different additive techniques, including stereolithography, digital light processing, selective laser sintering, selective laser melting and fused deposition modeling. The available data indicate that 3D printing can provide clinically acceptable dimensional accuracy, satisfactory mechanical properties and improved workflow efficiency for dental crown frameworks. SLA and DLP are especially relevant for resin and ceramic restorations, while SLS and SLM are suitable for metallic frameworks with good marginal adaptation. However, the technique still presents limitations related to post-processing requirements, sintering shrinkage, material-dependent mechanical behavior and the lack of long-term clinical evidence. Further research is required to standardize fabrication protocols and validate the clinical performance of fully 3D-printed dental restorations.

Keywords: 3D printing, dental crown frameworks, additive manufacturing, zirconia-based ceramics, high-performance polymers, cobalt-chromium alloys, digital workflow.

3D-Printed Resin Orthodontic Brackets: A Systematic Review of Mechanical Performance

Bianca SOPRON[1], Husam SOBOH[1], Daniela Lucia CHICET[2,*], Madalina CIORNEI[1], Georgeta ZEGAN[1]

[1]"Gr.T.Popa" U.M.Ph., Faculty of Dentistry, Department of Surgical Disciplines, Orthodontics, Universității Street, no.16, 700115, Iasi, Romania
[1]"Gheorghe Asachi" Technical University of Iasi, Faculty of Mechanical Engineering, Blvd. Mangeron, No. 61, 700050, Iasi, Romania

[*]daniela-lucia.chicet@academic.tuiasi.ro

Abstract. This systematic review analyzes the mechanical performance of orthodontic brackets fabricated from photopolymerizable resins using additive manufacturing technologies. The study focuses on the clinical relevance of stereolithography, digital light processing and LCD/MSLA printing for the production of resin-based brackets, with particular attention to commercially available materials such as Permanent Crown Resin, Biomed Clear and Graphy Tera Harz TC-85/TC-85DAC. The review evaluates the influence of resin type, printing parameters and post-processing protocols on the final mechanical behavior of printed brackets. The main analyzed properties include flexural strength, elastic modulus, surface hardness, slot dimensional accuracy, torque transmission, frictional resistance, fracture toughness, shear bond strength, surface roughness and wettability. Compared with conventional metallic and ceramic brackets, photopolymerizable resin brackets present advantages related to customization, aesthetics and digital workflow integration, but also show important mechanical limitations. These include lower elastic modulus, higher dimensional variability of the bracket slot, potential plastic deformation of wings under ligature loading and sensitivity to post-curing conditions. Thermocycling, surface aging and incomplete polymerization may further influence frictional behavior, color stability, biocompatibility and long-term clinical reliability. Current evidence indicates that additive manufacturing can support the development of individualized orthodontic brackets, but further standardized in vitro testing and longitudinal in vivo studies are required to validate their mechanical stability and clinical performance.

Keywords: photopolymerizable resin brackets, additive manufacturing, orthodontic brackets, mechanical properties, torque transmission.

Cobalt-Based Alloys in Orthopedic Applications: Performance, Challenges, and Directions

Mihai TOFAN[1], Madalina Simona BALTATU[1,*], Andrei PRUTEANU[1], Andrei Victor SANDU[1,2,3], Ioan Gabriel SANDU[1], Mirabela Georgiana MINCIUNA[1], Petrica VIZUREANU[1,2,4,*]

[1]"Gheorghe Asachi" Technical University of Iasi, Faculty of Materials Science and Engineering, Iași, Romania
[2]Academy of Romanian Scientists, 54, Spaliul Independenței St., Sect. 5, 050094, Bucharest, Romania
[3]Romanian Inventors Forum, Str. Sf. P. Movila 3, Iași, Romania
[4]Technical Sciences Academy of Romania, 26 Dacia Blvd., 030167 Bucharest, Romania

[*]petrica.vizureanu@academic.tuiasi.ro;[*]madalina-simona.baltatu@academic.tuiasi.ro

Abstract. Metallic biomaterials are essential in orthopedic applications for restoring the biomechanical function of the skeletal system, requiring a balance between mechanical strength, wear resistance, biocompatibility, and long-term stability in physiological environments. Among these, cobalt-based alloys—particularly those in the Co–Cr–Mo system—are widely used in high-load orthopedic components due to their excellent mechanical and tribological performance. Cobalt-based alloys exhibit high strength, very good wear resistance, and reliable fatigue behavior, making them suitable for demanding applications such as joint prostheses and articulating surfaces. Their resistance to corrosion and combined tribocorrosion effects contributes to their durability in biological environments. However, these materials also present several limitations, including a high elastic modulus that may lead to stress shielding, relatively high density, and the potential release of metal ions, which can influence the biological response. Material development is therefore focused on improving the performance of cobalt-based alloys through compositional optimization, microstructural refinement, and surface modification techniques. These approaches aim to reduce ion release, improve biocompatibility, and enhance surface behavior without compromising mechanical integrity. As a result, cobalt-based alloys remain key materials for orthopedic implants, with ongoing research directed toward increasing their safety and long-term performance.

Keywords: cobalt-based alloys, Co–Cr–Mo; orthopedic implants, wear resistance, biocompatibility, mechanical properties, corrosion, stress shielding.

Influence of Key Alloying Elements on the Microstructure and Properties of Titanium Alloys

Ion GHICULESCU[1], Madalina Simona BALTATU[1,*], Andrei PRUTEANU[1], Andrei Victor SANDU[1,2,3], Manuela PERJU[1], Petrica VIZUREANU[1,2,4]

[1]"Gheorghe Asachi" Technical University of Iasi, Faculty of Materials Science and Engineering, Iași, Romania
[2]Academy of Romanian Scientists, 54, Spaliul Independenței St., Sect. 5, 050094, Bucharest, Romania
[3]Romanian Inventors Forum, Str. Sf. P. Movila 3, Iași, Romania
[4]Technical Sciences Academy of Romania, 26 Dacia Blvd., 030167 Bucharest, Romania

[*]madalina-simona.baltatu@academic.tuiasi.ro

Abstract. Titanium and its alloys are of significant interest for advanced engineering and biomedical applications due to their high strength-to-weight ratio, excellent corrosion resistance, and outstanding biocompatibility. Their properties are strongly governed by the type and concentration of alloying elements, particularly those that stabilize the β phase. In contrast to the α phase, which exhibits a hexagonal close-packed (HCP) structure, the β phase has a body-centered cubic (BCC) structure, whose thermodynamic stability is controlled by alloy chemistry. Molybdenum, niobium, and tantalum act as strong β-stabilizing elements, being fully soluble in titanium and effectively lowering the β-transus temperature as their concentration increases. Zirconium, although generally considered neutral with respect to phase stabilization, plays an important role in microstructural refinement and contributes to enhanced mechanical strength and corrosion resistance. Metastable β-type titanium alloys are capable of retaining the β phase after rapid cooling; however, this phase may undergo transformations during aging or under applied mechanical stress. Increasing the content of β stabilizers generally improves yield strength, hardenability, and formability, although excessive additions may negatively affect ductility and fracture toughness. Through careful control of alloy composition and appropriate thermomechanical processing, the microstructure and phase distribution can be tailored to meet specific application requirements. Owing to their favorable combination of mechanical and functional properties, titanium alloys alloyed with Mo, Zr, Ta, and Nb are widely used in aerospace, automotive, and biomedical implant applications.

Keywords: Biomaterials, elastic modulus, β-titanium alloys.

Geopolymers: Processing, Characterization, and Recent Developments

Alexandru Codrut PERUC[1], Dumitru-Doru BURDUHOS-NERGIS[1], Cristina-Manuela PERJU[1], Madalina-Simona BALTATU[1], Dragos-Cristian ACHITEI[1], Petrica VIZUREANU[1,2,3], Andrei-Victor SANDU[1,2,4,*]

[1]Faculty of Materials Science and Engineering, "Gheorghe Asachi" Technical University of Iasi, 67 Prof. D. Mangeron Blvd., 700050 Iasi, Romania
[2]Academy of Romanian Scientists (AORS), 54 Splaiul Independentei St., Sector 5, 050094 Bucharest, Romania,
[3]Technical Sciences Academy of Romania, 26 Dacia Blvd., 030167 Bucharest, Romania
[4]Romanian Inventors Forum, 3 Sf. Petru Movila St., L11, III/3, 700089 Iasi, Romania

[*]andrei-victor.sandu@academic.tuiasi.ro

Abstract. The construction materials industry, particularly the cement sector, faces increasing pressure to reduce CO_2 emissions, energy consumption, and environmental impact, as conventional Portland cement production is highly energy-intensive and carbon-emitting. Consequently, the development of sustainable, low-carbon alternatives has become a major research priority. In this context, geopolymers and alkali-activated materials have emerged as viable substitutes for traditional binders, offering reduced environmental impact while maintaining competitive mechanical and durability properties. These materials are synthesized through the alkaline activation of aluminosilicate precursors such as fly ash, slag, metakaolin, and other industrial by-products, supporting circular economy principles through waste valorization. Geopolymer processing involves dissolution, polycondensation, and the formation of three-dimensional aluminosilicate networks, with key parameters—such as activator type, Si/Al ratio, curing conditions, and water content—governing reaction kinetics and final properties. Recent developments focus on improving production consistency, scalability, and long-term durability, while expanding applications in sustainable construction. Although challenges related to raw material variability and standardization persist, geopolymers remain a promising class of eco-friendly materials capable of partially or fully replacing conventional cement-based systems.

Keywords: geopolymers, eco-friendly materials, sustainable buildings.

Correlation Between Structure and Electrical Behavior in ZnO–Containing Vanadate Glasses

Tina TASHEVA[1,*], Ondrej BOŠÁK[2], Marian KUBLIHA[2]

[1]University of Chemical Technology and Metallurgy, 8 Kliment Ohridski blvd., 1797 Sofia, Bulgaria
[2]Faculty of Materials Science and Technology, Slovak University of Technology, Bottova 25, 917 24 Trnava, Slovakia

[*]tina.tasheva@uctm.edu

Abstract. Vanadium-based oxide glasses exhibit semiconducting behavior, typically governed by small polaron hopping between vanadium ions of different valence states. Their structural and electrical properties can be effectively tuned through the incorporation of additional metal oxides. In this work, the ZnO–BaO–V_2O_5 glass system was studied as a function of the ZnO/V_2O_5 ratio in order to clarify the relationship between composition, structure and charge transport. Spectroscopic investigations reveal that increasing ZnO content promotes the formation of new structural units involving VO_4 and VO_5 polyhedra, accompanied by modifications in V–O–V linkages and network connectivity. These structural changes influence the compactness and degree of polymerization of the glass matrix. Electrical characterization based on temperature-dependent DC and AC conductivity measurements, together with impedance and electric modulus spectroscopy, shows that ZnO concentration has a significant effect on conductivity and dielectric relaxation behavior. The obtained results highlight the close correlation between glass structure and transport mechanisms, emphasizing the potential of ZnO–BaO–V_2O_5 glasses for functional electronic applications.

Keywords: vanadate glasses, heavy metal glasses, impedance spectroscopy.

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The Potential of Ultra-High-Molecular-Weight Polyethylene in Metakaolin-Based Geopolymer for Heavy Metal Adsorption: A Review

Muhammad Salihin ZAKARIA[1,2,*], Mohd Mustafa Al Bakri ABDULLAH[1,2], Romisuhani AHMAD[1,3], Yun Ming LIEW[1,2], Emy Aizat AZIMI[4]

[1]Centre of Excellence Geopolymer and Green Technology (CEGeoGTech), Universiti Malaysia Perlis (UniMAP), 02600 Perlis, Malaysia
[2]Faculty of Chemical Engineering & Technology, Universiti Malaysia Perlis (UniMAP), 02600 Perlis, Malaysia
[3]Faculty of Mechanical Engineering & Technology, Universiti Malaysia Perlis (UniMAP), 02600 Perlis, Malaysia
[4]Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, 84600 Johor, Malaysia

[*]salihin@unimap.edu.my

Abstract. Pure metakaolin-derived inorganic networks applied in wastewater remediation inherently suffer from mechanical brittleness, structural degradation, and restricted heavy metal diffusion due to dense aluminosilicate matrices. Mitigating these persistent structural vulnerabilities strictly necessitates the strategic integration of robust polymeric reinforcements to act as binder agents. Integrating Ultra-High-Molecular-Weight Polyethylene (UHMWPE) into the aluminosilicate matrix presents a transformative solution to surmount these mechanical limitations while tailoring the requisite porosity for environmental remediation. Heavy metal sequestration within this porous composite is predominantly governed by chemisorption mechanisms, specifically electrostatic attraction, surface complexation, and stoichiometric ion exchange of alkaline cations for divalent target pollutants. Consequently, the uptake kinetics and equilibrium behavior consistently adhere to the pseudo-second-order kinetic model and the Langmuir isotherm, confirming homogeneous monolayer pollutant coordination. Despite these promising structural and functional enhancements, a critical knowledge gap remains regarding the composite's long-term durability and efficacy under pilot-scale, continuous-flow competitive multi-ion conditions. Future investigations must prioritize dynamic column testing and real-world industrial effluent trials to validate the commercial viability and comprehensive regeneration potential of these hybrid materials.

Keywords: chemisorption, interfacial compatibility, divalent heavy metals, sintering-induced porosity, aluminosilicate networks, surface complexation.

Metakaolin-Derived Geopolymer Photocatalyst Membranes for Synthetic Textile Dye Waste Reduction: Performance Comparison of TiO_2, ZnO, and NiO

Laila Rezty HERTIWI[1,2], Taufik Qodar ROMADIANSYAH[1,2], Nur LAILIYAH[1], Zeni RAHMAWATI[1], Mohd Mustafa AL BAKRI ABDULLAH[1,3], Rosnita MOHAMED[1,3], Subaer[4], Petrică VIZUREANU[5], Hamzah FANSURI[1,*]

[1]Department of Chemistry, Faculty of Science and Data Analytics, Institut Teknologi Sepuluh Nopember, Kampus ITS Sukolilo, Surabaya 60111, Indonesia
[2]Department of Chemistry, Faculty of Science and Technology, Universitas Islam Darul 'Ulum, Lamongan, 62253, Indonesia
[3]Centre of Excellence Geopolymer & Green Technology (CEGeoGTech), Universiti Malaysia Perlis (UniMAP), 01000 Perlis, Malaysia
[4]Department of Physics, Faculty of Mathematics and Natural Sciences, Kampus UNM Parangtambung Jl, Daeng Tata, Makassar, Sulawesi Selatan 90223, Indonesia
[5]Faculty of Materials Science and Engineering, "Gheorghe Asachi" Technical University of Iasi, Romania

[*]h.fansuri@its.ac.id

Abstract. Photocatalytic geopolymer membranes based on metakaolin were successfully synthesized and applied for the reduction of synthetic textile dye wastewater. The metakaolin used as the precursor material was obtained through the calcination of Bangka kaolin at 650 °C for 2 hours. The membranes were synthesized byADDINg NaOH and Na_2SiO_3 as alkaline activators and H_2O_2 as a pore-forming agent. Membrane performance was enhanced by incorporating TiO_2, ZnO, and NiO photocatalysts at loadings of 2.50, 5.00, and 10.00 wt% of geopolymer. The resulting geopolymer membranes were characterized using FTIR, SEM, XRD, and open porosity analysis. The characterization results indicate that the photocatalyst incorporation does not disrupt the primary metakaolin framework. Membrane performance tests were conducted using a dead-end filtration reactor to treat synthetic textile dye waste at 0.50 bar for 60 minutes, with flux measured every 10 minutes. Two operating conditions were evaluated, namely without UV irradiation and with UV irradiation. Filtration without UV irradiation yielded the optimum flux using the ZnO-loaded geopolymer membrane at 10 wt%, achieving 11.43 L/m²·h·bar with a rejection of 92.10%. Under UV irradiation, the optimum performance was obtained with the TiO_2-loaded geopolymer membrane at 5.00 wt%, yielding a flux of 23.96 L/m²·h·bar and a rejection of 98.68%. The permeate quality analysis revealed DO of 20.90 ppm, TDS of 206.00 ppm, and pH of 8.03.

Keywords: geopolymer membrane, metakaolin, photocatalyst, clean water.

Recombinant Humanized Type III Collagen Peptide-RGD Functionalized Alginate Hydrogels Enhance MSC, hFOB, and Fibroblast Proliferation via Integrin α5β1 Activation

Lakshmi JEEVITHAN[1,*]

[1]Department of Biomaterials Engineering, Faculty of Health Sciences, UCAM-Universidad Católica San Antonio de Murcia, Campus de los Jerónimos 135, Guadalupe, 30107 Murcia, Spain

[*]jlakshmi@ucam.edu

Abstract. Alginate hydrogels (HG) are widely used in tissue engineering due to their tunable mechanics and biocompatibility, however, their inherent bio-inertness necessitates biochemical modification to facilitate cellular engagement. This study presents a novel dual-functionalized hydrogel platform (CPR-HG) incorporating both RGD and recombinant humanized type-III collagen peptide (rCP). We systematically characterized the functional and structural performance of single- and dual-peptide modified HGs, observing that rCP integration significantly improved hydration capacity and swelling kinetics. Furthermore, drug release profiles demonstrated sustained, diffusion-mediated peptide delivery. Biological evaluations across multiple cell lines bone marrow-derived mesenchymal stem cells (MSCs), human osteoblasts (hFOB), and fibroblasts (FB) revealed that CPR-HG consistently outperformed unmodified and single-peptide variants. Notably, the synergistic presence of RGD and rCP uniquely accelerated integrin α5 and β1 expression in MSCs and significantly supported hFOB proliferation. Confirmed by SEM and immunocytochemical analysis, the CPR-HG matrix promoted superior cellular spreading, upregulated collagen I expression, and enhanced receptor-level engagement. These findings underscore the potential of dual-peptide functionalized alginate as a versatile, bioactive scaffold for advanced regenerative medicine.

Keywords: dual-functionalized hydrogel platform, SEM, immunocytochemical analysis.

Architecture Controlled PAN–Collagen–Dexamethasone Electrospun Scaffolds for Mesenchymal Stem Cell Culture

Camilo ZAMORA-LEDEZMA[1,2,3,*], Nayeli Y GÓMEZ-CASTILLO[1,*]

[1]Bioengineering & Regenerative Medicine Research Group (Bio-ReM), Escuela de Ingeniería, Arquitectura y Diseño (EIAD), Universidad Alfonso X el Sabio (UAX). Avenida de la Universidad 1, 28691 Villanueva de la Cañada, Madrid, Spain
[2]Biomedical Research Unit (UIB-UAX), Universidad Alfonso X el Sabio (UAX). Avenida de la Universidad 1, 28691 Villanueva de la Cañada, Madrid, Spain
[3]Green and Innovative Technologies for Food, Environment and Bioengineering Research Group (FEnBeT), Faculty of Pharmacy and Nutrition, UCAM-Universidad Católica San Antonio de Murcia, Campus de los Jerónimos 135, Guadalupe, 30107 Murcia, Spain

*camilza@uax.es; *ngomecas@uax.es

Abstract. In this work, we will present the fabrication and optimization of electrospun PAN–collagen–dexamethasone composite scaffolds with controlled fiber architecture for mesenchymal stem cell (MSC) culture. We will also describe how solution composition and electrospinning parameters were tuned to modulate fiber diameter, porosity and surface features, and how these structural changes were correlated with mechanical, thermal and chemical properties. Further, we will show in vitro results on MSC adhesion, viability and proliferation on the different scaffold architectures, highlighting the influence of fiber organization and drug loading on cell behaviour. Finally, we will discuss how these architecture-controlled PAN–collagen–dexamethasone scaffolds can be positioned as a versatile platform for MSC-based regenerative medicine, which would be valuable for researchers and clinicians seeking to design ECM-mimetic, drug-releasing biomaterials for tissue repair.

Keywords: electrospinning, polyacrylonitrile, collagen, dexamethasone, mesenchymal stem cells.


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SECTION 2

PROCEDURES AND TECHNOLOGIES FOR MATERIALS ENGINEERING

Enhanced Radiation Shielding in SPS-Processed B_4C Ceramics through High-Entropy Alloy Additions

Burak Cagri OCAK[1], Gultekin GOLLER[1,*]

[1]Istanbul Technical University, Department of Metallurgical and Materials Enginnering, 34469, Maslak, Istanbul, Turkiye

[*]goller@itu.edu.tr

Abstract. Boron carbide (B_4C) is one of the most critical structural ceramics for extreme environments, combining exceptional hardness, low density, chemical stability, and strong neutron absorption capability. These attributes make B_4C highly attractive for lightweight armor and nuclear shielding applications; however, insufficient densification and intrinsically low fracture toughness continue to limit its broader structural utilization. This talk presents an approach to overcome these limitations through the incorporation of an equiatomic FeNiCoCrMo high-entropy alloy (HEA) as a multifunctional sintering aid for B_4C, followed by consolidation via spark plasma sintering. Various microstructural, phase, and mechanical characterization techniques were employed, and neutron shielding performance was evaluated experimentally at the ITU TRIGA Mark-II reactor using a Pu–Be source. In addition, Monte Carlo simulations (Geant4) based on experimentally determined densities and geometries are discussed to further elucidate radiation attenuation behavior. The results demonstrate that HEA incorporation significantly improves densification, mechanical integrity, and neutron attenuation efficiency, revealing a synergistic pathway that integrates compositional complexity, advanced sintering, and physics-based modeling. Overall, this talk highlights HEA-assisted B_4C ceramics as a promising platform for next-generation lightweight radiation-shielding systems relevant to nuclear energy and defense technologies.

Keywords: boron carbide, high-entropy alloy, Neutron shielding, spark plasma sintering, radiation attenuation.

Biofabrication of a High-Fidelity In Vitro Blood-Brain Barrier Model Using Decellularized Squid Mantle Scaffolds

Elango JEEVITHAN[1,*]

[1]Department of Biomaterials Engineering, Faculty of Health Sciences, UCAM—Universidad Católica San Antonio de Murcia, Campus de los Jerónimos 135, Guadalupe, 30107 Murcia, Spain

[*]jelango@ucam.edu

Abstract. Blood–brain barrier (BBB) models are essential for investigating neurological pathologies, however, the existing platforms often fail to replicate the structural complexity and intricate cell–cell interactions of the native neurovascular unit (NVU). This study reports the development of a novel BBB micro-organoid model established by integrating NVU cells onto a decellularized squid mantle scaffold (DSMS) film. The DSMS, processed through systematic decellularization and defatting, yielded a non-cytotoxic, highly biocompatible substrate. Lyophilization of the DSMS produced a film with optimized porosity and void ratios, facilitating the polarized adhesion and spatial organization of endothelial cells (hCMEC/D3) and astrocytes (hACs) into a BBB-like architecture. Functional validation of the micro-organoid demonstrated robust barrier integrity, achieving a transendothelial electrical resistance (TEER) of ~230 Ω/cm² and restricted macromolecular permeability (Papp of 6.3 x 10-7 cm/s for 10 kDa and 2.7 x 10-7 cm/s for 70 kDa FITC–dextran). Immunofluorescence confirmed the high expression of essential tight junctional complex (TJC) proteins, including VE-cadherin and ZO-1. Additionally, the stable expression of LRP1 was utilized as a diagnostic marker to evaluate model responsiveness to pathophysiological stimuli, specifically under simulated thrombotic conditions. This research validates the DSMS film as a superior biomimetic platform for constructing functionally competent BBB models. The resulting micro-organoid offers a reliable, high-fidelity in vitro platform for elucidating BBB-related pathological mechanisms and performing high-throughput screening of CNS-targeted drug permeability.

Keywords: blood–brain barrier, DSMS film, drug permeability.

A Physical-Mechanical Treatment Solution for a Zootechnical Farm Effluent: Adsorption onto Prepared Materials Based on Straw and Activated Carbon

Cristina-Alexandra HAIVAS[1], Carmen ZAHARIA[1,*]

[1]Department of Environmental Engineering, "Cristofor Simionescu" Faculty of Chemical Engineering and Environmental Protection, "Gheorghe Asachi" Technical university of Iasi, 73 Prof.Dr. docent Blvd, RO-700050 Iasi, Romania

[*]carmen.zaharia@academic.tuiasi.ro

Abstract. The research work proposes a few individual and composed solutions of prepared materials used in a physical-mechanical treatment step applied on real effluents produced in different activities of a zootechnical farm. The main influencing factors of the effluent treatment process, i.e. adsorbent dose, pH, temperature and solid/effluent contact time, were studied and the best solutions for highest removals of polluting species (e.g., suspended solids, turbidity, organics expressed as COD-Cr, colour, electric conductivity (EC), total dissoved solids (TDS), extractible substances in organic solvents) proposed. The adequate interval of variation for each studied influencing factors was also proposed. The optimal solutions mentioned after application of an experimental planning design based on an active composite rotatable design of 2^3 order were defined, mathematically modeled and the optimal values of influencing variables (adsorbent type and dose, contact time and pH) associated with the maximal removals (> 70%) proposed. The results are beneficial in solving the real concern of a zootechnical farm owner about the effluents produced onto the farm emplacement and fulfillment of the imposed environmental requirements from the water management authorization for proper operating and its development.

Keywords: adsorption, effluent treatment, hybrid materials, polluting species removal, process variables, straw-activated carbon based materials.

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A Chemical-Mechanical Treatment Solution Gor a Zootechnical Farm Effluent: Coagulation-Flocculation-Sedimentation Using Hybrid Polymeric Materials

Cristina-Alexandra HAIVAS[1], Corina-Petronela MUSTERET[1], Carmen ZAHARIA[1,*]

[1]Department of Environmental Engineering, "Cristofor Simionescu" Faculty of Chemical Engineering and Environmental Protection, "Gheorghe Asachi" Technical university of Iasi, 73 Prof.Dr. docent Blvd, RO-700050 Iasi, Romania

[*]carmen.zaharia@academic.tuiasi.ro

Abstract. The research work aims to comparatively present the experimental results obtained when using few combined inorganic-organic polymeric materials as hybrid coagulants and/or flocculants in the chemical-mechanical treatment step of real loaded zootechnical wastewaters. In the same operating conditions and working regime, there were compared the performances obtained in removals of various polluting species starting with solid matter (suspended solids, turbidity, new formed precipitates/co-precipitates and/or aggregates, total dissolved solids-TDS), dissolved organics (expressed as COD-Cr, BOD5), and other quality indicators (i.e. color, ammonia, extractible substances in organic solvents, free chlorine, electric conductivity etc.) of certain commercial hybrid materials, e.g., VTA Biosolit 6124, VTA Trioxan, VTA Nanofloc A644, VTA Calcoferit OX300 and VTA Nanocarbon, used in individual or combined form in the treatment process (i.e. Jar tests at the laboratory scale setup). The influence of certain process variables (e.g., stirring regime – especially agitation rate, time and number/duration of combined agitation steps, settlement time, etc.) were studied in the case of tested hybrid materials and their performances comparatively discussed. The adequate hybrid materials were selected when applied in treatment of zootechnical effluents and the best efficiency defined (especially the highest ones, or those higher than >70%). These experimental findings are necessary in selection of adequate hybrid materials for use in the chemical-mechanical treatment step of real wastewaters and solving the imposed environmental requirements from the zootechnical farm compliance plan related to water/wastewater factor for proper functioning and its water resources and area conservation.

Keywords: coagulation-flocculation, hybrid materials, polluting species removal, process variables, real zootechnical effluent treatment, sedimentation.

Effect of Mechanical Activation on the Sintering process of Fe–Cu–Ni–Sn Powder Mixtures during Hot Pressing

Mikheil TABATADZE[1,*], Nikoloz LOLADZE[1], Medea TSERODZE[1], Zurab AVALISHVILI[1], Nana TSERODZE[2], Vakhtang GABUNIA[2]

[1]Scientific Center of "Diamonds and Composite Materials", Georgian Technical University, 77 Kostava Street, Tbilisi, Georgia.2P. Melikishvili Institute of Physical and Organic Chemistry, Ivane Javakhishvili Tbilisi State University, Politkovskaya Street 31a Tbilisi, Georgia

[*]mikheil.tabatadze0210@gmail.com

Abstract. Superhard composite diamond-containing materials are manufactured mainly by powder metallurgy methods, which differ from each other by the time and temperature of sintering process and by the pressure value. Hot pressing is one of the main methods for producing DCM with metal binder. The objectives of this study was to identify and study the influence of the physical and physicochemical properties of the initial metal powders on the kinetics of their sintering process, as well as the properties of the resulting sintered materials under hot pressing conditions.To identify the role of the physical and physicochemical properties of the initial powders on the kinetics of the sintering process and the properties of the sintered materials, the initial powder mixture was subjected to additional activation. The powder of the composition under study Fe–Cu–Ni–Sn (47–32–13 and 8% respectively) was used. The powders were subjected to mechanical treatment by ball milling as well as to mechanical alloying in the high energy planetary mill. The sintering process was conducted on hot pressing equipment in pressure conditions up to 20 MPa and temperature up to 8300C.The presented data demonstrates that the powder activation process dramatically changes the habit and morphology of the initial powder components. The changes significantly alter the kinetics and kinetical parameters (activation energy) of the sintering processes occurring under P–T–т conditions with the participation of such powders and, as a result, the characteristics of the resulting product. It has been established that the use of processed powders makes it possible to significantly improve the characteristics of sintered powders at lower sintering parameters.

Keywords: powder metallurgy, hot pressing, mechanical activation, sintering kinetics, physicochemical properties.

Application of the Created Graphite-Ceramic Materials in Hot Pressing Technology

Zurab AVALISHVILI[1,*], Nikoloz LOLADZE[1], Medea TSERODZE[1], Mikheil TABATADZE[1], Bagrat GODIBADZE[2]

[1]Scientific Center of "Diamonds and Composite Materials", Georgian Technical University, 77 Kostava Street, Tbilisi, Georgia.2P. Melikishvili Institute of Physical and Organic Chemistry, Ivane Javakhishvili Tbilisi State University, Politkovskaya Street 31a Tbilisi, Georgia

[*]zura.avalishvili@yahoo.com

Abstract. The most applied classes of composites include metal-ceramic and diamond composite materials (DCMs). The quality and operational properties of DCMs depend on both the composition of a diamond-metal (the binder) and the technology of its production. Among various technological ways of DCM sintering the most popular ones are vacuum sintering, electro discharge sintering and hot pressing. The lack of hot-pressing technology causes low productivity and, consequently, high energy consumption, limited size and geometrical shape of the product. Therefore, it is very important that the maximum possible and permitted P–T parameters are implemented in the entire working volume of hot pressing. In other words, the urgent task of hot pressing technology is to conduct the sintering process in a gradient-free field as much as possible.Some technical ideas about how to eliminate the above-mentioned difficulties and thereby to improve the technological effectiveness and quality of the hot-pressing process are given in the present paper with the aim of producing DCMs based on metal and ceramic-metal binders.We realized this circuit by using the so-called thermo- and electro-insulating caps which were placed between the punches and the specimen. The developed material for thermal insulation is a graphite-mulita 2Al2O3·SiO2 composition compressed and subsequently sintered in a protective atmosphere at 13000C according to a specially developed technology. Experimental data presented in the paper confirm that the use of specially designed thermal and electrical resistance materials in hot pressure schemes allows significantly to improve sintering conditions. Consequently, the isotropy degree of the composite materials properties is improved throughout its volume. At the same time, the use of the developed thermal insulation materials leads to 70-80% reduction of energy capacity.

Keywords: metal-ceramic composites, hot pressing, thermal insulation, sintering conditions.

Rapid Assessment of Corrosion Resistance in the Experimental Development of Implant Compositions

Andriana SURLEVA[1,*], Luydmila ANGELOVA[1], Darya ILIEVA[1], Dimka FACHIKOVA[1]

[1]University of Chemical Technology and Metallurgy, 8 "st. Kl. Ohridski" blvd., 1756 Sofia, Bulgaria

[*]surleva@uctm.edu

Abstract. It is well established that the chemical corrosion resistance of metallic biocompatible implants depends less on pH and more on the redox environment. Laboratory testing involves immersing metallic implants for periods ranging from 24 hours to 28 days in various media containing oxidizing agents, reducing agents, and mixtures simulating human body fluids. Monitoring oxidation and reduction by quantifying the concentrations of metals and their compounds released from the implant enables the development of an empirical concentration–time model, which in turn provides a basis for evaluating corrosion resistance. This relationship, for each implant with desired properties, typically follows a characteristic curve consisting of an initial increase in concentration, a linear regime, and a saturation/passivation stage. Analytical methods used for determining metal concentrations in implants often require matrix matching during calibration or more complex sample preparation to accurately measure concentrations near the limits of quantification. An alternative approach for monitoring implant dissolution is the measurement of the conductivity of the medium in which the implant is immersed. Despite its lower sensitivity - making it difficult to distinguish conductivity differences corresponding to titanium ion concentrations below approximately 700 µg/L - conductivity measurements can provide a rapid and cost-effective assessment during the experimental development of metallic implant compositions.

Keywords: conductivity measurement, corrosion, Ti alloys, implants.

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In Vitro Testing of Different Biodegradable Magnesium-based Alloys Potentially Used in Oral Bone Regeneration

Iuliana CORNESCHI[1], Aurora ANTONIAC[1], Veronica PALTANEA (MANESCU)[1], Elena Eli POPESCU[1], Marian MICULESCU[1], Larisa POPESCU[1], Iulian ANTONIAC[1,2,*]

[1]National University of Science and Technology POLITEHNICA Bucharest, Faculty of Material Science and Engineering, Department of Materials Science and Physical Metallurgy, 313 Splaiul Independentei Street, 060042, Bucharest, Romania
[2]Academy of Romanian Scientists, 54 Splaiul Independentei Street, 050094, Bucharest, Romania

[*]antoniac.iulian@gmail.com

Abstract. Guided bone regeneration (GBR) is a widely used technique for restoring bone volume in deficient maxillary areas, allowing dental implant placement even under unfavourable conditions. Conventional membranes present limitations because they require a second surgical intervention for removal, while biodegradable membranes often lack sufficient mechanical strength, particularly in large defects. Magnesium-based alloys have emerged as promising alternatives due to their biodegradability and adequate mechanical properties for temporary implants during bone healing. The current study aimed to investigate the degradation in artificial saliva at pH 6.4 for two magnesium-based alloys, MRI202s and ZMX410. The degradation profile was evaluated at 3, 7, and 10 days by mass and volume loss measurements. Volume loss was determined by industrial computer tomography, a new and accurate method for determining the volume of materials. The results highlighted differences in degradation behaviour, significantly greater for the ZMX410 alloy than for MRI202s, which is more appropriate to clinical requests in terms of tissue healing time. In conclusion, MRI202s alloy represents a viable alternative to conventional dental membrane materials. Future research will focus on the evaluation of mechanical properties, as well as surface modifications to achieve better tissue integration and controlled degradation rates tailored to clinical requirements.

Keywords: Mg-based alloys, GBR, corrosion, volume loss, CT scan.

Fe/WC Type Composites Obtained by Powder Metallurgy Technique

Calin-Virgiliu PRICA[1,2,*], Argentina Niculina SECHEL[1,2], Florin POPA[1,2], Traian Florin MARINCA[1,2], Bogdan Viorel NEAMTU[1,2], Ionel CHICINAS[1,2], Norbert SZOBO[1]

[1]Technical University of Cluj-Napoca, Material Science and Engineering Department, 103-106, Muncii Ave., 400641, Cluj-Napoca, Romania
[2]EUT+ Institute of Nanomaterials and Nanotechnologies-EUTINN, European University of Technology, European Union

[*]calin.prica@stm.utcluj.ro

Abstract. The present work aims is to obtain and characterize metal matrix composites (Fe) reinforced with ceramic particles (WC) using powder metallurgy techniques (pressing and sintering). Sintering process was carried out in an endogas atmosphere, using the following parameters: sintering temperature – 1120 °C and holding time – 30 min. Befor sintering, the samples were pressed at 500 MPa. The influence of the WC addition on the structural and mechanical properties was investigated. The influence of WC addition on the microstructure was analyzed by optical microscopy (OM), scanning electron microspopy (SEM-EDX) and X-ray diffraction. Also, the effects on hardness and compressive strength were studied. Thus, at the interface between the Fe matrix and the WC particles, a new phase is formed - Fe3W3C (η-carbides). This η-carbides has also been identified in other studies [1]. The value of the modulus of elasticity (Young's modulus) decreases with increasing WC content, from 352 GPa (15 wt.%) to 335 GPa (30 wt.%). Also, the compressive strength decreases with increasing WC content, from a value of 976 MPa corresponding to the sintered compacts with 15% WC, to 910 MPa for the compacts with a 30% WC content.

Keywords: metal matrix composites, diffusive interface, sintering, compressive strength.

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Microstructural, Electrochemical and Mechanical Characterization of Novel Ti–Mo–Zr–Ta Alloys Manufactured Using SLM

Cristina JIMÉNEZ-MARCOS[1,*], Julia Claudia MIRZA-ROSCA[1], Madalina Simona BALTATU[2], Petrica VIZUREANU[2]

[1]Mechanical Engineering Department, University of Las Palmas de Gran Canaria, Campus Universitario de Tafira, Edif. Ingenieria, 35017, Gran Canaria, Spain
[2]Department of Technologies and Equipment for Materials Processing, "Gheorghe Asachi" Technical University of Iasi, Bulevardul Profesor Dimitrie Mangeron 67, Iași 700050, Romania

[*]cristina.jimenez112@alu.ulpgc.es

Abstract. Ti-Mo-Zr-xTa alloys (x = 5, 10, 15) were produced using selective laser melting (SLM) as a promising substitute for conventional metallic materials used in biomedical applications, which have drawbacks like the release of hazardous ions and a shorter implant service life. The addition of elements like tantalum (Ta), zirconium (Zr) and molybdenum (Mo) to titanium (Ti) alloys greatly enhances their mechanical and chemical characteristics as well as their biocompatibility in physiological settings, encouraging a more suitable response from bone tissue and increased implant durability [1]. To assess the alloys' corrosion behavior and suitability for biomedical applications, microstructural analysis, Vickers microhardness testing and electrochemical testing were applied. The results showed a biphasic microstructure of the three samples, with increased corrosion resistance and hardness as the Ta content rises. Moreover, SLM facilitates the creation of specialized medical devices by allowing precise control over material composition and design, making these alloys promising candidates for high-performance metal implants with improved clinical safety.

Keywords: VAR, titanium alloy, microstructure, corrosion, microhardness.

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Low Milling Time Alloying of Ni, Mn, Sn Elemental Powders Using Different Milling Energy

Florin POPA[1,2,*], Andra Teodora Anastasia MAN[1], Traian Florin MARINCA[1,2], Niculina Argentina SECHEL[1,2], Diana BENEA[3], Răzvan HIRIAN[3], Bogdan Viorel NEAMTU[1,2], Ionel CHICINAS[1,2]

[1]Department of Materials Science and Engineering, Technical University of Cluj-Napoca, 103-105 Muncii Avenue, 400641 Cluj-Napoca, Romania
[2]Eut+ European University of Technology Institute of Nanomaterials and Nanotechnologies, European Union
[3]Faculty of Physics, Babes-Bolyai University Cluj-Napoca, Kogalniceanu 1 Str., 400084 Cluj-Napoca, Romania

[*]florin.popa@stm.utcluj.ro

Abstract. Using elemental powders of Ni, Mn and Sn solid state synthesis was initiated using different mills and milling energies. The composition was chosen to be similar to that of the Ni2MnSn Husler alloy. Milling was performed up to 10 h for each experiment. Sampling was carried out to evaluate the elemental reactions and phase formation. Under all milling conditions, the Ni3Sn4 phase is formed the initial stages of milling. Depending on the milling energy, after 10 h of milling either B2 or A2 phase was obtained. Particle size distribution comparison between different regimes was performed. By X-ray diffraction and scanning electron microscopy, the phases and the particles morphology were evaluated. Elemental homogeneity was assessed by Energy Dispersive X-ray Spectroscopy. Traces of iron contamination were recorded.

Keywords: Heusler alloys, mechanical alloying, nanocrystalline.

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Solid-State Synthesis of Ni50Mn20Sn30 Heusler Type Alloy and the Impact of Low Temperature Annealing on Phase Formation

Andra Teodora Anastasia MAN[1], Traian Florin MARINCA[1,2], Niculina Argentina SECHEL[1,2], Diana BENEA[3], Razvan HIRIAN[3], Bogdan Viorel NEAMTU[1,2], Ionel CHICINAS[1,2], Florin POPA[1,2,*]

[1]Department of Materials Science and Engineering, Technical University of Cluj-Napoca, 103-105 Muncii Avenue, 400641 Cluj-Napoca, Romania
[2]Eut+ European University of Technology Institute of Nanomaterials and Nanotechnologies, European Union
[3]Faculty of Physics, Babes-Bolyai University Cluj-Napoca, Kogalniceanu 1 Str., 400084 Cluj-Napoca, Romania

[*]florin.popa@stm.utcluj.ro

Abstract. Solid-state synthesis of the $Ni_{50}Mn_{20}Sn_{30}$ Heusler type alloy was achieved by planetary ball milling starting from elemental powders. Milling was performed for up to 10 hours, and phase formation was investigated throught the milling process by sampling at selected intervals. To remove the internal stresses induced by milling, annealing treatments at temperatures up to 500 °C were carried out. After 10 hours of milling, the A2 phase was formed. Increasing the annealing temperature formation of the highly ordered $L2_1$ structure is promoted, along with a secondary Ni_3Sn_2 phase. The morphology of the milled powders was examined using scanning electron microscopy. Elemental distribution was analyzed by energy-dispersive X-ray spectroscopy as a function of milling time to observe chemical homogenization during milling. Changes in the particle size distribution of the milled powders were correlated with the formation of the Heusler phase.

Keywords: Heusler alloys, mechanical alloying, nanocrystalline, annealing.

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Electrochemical Characterization and Corrosion Resistance of Ti-Mo-Nb-Sn Alloys for Biomedical Applications

Nona SHIVACHEVA[1], Dimka FACHIKOVA[1,*], Luydmila ANGELOVA[1], Darya ILIEVA[1], Andriana SURLEVA[1]

[1]University of Chemical Tehnology and Metallurgy, 8 Kliment Ohridski Blvd., 1756 Sofia, Bulgaria

[*]dimkaivanova@uctm.edu

Abstract. The development and research of a new generation of biomaterials aims to overcome the limitations offered by stainless steels, such as low corrosion resistance, high modulus of elasticity, biocompatibility, which depends on the immunological specificity of each patient. The results obtained from the study of Ti-Mo-Nb-Sn alloys as materials for the manufacture of implants are presented. The tests were conducted in Simulated Body Fluid solutions (SBF), at different pH values and a temperature of 37°C. A three-electrode glass cell was used in open-air conditions. The following electrochemical methods were used: cyclic potentiodynamic polarization method and open circuit potential (OCP) measurement. The nature of the corrosion attack was determined by optical and scanning electron microscopy (SEM). The surface of the samples was also examined by EDX analysis to investigate the nature of the corrosion products. The chemical composition of the alloys was determined using a Glow Discharge Optical Emission Spectrometer (GDOES).

Keywords: titanium alloys, biomaterials, corrosion behavior.

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Effect of Titanium Alloying and Heat Treatment on the Corrosion Behavior of 17-4PH Martensitic Stainless Steel in Salt Spray Environment

Adrian Emanuel ONICI[1], Victor GEANTA[1,*], Radu STEFANOIU[1], Ionelia VOICULESCU[2]

[1]National University of Science and Technology POLITEHNICA Bucharest, Faculty of Materials Science and Engineering, Splaiul Independenței 313, 060042 Bucharest, Romania
[2]National University of Science and Technology POLITEHNICA Bucharest, Faculty of Industrial Engineering and Robotics, Splaiul Independenței 313, 060042 Bucharest, Romania

[*]victorgeanta@yahoo.com

Abstract. The present study investigates the influence of titanium additions (1–5 wt.%) on the microstructure, microhardness, and corrosion behavior of 17-4PH precipitation-hardened martensitic stainless steel [1]. The alloys were produced by vacuum arc remelting (VAR) and subjected to solution heat treatment at 1040 °C for 1 h, followed by aging at 482 °C (H900), 552 °C (H1025), 579 °C (H1075), and 621 °C (H1150). Microstructural characterization was performed using optical microscopy, while microhardness was evaluated using the Vickers method (HV0.2). Corrosion resistance was assessed by neutral salt spray testing in accordance with ASTM B117 for 72 h [2]. The results show that titanium additions influence the microstructure by promoting secondary phases and modifying the martensitic matrix. The microhardness was strongly dependent on heat treatment, with maximum values under H900 conditions and a decrease at higher aging temperatures due to overaging. All samples exhibited generalized corrosion with localized attack, and no significant improvement in corrosion resistance was observed with increasing titanium content. These results indicate that, without surface passivation, titanium alloying alone is insufficient to enhance corrosion resistance in chloride-rich environments.

Keywords: 17-4PH stainless steel, titanium alloying, heat treatment, microstructure, microhardness, salt spray corrosion.

Effect of Immersion Time on the Corrosion Behaviour of Ca-Zn-Mg Phosphate Conversion Coating Deposited on Ti6Al4V

Diana-Petronela BURDUHOS-NERGIS[1], Andrei-Victor SANDU[1], Petrica VIZUREANU[1,*], Dumitru-Doru BURDUHOS-NERGIS[1], Costica BEJINARIU[1]

[1]Faculty of Materials Science and Engineering, ''Gheorghe Asachi'' Technical University of Iasi, 700050 Iasi, Romania

[*]petrica.vizureanu@academic.tuiasi.ro

Abstract. Titanium alloys, particularly Ti6Al4V, are widely used in biomedical applications due to their mechanical properties and good corrosion resistance; however, their electrochemical behavior in physiological environments can be affected by degradation processes over time. In this context, phosphate conversion coatings doped with bioactive ions, such as Ca, Zn, and Mg, represent a promising solution for improving stability and interaction with the biological environment. Thus, this study investigates the influence of immersion time on the electrochemical behavior of Ca–Zn–Mg-type phosphate conversion coatings deposited on the Ti6Al4V alloy via a chemical conversion process. Electrochemical evaluation was performed using electrochemical impedance spectroscopy (EIS) after various immersion periods in a simulated physiological environment. The results highlight a time-dependent evolution of the protective properties, associated with layer stabilization and degradation processes. Analysis of Nyquist and Bode plots allowed the identification of time constants corresponding to the coating–electrolyte and substrate–coating interfaces, as well as the variation of electrochemical parameters, including charge transfer resistance and capacitive behavior. Equivalent electrical circuit models suggest a layered structure of the coating, with distinct contributions from the phosphate layer and the passive titanium oxide film.

Keywords: Ca-Zn-Mg phosphate coatings, EIS, Ti6Al4V, corrosion.

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Influence of Immersion Time on the Electrochemical Performance of Zn–Zr–Ca Phosphate Conversion Coatings on Ti6Al4V

Diana-Petronela BURDUHOS-NERGIS[1], Andrei-Victor SANDU[1,*], Petrica VIZUREANU[1], Dumitru-Doru BURDUHOS-NERGIS[1], Costica Bejinariu[1]

[1]Faculty of Materials Science and Engineering, ''Gheorghe Asachi'' Technical University of Iasi, 700050 Iasi, Romania

[*]andrei-victor.sandu@academic.tuiasi.ro

Abstract. Modifying the surface of titanium alloys using phosphate conversion coatings is an effective strategy for improving electrochemical behavior in physiological environments. In this context, the introduction of ions such as Zn, Zr, and Ca can lead to the formation of coatings with increased stability and superior functional properties. However, the performance of these coatings is highly dependent on their evolution over time in contact with the electrolytic environment. In this paper, the influence of immersion time on the electrochemical response of Zn–Zr–Ca phosphate conversion coatings deposited on the Ti6Al4V alloy is analyzed. The evaluation was performed using electrochemical impedance spectroscopy under conditions of prolonged exposure in a simulated physiological environment. The time evolution of the electrochemical response highlights changes in charge transfer mechanisms and capacitive behavior, associated with structural transformations within the coating. Analysis of the EIS data indicates the presence of multiple time constants, suggesting a layered architecture of the system, in which the contributions of the phosphate layer and the passive titanium oxide evolve differently during immersion. The role of zirconium is associated with increased layer compactness and stability, while zinc and calcium contribute to changes in electrochemical properties and, potentially, bioactivity. The results highlight the importance of medium-term evaluation of conversion coatings and demonstrate the potential of the Zn–Zr–Ca system for biomedical applications where electrochemical stability and interaction with the physiological environment are essential.

Keywords: Zn-Zr-Ca phosphate coatings, immersion time, EIS, Ti6Al4V, electrochemical corrosion.

Acknowledgments: This work was supported by a grant of the Ministry of Research, Innovation and Digitalization, CNCS-UEFISCDI, project number PN-IV-P2-2.1-TE-2023-1086.

Influence of Graphene Nanoplatelets Doping on the Corrosion Behavior of Ultra-High Temperature Ceramics in Artificial Sea Water

Alberto Daniel RICO-CANO[1,2,*], Burak Cagri OCAK[2], Gultekin GOLLER[2], Julia Claudia MIRZA-ROSCA[1,3]

[1]Universidad de Las Palmas de Gran canaria, Dpto. de Ingeniería Mecánica, Campus Universitario Tafira, 35017, Las Palmas de Gran Canaria, Spain
[2]Istanbul Technical University, Department of Metallurgical and Materials Engineering, 34469, Maslak, Istanbul, Türkiye
[3]Transilvania University of Brasov, Materials Engineering and Welding Department, 29 Eroilor Blvd., 500036, Brasov, Romania

[*]alberto.rico101@alu.ulpgc.es

Abstract. The manufacturing of Ultra-High Temperature Ceramics (UHTC) is a topic of total interest due to the conventional sintering difficulties to increase densification and achieve enough temperature [1]. Therefore, Graphene Nanoplatelets were added to ZrC-TiC system, a strong UHTC used for cutting tools, jet engine parts, nose caps and leading edges of re-entry space aircraft. SEM, XRD and electrochemical tests were carried out to complete microstructural and chemical characterization, as done in other ceramic matrix studies [2]. GNP addition did not modify ZrC lattice, as TiC or GNP phases were not detected. It was seen that GNP dispersed homogenously in the structure, leading to an improved densification and mechanical properties. Doped samples presented better corrosion resistance, greater as the doping percentage increase. In conclusion, graphene nanoplatelets addition to ZrC-TiC based systems achieve not only greater densification and mechanical properties, but a thicker and more stable passive layer is created on the GNP sample.

Keywords: UHTC, SPS, microstructure, GNP, corrosion.

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Concentrated solar radiation cladding of Al_2O_3-TiO_2-Ni coatings

Alexandru PASCU[1,*], Elena-Manuela STANCIU[1], Iosif HULKA[1]

[1]Transilvania University of Brașov, Faculty of Materials Science and Engineering, Department of Materials Engineering and Welding, Brașov 500036, Romania
[2]Politehnica University Timişoara, Research Institute for Renewable Energy, G. Muzicescu 138, 300501, Timisoara, Romania

[*]alexandru.pascu@unitbv.ro

Abstract. Nowadays, several deposition and cladding techniques are used to improve the surface properties of metallic components. Alongside thermal spraying and arc welding, laser cladding is commonly used for the fabrication of quality cladded layers. However, the low wall plug efficiency of laser generators, initially around 2-3% and more recently up to 30 - 40%, is a limitation in terms of energy consumption and sustainability. In contrast, concentrated solar radiation offers a highly efficient alternative, with an efficiency of ~70% been also a clean and nonpolluting energy source. This study addresses the feasibility of obtaneing coated layers using a preplaced powder method combined with a solar reactor operating under a controlled atmosphere. A shutter system was used to control the solar flux and ensure process stability during cladding. Solar cladding represents a new approach that enables the use of renewable energy for the synthesis of advanced ceramic and metal ceramic coatings, with applicability in the field of semiconductor technologies or for thermal barrier systems and environmental protection solutions. Experimental tests were carried out at the PROMES-CNRS facility in France. Coatings were produced using Al_2O_3 - TiO_2 powder mixtures with varying compositions, including nickel additions. The results indicate that nickel plays a key role in promoting the formation of a metallic matrix, enhancing wetting behavior and significantly improving the adhesion of the coating to the substrate.

Keywords: solar radiation, prepaced cladding, ceramic powder.

Laser Welding of Titanium Grade 2

George Laurentiu ARDELEAN[1,*], Dan Cristian CUCULEA[1], Ciprian IATAN[1], Alexandru PASCU[1], Julia Claudia MIRZA ROSCA[1,2]

[1]Transilvania University of Brasov, Materials Engineering and Welding Department, 29 Eroilor Blvd, 500036, Brasov, Romania
[2]University of Las Palmas de Gran Canaria, Mech. Eng. Dept., Mechanical Engineering Department, Campus Universitario de Tafira, Edif.Ingenieria, 35017, Gran Canaria, Spain

[*]george.ardelean@unitbv.ro

Abstract. Nowadays, in the industrial environment, titanium and its alloys are increasingly utilized in high performance industries due to their excellent strength-to-weight ratio and corrosion resistance. However, the high atmospheric reactivity of titanium during the welding process is challenging as the material oxidies instantly. The study addresses the optimization of laser welding parameters for butt joints of 1 mm thick commercially pure Grade 2 titanium plates. To improuve the weld quality, a dedicated shielding device was developed to ensure the proper gas sheling during the laser processing. The design of experiments method, based on the Taguchi approach, was applied to identify the optimal process parameters namely laser power, pulse duration and repetition rate. The experimental tests were performed using a Trumph Trupulse 556 laser, a Precitec laser welding head and integrated with a CLOOS 7-axis industrial robot. Following welding, the specimens were subjected to mechanical testing and microscopy analyses in order to evaluate the joint strenght and the grain size and distribution within the welded bead. The results show the relationship between process parameters, shielding efficiency and the resulting metallurgical of laser welded Grade 2 titanium.

Keywords: laser welding, titanium, pulsed laser.

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Physicochemical Tuning of Multicomponent Oxide Glasses for Optical Applications

Tina TASHEVA[1,*], Atanas DIMITROV[1]

[1]Department of Silicate Technology, University of Chemical Technology and Metallurgy 8 Kliment Ohridski blvd., 1797 Sofia, Bulgaria

[*]tina.tasheva@uctm.edu

Abstract. Multicomponent heavy metal oxide-containing glasses are among the most promising inorganic materials for modern technological applications due to their tunable properties and excellent processability. Materials based on tellurium, germanium and bismuth oxides are especially attractive for use in photonic devices, optical sensors, nonlinear optical components and dielectric systems. In the present study, selected glass compositions containing network-forming and modifying oxides were prepared by the melt-quenching technique. The formation of homogeneous amorphous materials was confirmed by powder X-ray diffraction analysis. Basic physicochemical characteristics such as density, oxygen packing density, and molar volume were evaluated to study the effect of composition on the glass network. Spectroscopic techniques including UV-VIS, FTIR and Raman analyses, were employed to obtain information about short-range ordering and bonding arrangement in the glass matrix. Optical constants were further assessed by ellipsometric measurements. The polarizability approach concept was applied to estimate the electronic response of the investigated materials and to predict trends in their functional behavior.

Keywords: oxide glasses, heavy metal glasses, physicochemical properties, spectroscopy, optical materials.

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Effect of Hydroxyapatite Concentration on the Temporal Corrosion Kinetics of AZ31 Alloy: Establishing a Foundation for Biomimetic Coatings

Siti Hawa SALLEH[1,2,3,*], Vincenzo BONGIORNO[1], Xiaorong ZHOU[1]

[1]Corrosion and Protection Group, Department of Materials, The University of Manchester, Oxford Road, Manchester M13 9PL, United Kingdom
[2]Department of Materials, Faculty of Chemical Engineering & Technology, Universiti Malaysia Perlis, 02600 Arau, Perlis, Malaysia
[3]Centre of Excellence Geopolymer & Green Technology, Universiti Malaysia Perlis, 02600 Arau, Perlis, Malaysia

[*]sitihawa@unimap.edu.my

Abstract. AZ31 magnesium (Mg) alloy is a primary candidate for biodegradable orthopedic implants. However, its clinical viability is constrained by rapid degradation in physiological environments. This study investigates the optimization of a single-layer hydroxyapatite (HA) coating as a foundational step toward a multi-layer biomimetic system. Specifically, the effect of HA concentration (2, 4, 10, and 30 g/L) on the coating's structural integrity and electrochemical stability was evaluated. The surface morphology was characterized via optical microscopy, while the corrosion kinetics were monitored using Electrochemical Impedance Spectroscopy (EIS) at 0, 1.5, 3 and 24 hour immersion intervals in 0.9% NaCl. The results demonstrate a time-dependent evolution between the coating and electrolyte interface. While samples prepared with 2 g/L and 4 g/L HA showed linear improvements in barrier performance over 3 hours, the 10 g/L concentration consistently exhibited the highest charge transfer resistance (Rct) and superior film uniformity. Conversely, the 30 g/L concentration yielded the lowest impedance values with optical analysis revealed that excessive particle loading led to significant macro-agglomeration and a porous surface microstructure, which compromised the coating's protective capacity. These findings identify 10 g/L of HA as the critical parameter for achieving stable surface passivity. This optimized single-layer configuration serves as the essential substrate for the subsequent development of a double-layer biomimetic system, incorporating a secondary calcium phosphate layer to further refine the biodegradation profile of AZ31 implants.

Keywords: AZ31, hydroxyapatite, electrochemical impedance spectroscopy, corrosion, biodegradable implants.

Fly Ash-Based Geopolymer-Coated Lightweight Expanded Clay Aggregate (LECA) for Structural Applications: A Review

Mohammad Tamizi SELIMIN[1,*], Mohd Mustafa Al Bakri ABDULLAH[1], Nur Liza RAHIM[2], Rafiza Abd RAZAK[2], Salwa Mohd Zaini MAKHTAR[2], Emy Aizat AZIMI[3]

[1]Faculty of Chemical Engineering & Technology, Universiti Malaysia Perlis (UniMAP), 02600 Perlis, Malaysia
[2]Faculty of Civil Engineering & Technology, Universiti Malaysia Perlis (UniMAP), 02600 Perlis, Malaysia
[3]Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, 84600 Johor, Malaysia

[*]tamizi@unimap.edu.my

Abstract. Lightweight expanded clay aggregate (LECA) has attracted growing interest in structural engineering due to its low density, porous structure, and ability to reduce the self-weight of concrete elements. However, its relatively low mechanical resistance and high-water absorption may restrict its direct use in load bearing components. This review evaluates the potential of fly ash-based geopolymer coating as a sustainable surface modification method to improve the performance of LECA for structural applications. This paper discusses geopolymer synthesis, coating development, and the mechanisms by which coated LECA may enhance aggregate matrix bonding and refine the interfacial transition zone. Key parameters influencing composite performance, including coating thickness, mix proportion, alkaline activator concentration, curing temperature, and curing duration, are examined. Reported findings suggest that geopolymer coating can reduce surface porosity, improve bond quality, limit microcrack formation, and enhance the durability of lightweight concrete systems exposed to environmental degradation. The potential application of geopolymer-coated LECA in beams, columns, wall panels, and other lightweight structural elements is also considered. Overall, the reviewed literature indicates that fly ash-based geopolymer coating may support the development of lightweight, durable, and more sustainable structural materials. Nevertheless, further research is required to optimize coating procedures, quantify long-term durability, and validate performance at larger structural scales.

Keywords: lightweight expanded clay aggregate, LECA, fly ash, geopolymer coating, lightweight concrete, structural applications, sustainability.

Measures for Converting a Screening Enclosure into a Reverberant Chamber

Viorica VOICU[1,*], Denisa BURADA[1],
Ionel DUMBRAVĂ[1], Ionuț TOMA[1]

[1]National Institute for Research-Development and Testing In Electrical Engineering – ICMET CRAIOVA, High Voltage Division, B-dul Decebal, No.118A, 200746 Craiova, Romania

[*]cem@icmet.ro

Abstract. The new approach, through Directive 2014/30/EU [1], ensures the free movement of products with electronic components if they comply with standardized requirements. In a laboratory that has the necessary equipment, compliance with the requirements regarding shielding efficiency can be verified. A reverberant chamber meets the requirements for making these measurements and can be obtained by modifying a shielded enclosure. The modifications consisted of both the construction of the stirrers and the entire drive system as well as the system for producing and measuring the electromagnetic field. There were two options for creating the reverberant chamber, a shielded enclosure with metal panels or a flexible Faraday enclosure. A brief presentation of two types of shielded enclosures, which are used for electromagnetic compatibility measurements, is provided. The comparative measurements were carried out in accordance to IEEE Std 299:2006 [2]. The article presents the results of measurements performed to evaluate the shielding efficiency of the two models of shielded enclosures. Analyzing the results and taking into account the technical advantages, it was decided to use the shielded enclosure with flexible walls to transform it into a reverberant chamber.

Keywords: shielded enclosures, stirrer, testing, reverberation chamber.

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Acknowledgement: This work was supported by the Ministry of Education and Research of Romania as part of the NUCLEU Program: PN 23 33 01 02.

SECTION 3

MATERIALS APPLICATION

Translating 3D Bioprinting Research, Development and Innovation into Marketable Patients Products: Legal, Corporate Sustainability and Governance Challenges

Eliana DÍAZ-CRUCES[1,*]

[1]Grupo de Investigación Derecho Equidad Gobernanza y Sostenibilidad para la Justicia Social (LEGOS), Facultad de Ciencias Jurídicas, Universidad a Distancia de Madrid (UDIMA), 28400 Collado Villalba, Madrid, Spain

[*]floreliana.diaz@udima.es

Abstract. 3D bioprinting enables the fabrication of personalized tissues and organs using living cells and holds great promise for regenerative medicine, disease modelling and drug development, yet only a few constructs are close to clinical use because current regulatory pathways do not fit these complex, cell-based products. This article first studies the legal challenges posed by bioprinted products, focusing on their hybrid classification, the allocation of liability among multiple actors and the protection of bioinks, digital designs and patient-derived data. Second, it develops a corporate sustainability analysis of 3D bioprinting, examining how localized and on-demand production can support more circular and resource-efficient models while still raising issues of energy use, material sourcing and biological and chemical waste management. Third, it explores the role of corporate governance, proposing governance arrangements in which Environmental Social and Governance (ESG) oriented corporate sustainability criteria are embedded in multidisciplinary oversight and traceability mechanisms. Drawing these strands together, this article demonstrates how an holistic view of law, corporate sustainability and governance would guide regulators, firms, healthcare providers and scientists in translating 3D bioprinting from research and development into safe, effective and trustworthy products for patients.

Keywords: 3D bioprinting, regulatory frameworks, corporate governance, sustainability (ESG), arketable patient products.

Electrochemical Sensor based on a Copper(I) Complex for the Simultaneous Detection of Phenolic Pollutants in Water

Alexandra Virginia BOUNEGRU[1,*], Cătălina ITICESCU[1,2], Simona BUTAN[1], Alina CEOROMILA[3], Aurel TABACARU[1]

[1]Romania Department of Chemistry, Physics and Environment, Faculty of Sciences and Environment, "Dunărea de Jos" University of Galați, 111 Domneasca Street, 800201, Galați, Romania
[2]REXDAN Research Infrastructure, "Dunărea de Jos" University of Galați, 98 George Coșbuc Street, 800385, Galați, Romania
[3]Cross-Border Faculty, "Dunărea de Jos" University, 111 Domneasca, 800201, Galați, Romania

[*]alexandra.meresescu@ugal.ro

Abstract. In this study, a novel electrochemical sensor based on a carbon screen-printed electrode modified with the copper(I) complex [Cu(SCN)(PPh_3)(dpa)] is proposed for the simultaneous detection of hydroquinone and resorcinol. The influence of the solvent used for complex immobilization was investigated, revealing that acetonitrile promotes the formation of a more homogeneous and electroactive surface, characterized by an increased active area and improved charge-transfer properties. Under optimized conditions, differential pulse voltammetry enabled the simultaneous detection of hydroquinone and resorcinol with detection limits in the nanomolar range. The sensor exhibited good reproducibility (RSD < 3%) and satisfactory selectivity in the presence of structurally related phenolic interferents. Application to real water samples demonstrated the practical utility of the system, with recovery values exceeding 88%. The newly developed modified sensor highlights the potential of copper coordination compounds as efficient electrocatalytic modifiers, offering a promising approach for rapid and sensitive water monitoring. Furthermore, the simplicity of the fabrication method and the use of screen-printed electrodes support the prospects of miniaturization and the development of portable devices for in situ analysis.

Keywords: phenolic compounds, differential puls voltammetry, screen-printed electrode, water monitoring

Acknowledgements: This work was supported by the project HORIZON-MISS-2021-OCEAN-02-02, Danube Region Water Lighthouse Action, Dalia, project no. 101094070 and by the Research Grant no. 7967/31.03.2025, entitled "Integrated solution for decision support, monitoring, control and forecasting of water quality based on generative AI and multi-trophic techniques (SmartIAqua)", managed by Assist. Prof. PhD eng. ec. Stefan PETREA.

Liposomal Microbial Inulinase for Controlled Release and Metabolic Health Applications

Anca Daniela RAICIU[1,2,3], Amalia STEFANIU[4], Mihaela Carmen EREMIA[4]

[1]Department of Pharmacognosy, Faculty of Pharmacy, University of Titu Maiorescu, Phytochemistry,Phytotherapy, 16 Gh. Sincai Street, 040441 Bucharest, Romania
[2]Hofigal Export-Import S.A., Intrarea Serelor 2, 042124, Bucharest, Romania
[3]Planta Romanica Association,27-29 George Enescu Street, 010303, , Bucharest, Romania
[4]National Institute for Chemical-Pharmaceutical Research & Development—ICCF, Bucharest, 112 Vitan Avenue, 3rd District, 031299 Bucharest, Romania

*daniela.raiciu@prof.utm.ro

Abstract. The LIPHOIN project explores advanced liposomal nanosystems incorporating microbial inulinase as innovative platforms for prevention and management of metabolic disorders. Inulinase (EC 3.2.1.7) catalyzes the hydrolysis of β-2,1 fructan linkages in inulin, generating fructose and fructooligosaccharides with recognized prebiotic and metabolic benefits . Microbial sources such as Kluyveromyces, Aspergillus, and Penicillium demonstrate high enzymatic efficiency under optimized fermentation conditions, influenced by aeration, agitation, and substrate composition . Recent advances in pharmaceutical nanotechnology highlight liposomes and hydrogels as complementary delivery systems capable of improving stability, bioavailability, and controlled release of bioactive compounds for metabolic disease therapy . Hybrid liposome–hydrogel platforms further enhance intestinal permeability, reduce burst release, and increase systemic exposure of encapsulated bioactives . Integrating enzymatic biotechnology with nanostructured delivery systems provides a promising strategy for developing functional nutraceuticals targeting metabolic balance and personalized therapeutic interventions.

Keywords: microbial inulinase, liposomal delivery systems, controlled release, fructooligosaccharides, metabolic disorders.

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Innovation of Eliminate Toxic Gases in Industrial Factory by Applying High Intensity Ozonation Electrical System

Siseerot KETKAEW[1,*]

[1]Faculty of Engineering, Ramkhamhaeng University, Ramkhamhaeng Street, 10240, Bangkok, Thailand

[*]siseerotketkaew14@gmail.com

Abstract. This research paper presents innovations to eliminate toxic air gases in industrial factory by applying the high intensity ozonation electrical system, it consists of three parts : Part 1 : a set of high intensity pulse electric field cells with the process of static electricity combined with corona discharge for trapping small dust PM2.5, eliminating carbon monoxide gas, carbon dioxide gas and alcohol gas using the technique of adjusting the switching frequency in high voltage electrical circuits to control high voltage. Part 2 : A set of prefilter that trap large dust particles and a set of high efficiency HEPA air filter increases efficiency in trapping small dust particles and Part 3 : a high intensity ozone gas production set for use to increase efficiency in eliminating toxic gases. Part 1 has designed and construction a high voltage switching power supply circuit by using the flyback converter principle. The test results in part 1 show that when measuring ozone gas, a high voltage of 1.25 kV can produce ozone gas 1.5 ppm at a high voltage of 2.63 kV can produce ozone gas 1.8 ppm, at a high voltage of 3.27 kV can generate ozone gas 2.6 ppm, at a high voltage of 4.39 kV can generate ozone gas 3.5 ppm and at a high voltage and 5.78 kV can generate ozone gas 3.9 ppm. By testing with a paint spraying room in an industrial factory with an area of 200 square meters for 120 minutes, it was found that when testing using an amount of ozone gas of 3.9 ppm, it would result in the amount of carbon monoxide gas. carbon dioxide and alcohol gas will decrease. Part 2, a high efficiency HEPA air filter set, can capture PM2.5 dust particles with a dust trapping efficiency of 98.37 percent as measured by a standard dust meter and part 3, a high intensity ozone gas production set can increase efficiency in eliminating toxic gases and eliminating bad odors very well. This innovation to eliminate toxic air gases has passed the analysis of total electricity consumption, analyze leakage safety standards, grounding preparation testing, and electrical durability for the safety of users, it is completed.

Keywords: toxic gas, ozonation, dust, static electricity, corona discharge.

Research and Construction of Innovation to Reduce Air Humidity by Appling Electric Field Intensity Energy

Siseerot KETKAEW[1,*]

[1]Faculty of Engineering, Ramkhamhaeng University, Ramkhamhaeng Street, 10240, Bangkok, Thailand

[*]siseerotketkaew14@gmail.com

Abstract. This research paper presents research and construction of innovation to reduce air humidity by appling electric field intensity energy consists of 2 parts: Part 1, a set of high-intensity non-uniform electric field cells with the corona discharge process to cause ionization to break the bonds of water molecules for use in reducing the relative humidity in the air using the technique of adjusting the high voltage voltage in the high voltage circuit to control the intensity of the electric field, and Part 2 is a set to reduce the amount of ozone gas using an ultraviolet light with a wavelength of 253.7 nm. Part 1 has designed and construction a set of electric field cells consisting of a corona wire placed between two aluminum plates and High voltage flyback converter circuit consists of a high frequency pulse generator using IC number 555 for adjusting the electric field intensity from 5 kV/cm to 25 kV/cm under the adjustment of a high voltage of 1 kilovolt to 5 kilovolts, respectively, by using a pulse signal to stimulate the work of the IGBT to control the operation of high-frequency high-voltage transformers to produce high voltage electricity for supplying electrical energy to a set of electric field cells. The test results were that when measuring the relative humidity in the air, it was found that the electric field intensity was 25 kV/cm at a wind speed of 1 m/s able to reduce the amount of relative humidity in the air by 50%RH and produce 1 ppm of ozone gas in the computer laboratory, area size 20 square meters, in 60 minutes, and in the set to reduce the amount of ozone gas, it will be found the amount of ozone gas produced by the electric field set will be reduced to 0.01 ppm (OSHA or the Occupational Safety and Health Administration Set a requirement that you should not work in areas with an ozone concentration of more than 0.10 ppm. for more than 8 hours.) This research has passed the overall power consumption analysis test. and analyze safety standards regarding electrical leakage for the safety of users It is already completed at the testing room of the Electrical and Electronic Product Testing Center (ESET), NSTDA, and in the future, it can be further developed into an innovation that can be used for real use.

Keywords: humidity, electric field, corona discharge, ionization, convertor.

Decoding Magnetic Signatures in Magnetotactic Bacteria through Comparative Magnetometric Analysis

Natalia Lorela PAUL[1,2,3,*], Mihai GABOR[3,4,5], Mircea NASUI[3,4,5], Elena Rodica IONESCU[2,3], Catalin Ovidiu POPA[1,3,*]

[1]Materials Science and Engineering Department, Faculty of Materials and Environmental Engineering, Technical University of Cluj-Napoca, 400641 Cluj-Napoca, Romania
[2]Light, nanomaterials and nanotechnology (L2n) Laboratory, CNRS UMR 7076, University of Technology of Troyes, 12 Rue Marie Curie, CS 42060, CEDEX, 10004 Troyes, France
[3]Eut+ Institute for Nanomaterials & Nanotechnologies EUTINN, European University of Technology, European Union
[4]Centre for Superconductivity, Spintronics and Surface Science, Technical University of Cluj-Napoca, 400114 Cluj-Napoca, Romania
[5]Physics and Chemistry Department, Technical University of Cluj-Napoca, 400114 Cluj-Napoca, Romania

[*]natalia.paul@utt.fr; *natalia.paul@stm.utcluj.ro; *catalin.popa@stm.utcluj.ro

Abstract. Magnetic characteristics are a distinct way to explore the link between biomineralization processes and the varied application potential of magnetotactic bacteria (MTB). In this study, we analyzed the magnetic responses of four different strains - Magnetospirillum magnetotacticum (MS-1), Magnetospirillum aberrantis (SpK), Desulfamplus magnetovallimortis (BW-1) and Magnetospirillum gryphiswaldense (MSR-1). The research methodology correlates hysteresis measurements, remanent and saturation magnetization assessments with the structural attributes of magnetosomes (size, morphology and intracellular arrangement). The obtained results reveal differences between strains suggestive of variations in biomineralization mechanisms and the degree of organization of magnetic crystals. Strains MS-1 and MSR-1 have a more uniform magnetic response, correlated with the presence of ordered magnetosomal chains. In contrast, the behavior of strains BW-1 and SpK is more varied, due to the distribution of magnetic inclusions. These results highlight the unique magnetic properties of each strain, and the varied potential of MTB in nanotechnology and biomedicine.

Keywords: magnetotactic bacteria, magnetosomes, magnetometric analysis, magnetic properties, nanobiotechnology.

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Research Advances and Challenges in Additive Manufacturing of Biomaterials for Patient-Specific Hand Joint Implants

Larisa POPESCU[1,*], Daniel VILCIOIU[2], Aurora ANTONIAC[1], Robert CIOCOIU[1], Iuliana CORNESCHI[1], Iulian ANTONIAC[1]

[1]National University POLITEHNICA of Bucharest, Faculty of Material Science and Engineering, ,313 Splaiul Independentei Street, 060042, Bucharest, Romania
[2]Clinica de Chirurgia Mâinii Dr. Vilcioiu, Calea Floreasca 112, 014463 București

[*]maria.popescu2010@upb.ro

Abstract. Additive manufacturing (AM) enables the fabrication of patient-specific implants with complex geometries. While these technologies are widely used for large joint prostheses and trauma implants, the development of implants for small hand joints, such as metacarpophalangeal and interphalangeal joints, remains challenging due to their small dimensions, complex loading conditions, and bone remodeling processes.Biomaterials for hand surgery implants include metals (titanium alloys, stainless steel, Nitinol), polymers (silicone, PE), ceramics, and pyrolytic carbon. Key applications involve small joint arthroplasty (silicone spacers), fracture fixation (bioabsorbable PLA, titanium screws), and soft tissue repair.Key properties are required for these biomaterials, such as biocompatibility, adecquate mechanical properties, surface properties, and stability in time. Advanced design strategies are possible to be made today due to the advancements in processing of medical image obtained by CT/MRI, new software for design, additive manufacturing techniques, including bioinspired shapes and gradient porous architectures who aim to mimic bone structure and enhance biological integration. Additionally, the integration of antimicrobial coatings and bioactive agents, represents an important direction for the development of personalized implants with multiple properties for hand surgery.

Keywords: biomaterials, additive manufacturing, hand surgery, implants, design, surface.

Impact of Thermal Modernization Strategies and Heating Systems on the Energy Performance of a Historic Building

Aleksandra KUŚMIERSKA[1] , Mariusz KOSIŃ[1,*], Joanna GONDRO[2]

[1]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, Akademicka Street 3, Czestochowa 42-201, Poland
[2]Czestochowa University of Technology, Faculty of Production Engineering and Materials Technology, Department of of Physics, Al. Armii Krajowej Street 19, Częstochowa 42-201, Poland

[*]mariusz.kosin@pcz.pl

Abstract. Improving the energy efficiency of historic buildings is a key challenge in heritage conservation, requiring a balance between reducing energy consumption and preserving architectural value. This study evaluates the impact of different thermal modernization strategies and heating systems on the energy performance, environmental impact, and operating costs of a historic residential building. A case study of a manor house in southern Poland was conducted. Two insulation approaches were analysed: internal insulation, compliant with conservation requirements, and external insulation as a comparative option. Additionally, two heating systems were considered: a hybrid system (gas boiler + heat pump) and a heat pump system integrated with mechanical ventilation and heat recovery. Calculations based on national methodology enabled comparison of energy demand, emissions, and costs. Results show that insulation location has limited influence when similar thermal parameters are achieved, whereas the choice of heating system significantly affects performance. The heat pump-only system proved most advantageous in terms of environmental impact and operating costs.

Keywords: historic buildings, heritage conservation, thermal modernization, energy efficiency, heat pump systems, historic manor house.

Conservation and Adaptation of Historic Tenement Houses as a Tool for Shaping Urban Identity: The Case of Częstochowa

Nina SOŁKIEWICZ-KOS[1,*], Malwina TUBIELEWICZ-MICHALCZUK[1], Paweł PIETRUSIEWICZ[2]

[1]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, Akademicka Street 3, Czestochowa 42-201, Poland
[2]Czestochowa University of Technology, Faculty of Production Engineering and Materials Technology, Department of of Physics, Al. Armii Krajowej Street 19, Częstochowa 42-201, Poland

[*]n.solkiewicz-kos@pcz.pl

Abstract. The article addresses the issues of conservation and adaptation of historic buildings as significant city-forming elements that directly influence concepts for the development of historic urban zones. The subject of analysis is the medium-sized city of Częstochowa, selected due to its historical and cultural significance at the national level, as well as its particular role as a pilgrimage, academic, and tourist center. In cities of this type, architectural and urban planning solutions should reflect the uniqueness of the place and its cultural identity. The article discusses measures aimed at organizing the historic urban fabric of downtown complexes, using historic residential tenement houses as case studies. The analysis emphasizes the potential of heritage protection and properly conducted adaptation processes as key factors in improving the city's image, integrating contemporary functional needs with the historical legacy of the place, and fostering social and local activation. The research includes an analysis of scientific and professional literature, participant observation, and a review of design documentation for selected historic tenement houses. The conclusions indicate the need to enhance the aesthetic and functional values of historic buildings while respecting the cultural context. Historical heritage, combined with appropriately implemented adaptation measures, can create a new and attractive downtown space. Conservation and adaptation activities constitute an effective form of cultural heritage protection under conditions of a market economy, complex ownership structures, and modernization pressures affecting central urban areas.

Keywords: cultural heritage protection, conservation, revitalization of downtown areas, renovation of monuments.

Assessment of the Technical Condition of the Historic Underground Complex in Będzin (Poland)

Przemysław KASZA[1], Maciej MAJOR[1,*], Marcin NABIAŁEK[2]

[1]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, Akademicka Street 3, Czestochowa 42-201, Poland
[2]Czestochowa University of Technology, Faculty of Production Engineering and Materials Technology, Department of of Physics, Al. Armii Krajowej Street 19, Częstochowa 42-201, Poland

[*]maciej.major@pcz.pl

Abstract. This paper presents a comprehensive assessment of the technical condition of the historic underground complex located beneath Castle Hill in Będzin, Poland. The study is based on field inspections, non-destructive testing, structural analysis, and documentation review. Particular attention is given to the evaluation of structural elements, including concrete linings and steel supports, as well as to environmental factors such as moisture and corrosion. The results indicate a heterogeneous technical condition, with generally stable rock mass and concrete structures, but significantly degraded steel elements. The study identifies key threats to structural durability and safety and provides a basis for future conservation and adaptive reuse strategies.

Keywords: underground heritage, technical assessment, structural condition, conservation, Będzin.

Antibacterial Coatings for the Protection of Religious Artifacts

Kinga JEŻ[1,*], Marcin GACEK[2]

[1]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, Akademicka Street 3, Czestochowa 42-201, Poland
[2]Czestochowa University of Technology, Faculty of Production Engineering and Materials Technology, Department of of Physics, Al. Armii Krajowej Street 19, Częstochowa42-201, Poland

[*]kinga.jez@pcz.pl

Abstract. Nowadays, epidemics related to the excessive emission of viruses and bacteria are very common. Society is becoming increasingly susceptible to viral and bacterial infections, which are becoming more difficult to combat. The increased number of available, not fully tested vaccines and antibiotics produced in the laboratories of pharmaceutical companies does not contribute to solving this problem. 90% of superficially tested medicines are a temporary solution that does not address the problem in a generational or long-term sense. This statement is often controversial, but the safest options are natural or well-tested medications. It should be noted that the human body's defense mechanisms react differently to viral and bacterial infections. The use of antiviral vaccines and antibiotic therapy against bacteria is common. This scientific study will present the issue of transmission of the bacterium Pseudomonas aeruginosa in places of religious worship, with the greatest emphasis on church objects that are constantly touched by the faithful.

Keywords: Pseudomonas aeruginosa, religious Religious Artifacts, infection, bacteria, silver nanoparticles.

Acoustic Performance of Recycled Polymer Panels Manufactured by Fused Granular Fabrication

Mihai Alin POP[1,*], Andrada CIUFU[1]

[1]Materials Science Department, Transilvania University of Brasov, 29 Eroilor Ave., 500484 Brasov, Romania, Romania

[*]mihai.pop@unitbv.ro

Abstract. In this paper, the authors demonstrate the importance of recycling polymeric materials resulting from 3D printing processes. Filament scraps and discarded parts were shredded, and with the help of the PioCreat G5 – Fused Granular Fabrication printer, sound-absorbing panels with alpha coefficients over 0.9 were obtained. Three internal architectures were used, namely cross, grid and zigzag, and each of them with a specimen height of 2, 4, 6, 8 and 10 mm. The best results were recorded with the internal zigzag configuration, height of 8 mm at a frequency of 500 Hz. and the value of the alpha coefficient of 0.98. The frequency of 500 Hz is in the middle of the audio spectrum (sounds clearly perceived by the human ear), so it appears in many areas where there are mechanical vibrations, air flows, rotating machinery, manufacturing lines, metal processing, document copying offices, etc. In addition to the high acoustic performance at this frequency that makes them a very good solution for improving comfort in the work environment, they can also be used for decorative purposes since any geometric shape can be obtained through the 3D printing process.

Keywords: 3D printing, sound-absorbing panels, polymeric materials, recycling, occupational health.

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Performance Improvement of Hygienic and Olfactory Properties in Military Base Layer Textiles

Emilia VISILEANU[1,*], Elena PERDUM[1], Roxana CONSTANTINESCU[1], Alina VLADU[1], Felicia DONDEA[1,2], Florin MICULESCU[2], Aura Cătălina MOCANU[2], Daniela MANOLE[2]

[1]The National Research and Development Institute for Textiles and Leather 16, Lucretiu Patrascanu Street, district 3, code 0305608, Bucharest, Romania
[2]Department of Metallic Materials Science, Physical Metallurgy, National University of Science and Technology Politehnica Bucharest, 313 Splaiul Independentei, J Building, District 6, 060042 Bucharest, Romania

[*]e.visileanu@incdtp.ro

Abstract. Military base layer garments, worn directly against the skin, play a crucial role in ensuring hygiene, comfort, and sustained operational performance under prolonged and physically demanding missions. In such conditions, bacterial proliferation and the accumulation of odour-causing compounds can negatively impact skin health, comfort, and mission effectiveness. Optimising these functional properties is therefore critical for military textile equipment. This study evaluates the hygienic and olfactory performance of base layer materials. Antibacterial activity is quantified using standardised protocols, including ISO 20743 and AATCC 100, alongside modern rapid microbiological assays and instrumental techniques to assess microbial viability. Odour-control performance is determined through standardised organoleptic tests, sensory panels, and advanced instrumental methods such as gas chromatography (GC) and electronic nose systems, capable of identifying and quantifying volatile compounds responsible for unpleasant odours. A key focus of this research is the durability of functional effects under real-world conditions. Experiments will simulate repeated laundering, mechanical abrasion, and prolonged wear to determine the persistence of antibacterial and odour-control properties. This approach provides essential insights into the long-term effectiveness of treated base layer garments in operational environments. By integrating performance evaluation with durability testing, this study demonstrates the potential of advanced textile solutions to maintain hygiene, reduce microbial contamination, and enhance olfactory comfort, even under challenging operational conditions. Such functional optimisation supports the well-being, readiness, and effectiveness of military personnel, highlighting the importance of targeted material design in modern military applications.

Keywords: military textiles, base layer garments, antibacterial performance, odour control, functional durability, hygiene.

Service Behavior of Novel Biodegradable Mg-Zn Alloys for Biomedical Applications

Francisco M. Sánchez SOSA[1,*], Julia C. MIRZA ROSCA[1]

[1]Department of Mechanical Engineering, Universidad de Las Palmas de Gran Canaria, Spain

[*]francisco.sanchez@alu.ulpgc.es

Abstract. The biodegradable impants represents a key research line in modern biomedical engineering, in temporary implants. Magnesium based alloys have attracted significant attention due to their biocompatibility, low density, and elastic modulus close to that of human bone. However, the high corrosion rate of Mg limits its clinical application, motivating the development of Mg-Zn alloys with improved degradation control [1]. In this work we will study six compositional variants of Mg-Zn alloys (1.4 -7.8 wt.% Zn), in order to evaluate their service behavior. The experimental methodology includes metallographic analysis, microhardness testing, and electrochemical characterization. The impedance data were fitted using equivalent electrical circuit models to better understand the corrosion mechanisms. The results indicate that increasing of the concentration of Zn improves the hardness of the alloys, as well as their corrosion resistance. Alloys with intermediate Zn content exhibit best performance, showing reduced corrosion rates and improved electrochemical stability. However, excessive Zn content may lead to microstructural defects such as porosity, negatively affecting mechanical integrity. In conclusion, Mg-Zn alloys demonstrate strong potential as bioabsorbible material for medical applications, offering a balance between mechanical strength and controlled degradation. The optimization of Zn content is critical to achieving the desired performance, and further research should focus on microstructural control and long-term in vivo validation to ensure clinical applicability.

Keywords: Mg-Zn alloys, biodegradable biomaterials, corrosion, electrochemical impedance spectroscopy, microhardness, biomedical implants.

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Organosilane Functionalization of ZnO Quntum Dots: A Versatile Platform for Antitumor Applications

Mariana BUSILA[1,*], Alexandra Virginia BOUNEGRU[1], Aurel TABACARU[1]

[1]„Dunarea de Jos" University of Galati, Romania

[*]mariana.busila@ugal.ro

Abstract. Zinc oxide quantum dots (ZnO QDs) are promising nanomaterials for biomedical applications due to their wide band gap, photoluminescence properties and intrinsic biocompatibility. The morphology and surface structure influence their interactions with biological cells and, implicitly, their efficacy in biomedical applications, such as cancer therapy [1,2]. In this work, we present bottom-up approaches used in the synthesis of ZnO QDs, such as sol-gel, hydrothermal and microwave-assisted methods, which allow control of their size and morphology. To enhance their stability and functionality, the nanoparticles were surface functionalized with different types of organosilanes, including aminosilanes, mercaptosilanes, epoxysilanes and carboxysilanes. This modification led to the formation of a stable organic-inorganic interface, improving colloidal stability, tunability of surface charge, and allowing subsequent conjugation with targeting molecules or therapeutic agents. The functionalized ZnO QDs were characterized using TEM, FTIR, UV-Vis and photoluminescence spectroscopy, confirming the successful modification of the surface while preserving the optical properties. From a biomedical perspective, the obtained nanostructures exhibit significant antitumor potential, mainly through the generation of reactive oxygen species (ROS), induction of apoptosis and targeted delivery mechanisms. These results highlight the potential of organosilane-functionalized ZnO QDs as versatile platforms for cancer theranostics.

Keywords: ZnO quantum dots, organosilane functionalization, antitumor activity, surface engineering.

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Restoration and Conservation of a Personal Document with a Metal Object from the Cover

Dimka FACHIKOVA[1,*], Iskra TSVETANSKA[1]

[1]University of Chemical Tehnology and Metallurgy, 8 Kliment Ohridski Blvd., 1756 Sofia, Bulgaria

[*]dimkaivanova@uctm.edu

Abstract. The object presented for restoration and conservation is a document – a congratulatory address to Dr. Angel D. Pyuskyuliev – Bulgarian physician, philanthropist, director of the National Health Service, chairman of the Sixth Council of Ministers (1892-1894) and mayor of the city of Varna, in post-liberation Bulgaria, with a metal object on the cover. The document was donated and is currently part of the collection of the Museum at the Medical University, Varna. The metal object is a casting representing the symbol of medicine – a cup with two snakes around it, which is located at the top of the front cover of the document. The surface of the frame before processing was of an uneven black-gray color and covered with dirt and corrosion products. SEM and EDX analyses determined the elemental composition of the substrate and the remnants of the original coating, as well as the topography and morphology of the surface. It was found that the body of the object is made of brass, and the coating applied to the latter is silver. The silver plating was carried out in order to improve the durability and decorative appearance of the object. The restoration of the metal object was carried out in the following sequence: removal of dirt, corrosion products and silver coating residues, surface treatment and electrolytic application in a cyanide bath of a silver coating with a thickness of about 20 μm. The silver coating is treated in a special passivating solution.

Keywords: silver coatings, restoration of brass, conservation coatings.

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Modeling and Dynamic Analysis of Synchronized Hydraulic Drives of an Automatic Machine for Forming Ceramic Blanks from Plastic Ceramic Mass

Viktor BILICHENKO[1], Yurii A. BURIENNIKOV[1], Yurii Yu. BURIENNIKOV[1], Leonid KOZLOV[1,*], Viacheslav PEREPELITSIA[1], Oleksandr PETROV[1], Viktor PURDIK[1]

[1]Vinnytsia National Technical University, 95, Khmelnytske Shose, 21021, Vinnytsia, Ukraine

[*]osna3030@vntu.edu.ua

Abstract. The paper considers an automatic machine for forming blanks from plastic ceramic mass. The machine is equipped with a feeding unit for a plastic ceramic bar, which moves uniformly relative to the machine along the carriage surface. The moving carriage, with a traverse mounted on it, performs reciprocating motions during which the bar is cut by the traverse wires. Six blanks are cut simultaneously. The carriage and traverse are driven hydraulically. The operation of the hydraulic drive is controlled by a programmable controller based on a signal from a displacement sensor. During operation, synchronization of the motion of the bar and the traverse is ensured, which provides the required geometric dimensions of the brick blanks. A nonlinear mathematical model of the machine has been developed. The mathematical model includes experimentally determined characteristics of the solenoid of a proportional throttle valve, the cutting force of the bar by the wires, the flow characteristics of the proportional throttle valve, and the dynamic properties of the controller. Based on the mathematical model, a study was carried out on the influence of hydraulic drive parameters and the shape of the controller control signal on the magnitude of the error occurring during blank formation. A control signal shape in the form of a piecewise fractional function has been determined, for which the dimensional error of the blanks does not exceed the permissible limits.

Keywords: automatic machine, hydraulic drive, mathematical model, controller, control signal generation, dimensional error of blanks.

Fractional-Order PID Control for Condensation Pattern Generation Using Thermoelectric Modules

Miguel FERRER[1,*], Carlos SÁNCHEZ[2], Federico LEÓN[2], Alejandro RAMOS[1]

[1]University Institute of Intelligent Systems and Numerical Applications in Engineering, University of Las Palmas de Gran Canaria, Spain
[2]Department of Process Engineering, University of Las Palmas de Gran Canaria, Spain

[*]miguel.ferrer104@alu.ulpgc.es

Abstract. This work presents a fractional-order proportional-integral-derivative (FOPID) control strategy for generating controlled patterns of water condensation on surfaces using thermoelectric cells. A thermoelectric module was driven through pulse-width modulation to regulate surface cooling, enabling the formation of structured condensation phenomena. The ambient temperature and relative humidity were used to estimate the dew point temperature. This temperature served as a dynamic reference for controlling phase change and the onset of condensation. The controller that has been implemented uses integral and non-integral derivative commands to improve thermal regulation under the slow, nonlinear and coupled dynamics of the thermoelectric system. The experimental results demonstrated the efficacy of the proposed FOPID controller in maintaining surface temperature near the dew point. This was achieved with reduced overshoot and enhanced stability, surpassing the performance of conventional integer-order control methods. This enabled reproducible and spatially coherent condensation patterns to be achieved on the cooled surface. The proposed methodology demonstrates a simple and low-cost approach for programmable condensation pattern generation, with potential applications in surface engineering, anti-fogging systems, atmospheric water harvesting, and thermal management.

Keywords: FOPID, thermoelectric cells, condensation control, dew point tracking, thermal regulation.

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Health and Safety Implications of Powders in 3D Printing and Laser Cladding

Claudia-Corina MICU[1], Dan-Cristian CUCULEA[1,*], George-Laurențiu ARDELEAN[1], Alexandru PASCU[1], Elena-Manuela STANCIU[1]

[1]Transilvania University of Brașov, Faculty of Materials Science and Engineering, Department of Materials Engineering and Welding, Brașov 500036, Romania

[*]dan.cuculea@unitbv.ro

Abstract. As additive manufacturing becomes more relevant in modern industry, the workers are facing rising exposure to health threats caused by powder morphology and particle size. The medical consequences of using the metallic powders are not fully understood and not easily observed [1]. In the laser cladding process, fine metallic particles remain airborne for longer periods leading to inhalation risks and the contamination of operators protective clothing. This study analyzes how powder characteristics, mainly composed of Ni, Cr, Nb, Ti and Polyamide 12 used in various manufacturing processes ranging from surface engineering to Selective Laser Sintering, interact with and impact textile fabrics. The experimental tests were carried out by using a Laser Trumpf Trupulse 556 with Precitec YC50 cladding module, a SLS Center sPro and for analyzing the fabrics and the airborne dust a SEM Tescan Vega LMU and SERS Raman StellarCASE. The results show that additive manufacturing can present high risks for health of personnel that is exposed to fumes and residual particles resulted during laser processing.

Keywords: laser cladding, health and safety, metallic powders, SLS.

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The Effect of Zeolite Aggregates on the Performance of Geopolymers in Marine Environmental Remediation Processes

Dumitru Doru BURDUHOS NERGIS[1,2], György DEÁK[3], Petrica VIZUREANU[1,2,*], Andrei Victor SANDU[1,2]

[1]Faculty of Materials Science and Engineering, "Gheorghe Asachi" Technical University of Iasi, Prof. D. Mangeron Street, No. 41, 700050, Iasi, Romania
[2]Romanian Inventors Forum, Sf. P. Movila 3, Iasi, Romania
[3]National Institute for Research and Development in Environmental Protection, 294 Splaiul Independenței, 6th District, 060031, Bucharest, Romania

[*]peviz2002@yahoo.com

Abstract. Marine pollution, exacerbated by industrial activities and contaminants related to armed conflicts, calls for the development of advanced materials that enable efficient, sustainable decontamination. Geopolymers represent a promising class of materials due to their aluminosilicate structure and their ability to adsorb a wide range of pollutants. This study investigates the influence of zeolite aggregates on the structural, morphological, and functional properties of geopolymers, as well as on their effectiveness in seawater decontamination processes. In this study, metakaolin-based geopolymer systems were developed, both without additives and with zeolite aggregates, to investigate the resulting microstructural changes and their impact on material performance. The incorporation of zeolite aggregates results in a more interconnected structure and an increase in the active surface area, thereby favoring adsorption and ion-exchange processes. The study demonstrates the potential of geopolymers modified with zeolite aggregates as effective solutions for decontaminating polluted seawater.

Keywords: marine pollution, armed-conflict pollution, remedial solutions, oil spills, zeolite aggregates.

Acknowledgements: This work has been carried out through the project Black Sea SIERRA Harnessing complementary curricular preparedness via sustainable management in response to civil and military pollution on the coastline, tributaries and lagoons in Black Sea's North, West, South zone, funded through the call EMFAF-2023-PIA-FLAGSHIP by the European Climate, Infrastructure and Environment Executive Agency (CINEA). Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Innovative Flotation-based Wastewater Treatment Technologies Employing Magnetic Oxide Nanomaterials

Sorin IONESCU[1], Ancuta VLAD[1], Corina Ioana MOGA[1], Sorin Stefan BIRIS[1], Gigel PARASCHIV[1], Cristina-Ileana COVALIU-MIERLA[1,*]

[1]University of Science and Technology Politehnica Bucharest, 313 Splaiul Independenței, 060042, Bucharest, Romania

[*]ileana.covaliu@upb.ro

Abstract. The advancement of nanotechnology have introduced new and efficient approaches for pollutant removal from wastewater through the use of nanomaterials, which exhibit unique structural and morphological properties. Flotation is a widely applied conventional method in wastewater treatment. This study aims to enhance the efficiency of flotation-based wastewater treatment by incorporating magnetic oxide nanomaterials ($NiFe_2O_4$and $CuFe_2O_4$) into a novel technological system. Both nanomaterials were synthesized and characterized structurally and morphologically through XRD and TEM analyses. The results demonstrated that the use of magnetic oxide nanomaterial led to high wastewater treatment efficiency, improved foam stability, and reduced treatment time.

Keywords: innovative flotation, magnetic oxides, wastewater treatment.

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Acknowledgements: This work was carried out under the PN-IV-P7-7.1-PTE-2024-0200 Innovative flotation installation with hybrid ecological nanomaterials, used in wastewater treatment.

Nanotechnologies and Nanomaterials with Potential Applications in Industrial Wastewater Treatment

Cristina-Ileana COVALIU-MIERLA[1,*], Gigel PARASCHIV[1]

[1]University of Science and Technology Politehnica Bucharest, 313 Splaiul Independenței, 060042, Bucharest, Romania

[*]ileana.covaliu@upb.ro

Abstract. Over recent years, nanotechnology has emerged as an advanced and effective approach for the removal of pollutants compounds from wastewater. This paper focuses on the use of nanomaterials in the treatment of wastewater contaminated with heavy metals. Due to their high surface area and specific adsorption capacity, nanoparticles are widely applied in water treatment implying different processes. Compared to conventional methods, nanomaterial-based depollution techniques are generally more cost-effective, require less time and energy, and produce little to no secondary waste. The aim of this review is to provide a comprehensive overview of the applications of nanomaterials in industrial wastewater treatment. Several studied directions include the use of adsorbents such as magnetic oxides, zeolites, and carbon nanotubes, as well as catalysts like titanium dioxide and zinc oxide in the processes of removal of pollutants from wastewater.

Keywords: nanotechnology, nanomaterials, magnetic oxides, titanium oxides, carbon nanotubes, wastewater treatment.

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Acknowledgements: This work was carried out under the PN-IV-P7-7.1-PTE-2024-0200 Innovative flotation installation with hybrid ecological nanomaterials, used in wastewater treatment.

Cy5–Trastuzumab Conjugation Optimization for HER2-Targeted Optical Imaging Probe Development

Matthis Shanshu LEE[1], Leonard Shanji LEE[1,*]

[1]Taiwan Math Science Circle, 2F., No. 390, Beitun Rd., Beitun Dist., Taichung City, Taiwan

[*]leo701347@gmail.com

Abstract. Cy5–trastuzumab conjugates represent a promising platform for HER2-targeted optical imaging probe development by combining the targeting specificity of trastuzumab with the fluorescent properties of Cyanine5 (Cy5). Conjugation efficiency and labeling performance were evaluated using 2X, 4X, and 8X Cy5-to-trastuzumab molar excesses under aqueous buffer conditions. Purification was performed following conjugation, and the resulting products were characterized using UV/Vis spectroscopy and high-performance liquid chromatography (HPLC). UV/Vis analysis showed a progressive increase in dye-to-antibody ratio from approximately 0.33 at 2X to 0.58 at 4X and 0.77 at 8X, indicating increased fluorescent loading with higher Cy5 input. HPLC analysis demonstrated corresponding UV and fluorescence peaks, confirming Cy5 co-elution with the antibody-containing fraction. The 2X and 4X conditions produced relatively clean co-elution profiles, while the 8X condition showed broader peak tailing and increased heterogeneity, suggesting reduced conjugate uniformity at higher labeling ratios. These findings indicate that increased Cy5 input improves fluorescent loading only to a practical limit, after which additional dye contributes limited benefit and greater structural variability. The optimized Cy5-trastuzumab conjugate provides a preliminary foundation for further evaluation of HER2-targeted optical imaging performance.

Keywords: Fluorescence Probe, ADC.

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Development of a Clitoria ternatea Anthocyanin-Based pH-Sensitive Pad for Early Detection of Pressure Ulcer Risk

Yu-Chen LAI[1], Shu-Meng CHANG[1,*]

[1]University of North Carolina at Chapel Hill, 200 E Cameron Ave, Chapel Hill, NC 27514, USA

[*]pa081001ma@gmail.com

Abstract. A low-cost, electricity-free, and non-toxic visual warning pad was developed for the early prevention of pressure ulcers (bedsores) in long-term bedridden patients. Anthocyanins extracted from Clitoria ternatea were used as a natural pH indicator because of their clear color-changing properties under different acid–base conditions. A multilayer sensing structure consisting of a sponge layer, Clitoria ternatea-dyed fabric, and plastic wrap was designed to simulate body fluid leakage under pressure. The sensing fabric showed accurate color changes within the pH range of 5 to 8, changing from blue to purple and green as alkalinity increased, corresponding to the pH rise commonly observed during early skin damage and pressure ulcer formation. The material demonstrated good water absorption, structural stability, and clear color visibility. Under pressure simulation, color diffusion appeared within 5 seconds, providing an immediate and intuitive warning signal for caregivers. The natural plant-based indicator also avoided the potential risks of chemical dyes and improved safety for direct skin contact. Further improvements should focus on enhancing long-term color stability, durability under repeated pressure, and testing under real clinical conditions. Optimization of the multilayer structure and pH sensitivity may improve reliability and support wider application in long-term care settings.

Keywords: pressure ulcer prevention, clitoria ternatea, anthocyanin, natural pH indicator, colorimetric sensor, non-toxic healthcare material.

Development of Green Hybrid Composite Autonomous Surface Vehicle Searching Boat

Suriani MAT JUSOH[1,2,*]

[1]Faculty of Ocean Engineering Technology, Universiti Malaysia Terengganu, 21300, Kuala Nerus, Terengganu, Malaysia
[2]Marine Materials Research Group, Faculty of Ocean Engineering Technology, Universiti Malaysia Terengganu, 21300, Kuala Nerus, Terengganu, Malaysia
[3]Biocomposite Lab, Institute of Tropical Forestry and Forest Product (INTROP), Universiti Putra Malaysia, 43400, Serdang, Selangor, Malaysia

[*]surianimatjusoh@umt.edu.my; [*]surianimatjusoh@gmail.com.my

Abstract. The marine composite industry remains heavily dependent on fully synthetic fibre-reinforced polymers, particularly glass fibre composites, which present environmental concerns related to non-biodegradability and high embodied energy. Hybridisation with natural fibres offers a promising strategy to reduce environmental impact while maintaining structural performance. This study investigates the development of a high-performance woven kenaf/glass fibre hybrid polyester composite for marine hull applications, with particular emphasis on material design, mechanical performance, and structural integration. A layered hybrid composite architecture was designed by strategically combining woven kenaf fabric with woven glass fibre reinforcement within a polyester matrix. The hybrid configuration was engineered to optimize load transfer efficiency, interfacial bonding, and stiffness-to-weight ratio while mitigating the intrinsic hydrophilicity and variability associated with natural fibres. The fabricated laminates were characterized in terms of mechanical behaviour, structural integrity, and suitability for dynamic marine loading conditions. Failure mechanisms and hybrid interaction effects were analysed to elucidate the synergistic contribution of kenaf and glass fibres to overall composite performance. The optimized hybrid laminate was subsequently applied in the fabrication of a high-speed boat hull prototype integrated with an Autonomous Surface Vehicle (ASV) system. Material–structure compatibility and system-level performance were evaluated to assess the feasibility of employing bio-based hybrid composites in functional marine platforms. The results demonstrate that partial substitution of synthetic reinforcement with woven kenaf can achieve competitive structural performance while reducing synthetic fibre dependency and material density. This work advances the understanding of natural/synthetic fibre hybridisation in marine-grade composites and provides a scalable material design framework for sustainable, high-performance structural applications in next-generation maritime systems.

Keywords: Autonomous Surface Vehicle (ASV), hybrid composite, natural fibre reinforced composite, Kenaf fibre, material design.

Advanced Treatment of Recalcitrant Industrial Wastewater: Validation of a Tri-Component System Using Ligninolytic Fungi and Hybrid MBBR Technology

Ioana-Corina MOGA[1,*], Ovidiu IORDACHE[2], Bogdan CAZAN[2], Gabriel PETRESCU[1], Elena PERDUM[2]

[1]DFR Systems SRL, Drumul Taberei Street No. 46, sector 6, Bucharest, Romania
[2]National Research and Development Institute for Textile and Leather (INCDTP), Lucretiu Patrascanu Street No. 16, 030508, Bucharest, Romania

[*]corinamoga@yahoo.com

Abstract. Industrial effluents from the textile and leather sectors pose a persistent challenge for conventional treatment plants due to high loads of synthetic azo dyes and heavy metals that resist biodegradation. The 3TREAT project addresses this by proposing an integrated tri-component system that combines ligninolytic macromycetes with a Moving Bed Biofilm Reactor (MBBR) and downstream ultrasonic polishing. A screening of seven macromycete strains identified Pholiota nameko and Flammulina velutipes as top performers, achieving decolorization efficiencies of up to 85.6% on synthetic dye solutions. Morphological characterization using SEM–EDAX confirmed a dense hyphal architecture compatible with the specialized polymer carriers used in the process. Based on these findings, a 5 L pilot-scale bioreactor was developed to operate as a bubble-aerated MBBR under optimized air flow and pH conditions. This modular platform offers a reproducible and sustainable alternative to traditional oxidation methods, effectively treating wastewater without generating toxic byproducts.

Keywords: textile wastewater, fungal bioremediation, MBBR, hybrid treatment, textile dyes.

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SECTION 4

MATERIALS & LIFE SCIENCE

Preservation and Conservation Issues of the Salesian Monastery Facade in Oświecim: Lessons from Ukrainian Practice

Mykola ORLENKO[1], Krystyna PAPRZYCA[2,*], Yulia IVASHKO[3], Andrii DMYTRENKO[4], Ks. Łukasz KRYSMALSKI[5], Bianka BOROS[6]

[1]Ukrrestavratsiia Corporation, 6 Boryspilska Street, Kyiv, 02099, Ukraine
[2] Academy of Silesia, Faculty of Architecture, Civil Engineering and Applied Arts, 43 Rolna Street, 40-555, Katowice, Poland
[3]Kyiv National University of Construction and Architecture, 31 Povitrianykh Syl Avenue, Kyiv, 03037, Ukraine
[4]National University "Yuri Kondratyuk Poltava Polytechnic", 24 Vitaliia Hrytsaienka Avenue, Poltava, 36011, Ukraine
[5]John Bosko Salesian Monastery,10 Władysława Jagiełły Street, 32-600, Oświęcim, Poland
[6]"George Enescu" National University of Arts of Iasi, Faculty of Visual Arts and Design, 29 Cuza Vodă St., (Casa Balş), 700040 Iași, Romania

[*]kpaprzyca@gmail.com

Abstract. The research is devoted to the study of the problems of conservation and restoration of facades of historical buildings, considered on the example of the Salesian Monastery in Oświęcim. The main problems that arise in this case and ways to solve them are highlighted. A comparison of facade restoration technologies adopted in Polish and Ukrainian restoration schools, and their development during the 19th – 20th centuries, is carried out.General strengthening of walls and strengthening of brickwork in many cases allows for the elimination of the emergency state of buildings; however, these works should, as a rule, be carried out together with measures to strengthen the foundations and substructures, which are in many cases the root cause of wall deformation. In some cases, it is necessary to first strengthen and strengthen the walls and then proceed to strengthen the foundations.

Keywords: facade, preservation, conservation, Salesian Monastery, Oświęcim, Ukraine's experience.

Integrating Heritage Conservation and Contemporary Architecture: Renovation and Modernization of the Terrace at Uniejów Castle

Karol WYSZNACKI[1,*]

[1]Institute of Architecture and Urban Planning, Faculty of Civil Engineering, Architecture, and Environmental Engineering, Lodz University of Technology, Poland

[*]karol.wysznacki@lodz.p.pl

Abstract. The article presents comprehensive research over renovation and modernization works on the terrace of the Uniejów Castle, a monument of exceptional historical importance dating back to the 14th century. The analysis is based on the results of detailed architectural and conservation studies commissioned by the architectural office "Marciniak & Witasiak Architekci", responsible for the terrace reconstruction project. The paper discusses the low technical condition of the structure, revealed by exposures, which was caused by the castle's location on wetlands near the Warta River. It also describes the use of modern renovation methods and materials that allowed for the reinforcement of the structure while maintaining its historical authenticity. In addition, the article presents the design and implementation of a modern steel and glass roof structure, in accordance with conservation guidelines, harmoniously fitting into the historical architecture of the castle and providing protection for terrace users from weather conditions. The multi-faceted approach shows the challenges and solutions related to the adaptation of a medieval monument to contemporary functions without compromising its cultural and architectural values.

Keywords: Uniejów Castle, heritage conservation, terrace renovation, defensive architecture, redevelopment, steel and glass structure.

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Functioning Features of the Poltava Local Memorial Museums

Yulia IVASHKO[1,*], Andrii DMYTRENKO[2], Pavol TIŠLIAR[3], Aneta PAWŁOWSKA[4], Andriy PAVLIV[5], Gelena KOVALSKA[1], Marek PABICH[6]

[1]Kyiv National University of Construction and Architecture, 31 Povitrianykh Syl Avenue, Kyiv, 03037, Ukraine
[2]National University "Yuri Kondratyuk Poltava Polytechnic", 24 Vitaliia Hrytsaienka Avenue, Poltava, 36011, Ukraine
[3]Masaryk University, Faculty of Arts, Department of Archaeology & Museology, 1 Arna Nováka Street, 602 00 Brno, Czech Republic
[4]University of Lodz, Institute of Art History, 65 Narutowicza Street, Lodz, 90-131, Poland
[5]Lviv Polytechnic National University, 12 Stepana Bandery St, Lviv, 79000, Ukraine
[6]Lodz University of Technology, Institute of Architecture and Urban Planning, 116 Żeromskiego Street, 90-924 Lodz, Poland

[*]yulia-ivashko@ukr.net

Abstract. The study focuses on the functioning of local memorial museums in Poltava, specifically those dedicated to writers Ivan Kotliarevskyi and Panas Myrnyi. A feature of the activities of such museums in Poltava is the division into memorial and literary parts. Usually, each part is located in a separate building within the estate, or is generally a separate museum, such as the Ivan Kotliarevskyi Literary Memorial Museum and the Ivan Kotliarevskyi Museum-Manor, located in the historical part of the city on Ivanova and Instytutska Hills, respectively, at a distance of 400 m as the crow flies. The memorial part presents furnishings with the personal belongings of the writers. The literary part presents publications of their works and everything related to literary creativity. In addition to the memorial and literary parts, the third component of local memorial museums in Poltava is the presence of a garden in the estate, the area of which varies significantly. In the context of the Russian-Ukrainian war, museums began to perform the unconventional function of rehabilitation from PTSD of military and civilians, and museum gardens in many cases became substitutes for therapeutic gardens.

Keywords: Local memorial museum, feature, functioning, Poltava.

Challenges in the Preservation of Historical Heritage in Mountain Resorts: The Case of Krynica

Yulia IVASHKO[1,*], Krystyna PAPRZYCA[2], Andrii DMYTRENKO[3], Oleksandr IVASHKO[1]

[1]Kyiv National University of Construction and Architecture, 31 Povitrianykh Syl Avenue, Kyiv, 03037, Ukraine
[2]Academy of Silesia, Faculty of Architecture, Civil Engineering and Applied Arts, 43 Rolna Street, 40-555, Katowice, Poland
[3]National University "Yuri Kondratyuk Poltava Polytechnic", 24 Vitaliia Hrytsaienka Avenue, Poltava, 36011, Ukraine

[*]yulia-ivashko@ukr.net

Abstract. The study analyzes the experience of preserving the historical resort architecture of the so-called "alpine" style in the town of Krynica in the Polish Beskid Sądecki. The main problems of preservation and modern use of historical villas, boarding houses, mineral water pavilions, and the natural environment are identified. The main materials used in the construction of villas are characterized, and it is argued that the main problems of their existence are fires and increased humidity, caused by both atmospheric factors and the presence of a large number of mineral springs and mountain rivers with tributaries. The corresponding restoration technologies are presented. The main problems of preserving the promenade villas are the threat of fires, waterlogging of foundations and structures, cracking of wood, peeling paint, deflection and deformation of wooden parts. The damage to historical villas visually recorded by the authors requires further field surveys. Priority measures include the following: inspection of the condition of waterproofing, foundations and roofs to exclude dampness and waterlogging; elimination of deflections and deformations, removal of emergency wooden fragments and their replacement; restoration with the return to their previous places of partially damaged elements; impregnation of wooden elements with antiseptics and flame retardants; use of modern wood paints with protective properties.

Keywords: preservation problem, historical heritage, mountain resort, Krynica.

Assessment of Crack Injection Methods in the Restoration of Historic Brick Buildings

Oleksandr MOLODID[1,*], Sergii BENDERSKYI[1], Ruslana PLOKHUTA[1], Sergey BOGDAN[2], Volodymyr SKOCHKO[1], Yevheniia NOVAK[3], Katarzyna SŁUCHOCKA[4]

[1]Kyiv National University of Construction and Architecture, 31 Povitryanykh Syl Avenue, Kyiv, 03037, Ukraine
[2]Prydniprovska State Academy of Civil Engineering and Architecture, Technology of Building Materials, Products and Structures Dept., 24-a Architect Oleh Petrov Street, Dnipro, 49005, Ukraine
[3]Yuriy Fedkovych Chernivtsi National University, 2 Kotsiubynskoho Street, Chernivtsi, 58012, Ukraine
[4]Faculty of Architecture, Poznan University of Technology, 60-965 Poznan, Poland

[*]molodid2005@ukr.net

Abstract. Experimental studies were conducted to determine the possibility of using modern repair materials (high-flow cement mortar Stabilcem, polymer compositions Epojet and Edmok) to repair brickwork cracks. The best results were observed in polymer compositions. The possibility of restoring the cracked samples' bending strength after the repair mortar's injection was tested. After injecting a crack with an opening width of 2-3 mm (for polymer compositions) and 6-8 mm (for cement composition), the restored samples' bending strength was 125.6% of the previous for Stabilcem, 182.5% for Edmok, and 315% for Epojet. When the cracks were previously filled with coarse quartz sand with an opening width of 4-5 mm (for polymer compositions) and 10-12 mm (for cement compositions), the repaired samples' bending strength was: 67% of the previous for Stabilcem, 174.9% for Edmok and 161% for Epojet. The study's results indicate the possibility of using polymer compositions for crack repair with masonry structural restoration both in empty and sand-filled cracks, and Stabilcem for masonry structural restoration in empty cracks.

Keywords: historical building, damage, restoration of structures, masonry, crack, injection, injectable solution, reinforcement, restoration.

Post-Industrial Heritage and Contemporary Spatial Transformation: The Case of Lodz, Poland

Anna Aneta TOMCZAK[1,*], Sylwia KRZYSZTOFIK[1]

[1]Institute of Architecture and Urban Planning, Faculty of Civil Engineering, Architecture, and Environmental Engineering, Lodz University of Technology, Poland

[*]aneta.tomczak@p.lodz.pl

Abstract. The main research theme is the scope and direction of transformations in the historic post-industrial district and how to preserve the character of its cultural heritage on an urban and architectural scale. The research used a mixed method, combining quantitative and qualitative elements, allowing for a comprehensive portrayal of changes in the areas where industrial Lodz was formed in the 19th century. Over two centuries, the described area of the Posiadła wodno-fabryczne (Water and Factory Estates) underwent successive stages of development: from the establishment of factories on the river, through dynamic growth in production and intensification of development, recession, political changes, and industrial decline, to renewal and reuse through the introduction of new functions throughout the area. These changes exemplify the enhancement of urban resilience through flexible solutions, adaptability, and improved connectivity. Reusing abandoned post-industrial areas increases the efficiency of urban areas and reduces spatial barriers.

Keywords: adaptation of urban areas, area revitalization, urban standard, urban resilience, monument, post-industrial heritage, water and factory estate, efficiency.

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The Reconstruction and Restoration of the Former Jewish Hospital in Kropyvnytskyi

Maryna OMELIANENKO[1,*], Marek PABICH[2], Paulina SZTABIŃSKA-KALOWSKA[3]

[1]Kyiv National University of Construction and Architecture, 31 Povitrianykh Syl Avenue, Kyiv, 03037, Ukraine
[2]Lodz University of Technology, Institute of Architecture and Urban Planning, 116 Żeromskiego Street, 90-924 Lodz, Poland
[3]University of Lodz, Institute of Art History, 65 Narutowicza Street, Lodz, 90-131, Poland

[*]mariom@ukr.net

Abstract. The research analyzes the experience of reconstructing and restoring one of the former buildings of the Jewish hospital in the city of Kropyvnytskyi. This object is an architectural monument, built in 1910–1914 in the eclectic style with elements of modernism, in interiors with motifs of the traditional "Jewish" style. It is significant that, during its existence, the hospital was used for its intended purpose; however, some buildings were rebuilt and lost part of their original decor. As of the beginning of the restoration work, building No. 2 had signs of disrepair. The article highlights the history of the object, its style characteristics, and characteristics of the original structural roofs and materials. The stages and content of the restoration project are described. After the completion of the restoration work, a scientific restoration report based on the results of the author's supervision was provided to the body for the protection of cultural heritage. The experience of developing a restoration project has demonstrated serious contradictions between the current Ukrainian monument protection legislation and the real needs of customers, including such socially significant objects as healthcare institutions.

Keywords: reconstruction, restoration, Jewish hospital, Kropyvnytskyi.

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Key Aspects on Desalination in Historic Brick Masonry

Yulia IVASHKO[1,*], Dominika KUŚNIERZ-KRUPA[2], Mykola ORLENKO[3], Andrii DMYTRENKO[4], Lukasz BEDNARZ[5],Valerii TOVBYCH[1], Oleksandr KRAVCHUK[1]

[1]Kyiv National University of Construction and Architecture, 31 Povitrianykh Syl Avenue, Kyiv, 03037, Ukraine
[2]Cracow University of Technology, Faculty of Architecture, 24 Warszawska Street, 31-155, Cracow, Poland
[3]Ukrrestavratsiia Corporation, 6 Boryspilska Street, Kyiv, 02099, Ukraine
[4]National University "Yuri Kondratyuk Poltava Polytechnic", 24 Vitaliia Hrytsaienka Avenue, Poltava, 36011, Ukraine
[5]Wroclaw University of Science and Technology, Faculty of Civil Engineering, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland

[*]yulia-ivashko@ukr.net

Abstract. The research analyzes the problems of brickwork in historical fortifications. It is proven that in most cases, the causes and consequences of damage to brickwork are common to objects in different regions and in different countries. The experience of brickwork desalination, tested at objects in Ukraine by specialists of the Ukrrestavratsiia corporation, is described. Removing salts only from the surface layer of the masonry and strengthening only the outer layer with hydrophobic substances does not solve the problem, since water-soluble salts remain in the masonry thickness. Specialists have developed a technology for desalination of the lower part of a brick wall to a height of 2–3 m from the ground surface in the absence of waterproofing and perimeter paving. The salinity level, salt composition, and causes of salinity (from groundwater, atmospheric pollution, etc.) are previously established.

Keywords: desalination feature, historical brickwork.

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Approaches to Organizing Recreational Spaces in Forefields of Historic Fortification

Yulia IVASHKO[1,*], Andrii DMYTRENKO[2], Michał KRUPA[3], Łukasz BEDNARZ[4]

[1]Kyiv National University of Construction and Architecture, 31 Povitrianykh Syl Avenue, Kyiv, 03037, Ukraine
[2]National University "Yuri Kondratyuk Poltava Polytechnic", 24 Vitaliia Hrytsaienka Avenue, Poltava, 36011, Ukraine
[3]Cracow University of Technology, Faculty of Architecture, 24 Warszawska Street, 31-155, Cracow, Poland
[4]Wroclaw University of Science and Technology, Faculty of Civil Engineering, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland

[*]yulia-ivashko@ukr.net

Abstract. The article analyzes the techniques of landscape design in the castle territories of Oświęcim Castle, Malbork Castle, and Wawel Castle in Kraków. The main features of the territories and the influence of water bodies on the nature of the layout of recreational areas are determined. The common and distinctive features between the applied recreational techniques are analyzed, and on this basis, possible options for transforming the castle territories into park areas with a different set of functions are indicated. Despite the positive consequences, the landscaping of the historical forefield has certain problems, since it contributes to additional moistening of already subsiding soils, which, in turn, affects the soaking of foundations and foundations, and gradually leads to soaking of masonry, subsidence of parts of buildings, and the appearance of active cracks, especially if part of the castle is located close to the water and not on an elevation (as in the Lower Castle in Malbork).

Keywords: specificity, recreational space, historical fortification, Oświęcim Castle, Malbork Castle, Wawel Castle.

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Reprofiling Sacred Heritage for Museum Use: Ukraine, Norway and China as Case Studies

Oleksandr IVASHKO[1,*], Michał KRUPA[2], Mykola ORLENKO[3]

[1]Kyiv National University of Construction and Architecture, 31 Povitrianykh Syl Avenue, Kyiv, 03037, Ukraine
[2]Cracow University of Technology, Faculty of Architecture, 24 Warszawska Street, 31-155, Cracow, Poland
[3]Ukrrestavratsiia Corporation, 6 Boryspilska Street, Kyiv, 02099, Ukraine

[*]ghok2233@gmail.com

Abstract. The article studies a specific type of museum in famous sacred sites in Ukraine, China and Norway. The following main types of shrines-museums are identified: 1) a shrine that does not perform a sacred function, but is a museum exhibition (a museum exhibition is its authentic appearance; a museum exhibition is its authentic appearance with additional permanent exhibitions; a museum exhibition is its authentic appearance with temporary exhibitions; a museum exhibition is its authentic appearance with additional permanent and temporary exhibitions); 2) a shrine that combines sacred and museum functions (a museum exhibition is its authentic appearance, where worship services are held simultaneously; a museum exhibition is its authentic appearance with additional exhibitions or concerts of classical and spiritual music and the holding of worship services). It is proven that if the function of worship is returned to the temple, in some cases, this excludes the continuation of the museum function. Such a continuation can be said in the case when the temple is transferred to the community of believers, but remains under the jurisdiction of a museum or a National Reserve. Using the example of restoration technologies on the mosaics of St. Sophia Cathedral in Kyiv, the need to maintain the subordination of such outstanding objects to state reserves is argued to ensure control over their preservation and the appropriate level of restoration measures.

Keywords: repurposing, additional functions, museum function, sacred objects.

Classification of the Four Largest Rock-cut Cave Monasteries in China by Cave Shape

Shiru WANG[1,*], Zhijun WANG[2],
Katarzyna JANICKA- ŚWIERGUŁA[3]

[1]Lanzhou City University, 11 Jiefang Road, Anning District, Lanzhou City, Gansu Province, 730070, China
[2]School of Architecture and Art Design, Lanzhou University of Technology, 287 Langongping Road, Qilihe District, Lanzhou City, Gansu Province, 730050, China
[3]Lodz University of Technology, Institute of Architecture and Urban Planning, 116 Zeromskiego Street, Lodz, 90-924, Poland

[*]wangshiru923@163.com

Abstract. The four largest rock-cut monasteries in China represent the pinnacle of Buddhist art during the Northern Dynasties, Sui, and Tang Dynasties. Their forms and structures reflect the synthesis trajectory of religious ideologies, regional culture, construction technologies, and craftsmanship in different historical periods. This study constructs a three-dimensional classification model of “function-form-era”, dividing the Four Monasteries’ cave forms into four main categories: meditation, worship, residential, and burial caves. The Four Monasteries cave forms’ classification demonstrates the evolutionary logic of "Xiyu pattern – adaptation to Central Chinese culture – regional innovation". Under the Hexi River Basin culture’s influence, the Mogao Caves in Dunhuang formed a diverse and syncretic system of forms; the early Yungang Caves retain the Gandhara style, while in the late period they demonstrate a tendency toward Sinicization; the Longmen Grottoes directly adopted the Central China architectural traditions, forming regular structures; the Maijishan Grottoes created unique “rock-cut pavilion” structures. Differences in the cave forms’ classification are essentially the result of the interplay of religious needs, political intervention, and regional resources during the Sinicization of Buddhism. The classification system proposed in this article provides an opportunity for research into the rock-cut monasteries’ archaeology and opens up new perspectives on the Buddhist art localization.

Keywords: China, Rock-cut monastery, Mogao Caves in Dunhuang, Yungang Caves, Longmen Caves, Maijishan Caves, classification, cave shape.

Influence of Geological Conditions and External Factors on the Structure and Décor of the Rock-cut Monasteries of China

Yulia IVASHKO[1], Shiru WANG[2,*], Andrii DMYTRENKO[3], Przemysław BIGAJ[4]

[1]Kyiv National University of Construction and Architecture, 31 Povitrianykh Syl Avenue, Kyiv, 03037, Ukraine
[2]Lanzhou City University, 11 Jiefang Road, Lanzhou City, Gansu Province, 730070, China
[3]National University "Yuri Kondratyuk Poltava Polytechnic", 24 Vitaliia Hrytsaienka Avenue, Poltava, 36011, Ukraine
[4]Cracow University of Technology, Faculty of Architecture, 24 Warszawska Street, 31-155, Cracow, Poland

[*]wangshiru923@163.com

Abstract. Factors influencing the formation of four major rock monastery complexes in China – Mogao, Yungang, Longmen, and Maijishan – are analyzed. It is argued that the main factor was the geology of the mountains in which the caves were excavated: this influenced their quantity, dimensions, volume-planning solutions, and – most importantly – the spread of frescoes or sculptures as the main decorative technique. The second important factor was the status of the complex – "popular" or "imperial". In the first case, this resulted in a smaller scale of the caves and the absence of pomp and gigantism; in the second case, the large size of the caves and gigantic sculptures of the Buddha were emphasized, which corresponded to the proclaimed theory "Emperor-Buddha". The geological characteristics of the rocks in which the caves are excavated are described, and the characteristics of the cave types, planning, and construction solutions are given. The technologies of fresco painting and sculpture are analyzed. The problems of the modern use of four complexes and their significance for world culture are characterized. The scale of these borrowings varied: in the Mogao complex, they are most pronounced, ranging from Xiyu traditions in the early stage to the predominance of local traditions in the middle and late stages, thus turning the complex into an example of multiculturalism.

Keywords: influence, geological conditions, external factors, structure, decor, rock-cut monasteries, China.

Preservation and Adaptive Reuse of the Former Auschwitz I Slaughterhouse as a Visitors' Center Strategy

Magdalena KOZIEŃ-WOŹNIAK[1,*]

[1]Cracow University of Technology, Faculty of Architecture, 24 Warszawska Street, 31-155, Cracow, Poland

[*]magdalena.kozien@pk.edu.pl

Abstract. Over the last quarter of a century, there has been a trend towards creating Visitors' Centers near memorial sites, which are intended to serve as entrance areas, organizing visitor traffic and preparing visitors for their visit to the memorial sites [1]. The subject of the study is the reconstruction and modernization of the former Auschwitz concentration camp slaughterhouse building, located on the site of the former PKS transport base in Oświęcim, which is the element of the new Visitors' Center complex. Research included in the conservation study shows that this is a multi-phase building, renovated several times and significantly transformed after the war, after its adaptation into a PKS transport base.The aim of the study is to share the author's own experiences of "Kozień Architekci" architectural office in modernizing a slaughterhoouse belonging to the Camp Auschwitz I service area and incorporating it into the overall complex, taking into account the historical value of the former Auschwitz camp grounds. The approach to its preservation does not apply the strict rules that are followed at the protected by law Memorial.The degraded building was adapted to the functional needs of visitors, while restoring its wartime character, securing and highlighting historical fragments of its structure. Thanks to this approach, the Museum gained a new place to serve visitors, taking it outside the protected area and at the same time incorporating into the museum complex by recognizing the former slaughterhouse building as the most important point of the hole Visitors' Center.

Keywords: preservation, slaughterhoouse, Auschwitz I, adaptation, visitors' center, "Kozień Architekci".

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Green Space Revitalisation in Historic Urban Contexts: Impact on Cultural Heritage Conservation in Kraków

Justyna KOBYLARCZYK[1,*], Patrycja SERUGA[1]

[1]Faculty of Architecture, Chair of Housing Environment Cracow University of Technology, Poland

[*]justyna.kobylarczyk@pk.edu.pl

Abstract. This study analyses two selected green public spaces located within the historic urban fabric of Kraków, a provincial capital in southern Poland: Wisława Szymborska Park on Karmelicka Street and the green space at Axentowicza Square. The former area historically served as a barracks parade ground and later as a car park, while Axentowicza Square, whose origins date back to the early 20th century, underwent modernisation in 2021–2022. The analysis considers the historical context of each site and the influence of surrounding heritage on their present form. The research is based on desk studies, including a review of relevant literature and archival materials, complemented by site visits to assess the current state of development. Field analyses were supported by photographic documentation. The study evaluates the extent to which green spaces located in historic settings respond to contemporary functional and social requirements. The findings are a contribution to academic discussion and may also support practical decision-making related to the revitalisation and modernisation of public urban spaces of historical significance.

Keywords: Historic urban área, public space, modernisation, revitalisation.

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Conservation Challenges and Protection Strategies for Historic Architecture in Nowy Wiśnicz (Poland)

Justyna KOBYLARCZYK[1,*], Mateusz BUDZIAKOWSKI[2]

[1]Chair of Housing Environment, Faculty of Architecture, Cracow University of Technology, Podchorążych 1, 30-084 Kraków, Poland
[2]Chair of Housing Environment, Faculty of Architecture, Cracow University of Technology, Podchorążych 1, 30-084 Kraków, Poland

[*]justyna.kobylarczyk@pk.edu.pl

Abstract. This article examines conservation problems that concern Nowy Wiśnicz, a town of exceptional historical, architectural, and landscape value, which represents one of the most valuable examples of a 17th-century urban and architectural complex in southern Poland. This study addresses two main aspects: the town's historical architecture, with particular emphasis on the castle and the Carmelite monastery complex, and the spatial development processes that have produced its contemporary appearance. The research is based on an analysis of historical cartographic sources, including Austrian military surveys, as well as archival materials and current spatial planning regulations. The results demonstrate that, despite limited economic growth and spatial development in the 20th century, Nowy Wiśnicz has preserved a clearly legible historic urban layout and a high concentration of heritage assets. Special attention is given to the role of statutory conservation instruments, including the local spatial development plan and the designation of the town as a Monument to History, which provide an effective framework for the preservation of the cultural landscape and the protection of the town's historical identity.

Keywords: architecture, urban planning, history, Lesser Poland, Poland.

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Preservation of Architectural Heritage: Stratigraphic Analysis of a 19th Century Tenement House at 3 Maja Street in Rzeszów, Poland

Krystian SIKORSKI[1], Rafał LICHOŁAI[1],
Anna MARTYKA[1,*], Tomasz DZIURAWIEC[2]

[1]Department of Architecture and Cultural Heritage, Faculty of Civil and Environmental Engineering and Architecture, Engineering, Rzeszów University of Technology, Al. Powstańców Warszawy 12, 35-029 Rzeszów, Poland
[2]Independent researcher, Rzeszów, Poland

[*]amartyka@prz.edu.pl

Abstract. Conservation research plays a crucial role in documenting and protecting architectural heritage by providing insight into the historical appearance and construction technologies of historic buildings. This article presents the results of stratigraphic investigations conducted in the tenement house at 3 Maja 9 Street in Rzeszów, an example of urban architecture whose present masonry form dates to the late 19th century (1888–1903). The listed building has undergone numerous functional transformations over nearly two centuries.The research aimed to identify historical layers and analyze aesthetic and technological changes on the facades and in the interiors. A total of 93 stratigraphic probes were carried out on the facades, in the entrance hall and staircase, and in first-floor interiors, enabling the recognition of original plaster and paint finishes. The analysis revealed two main historical layers: the original late-19th-century lime-sand plasters and stucco elements, with preserved interior tempera polychromes, and later renovation layers, including cement-based mortars applied after 2005. The study highlights the building's adaptation to changing functions and provides conservation recommendations regarding facade color reconstruction and the exposure of painted decorations, emphasizing the value of stratigraphic methods in heritage protection.

Keywords: stratigraphic analysis, 19th century architecture, polychrome, conservation research, tenement house, architectural heritage, lime plasters, Rzeszów.

Transformations of Market Square Façades in Small Towns: Impact on Historical Legibility and Conservation Implications (Subcarpathia, Poland)

Anna MARTYKA[1,*], Agata MIKRUT-KUSY[1]

[1]Department of Architecture and Cultural Heritage, Faculty of Civil and Environmental Engineering and Architecture, Engineering, Rzeszów University of Technology, Al. Powstańców Warszawy 12, 35-029 Rzeszów, Poland

[*]amartyka@prz.edu.pl

Abstract. Although numerous studies have been conducted on urban development, long-term architectural and aesthetic changes to the façades of buildings surrounding market squares in small towns, particularly the role of colour schemes in preserving the historical legibility of urban layouts, remain insufficiently recognised. This article addresses this issue using the example of market squares in small towns in the Subcarpathia region, with particular emphasis on Przeworsk. The aim of the study is to identify the nature and scale of architectural transformations of market square building façades and to assess their impact on the clarity of the historical spatial layout of the market square and the preservation of the local identity of the place. A multi-faceted research approach was used, including expert analysis, visual assessment and comparative analysis of historical documentation, including archival plans, pre-war photographs and conservation materials.The analysis includes the period from the beginning of the 20th century, through war damage and post-war transformations, to contemporary modernisations and revitalisation programmes. Particular attention was paid to the analysis of the colour scheme of the façades, identifying the dominant shades, their variability over time and local cultural conditions. The results of the research indicate that uncontrolled colour changes significantly weaken the visual coherence and historical legibility of market squares, while solutions based on local colour palettes promote the preservation of the authenticity of the urban landscape and can form the basis for the development of contextual conservation guidelines.

Keywords: market square, historic façades, colour analysis, small towns, cultural heritage, urban identity.

Construction and Structural Specificities of Wartime Restoration of Early 20th-Century Heritage Buildings in Lviv

Ihor BOKALO[1], Mariana KAPLINSKA[1],
Iryna POHRANYCHNA[1], Bohdan CHERKES[2,*],
Karol WYSZNACKI[3]

[1]Lviv Polytechnic National University, 12 Stepan Bandera Street, 79000, Lviv, Ukraine
[2]University of Agriculture in Krakow, Aleja Mickiewicza 21, 31-120, Kraków, Poland
and Lviv Polytechnic National University, 12 Stepan Bandera Street, 79000, Lviv, Ukraine
[3]Lodz University of Technology Institute of Architecture and Urban Planning,
116 Zeromskiego St., Lodz, 90-924, Poland

[*]tscherkes53@gmail.com

Abstract. This study examines restoration challenges associated with war-damaged early twentieth-century residential heritage buildings, using Lviv as an empirical context. It analyses how original construction systems of this period shape damage patterns and inform restoration strategies following explosive impacts. Based on two severely affected residential buildings, the research synthesises archival sources, post-impact technical assessments and digital documentation. Structural decisions are examined in relation to heightened uncertainty, resource constraints and the need for rapid functional recovery, with particular attention to structural continuity and the integration of contemporary interventions into historic fabric. The study demonstrates that restoration practice under wartime conditions requires flexible technical responses that balance structural safety, material compatibility and the retention of historically verified architectural forms. It argues that informed interpretation of original construction logic offers a practical framework for decision-making where direct reproduction of historic systems is no longer feasible.

Keywords: war-damaged listed buildings, architectural heritage, wartime restoration, early twentieth-century construction systems, authenticity, conservation philosophy under wartime conditions.

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From Industrial Memory to Conservation Practice: Managing Heritage Landscapes in the Hexi Corridor

Zhijun WANG[1,*], Shuo WANG[1], Xinyu LUO[1]

[1]School of Architecture and Art Design, Lanzhou University of Technology, 287, China

[*]dzgs999@163.com

Abstract. This study aims to break through the limitations of the individual-based paradigm in industrial heritage protection, construct a theoretical framework for the industrial heritage corridor in the Hexi Corridor, and reveal its inherent value as a dynamic historical stratum. By integrating the spatial systematicity of heritage corridors with the temporal depth of layered landscapes, it proposes the " Dual-Core Driven, Four-Step Progressive, Three-Axis Supported" model, innovatively integrating the three dimensions of function, space, and meaning into an organic whole. The core lies in explaining the dynamic interaction mechanism of temporal layering, functional layering, and meaning layering, rather than simple superposition. Through layered narrative reconstruction technology, this framework transforms isolated relics such as Laojunmiao Oil Mine in Yumen City, Gansu Province (Laojunmiao Oil Mine) and Jiuquan Iron and Steel (Group) Co., Ltd (JISCO) into a thematic narrative network, realizing the organic integration of historical depth and contemporary significance. It defines industrial heritage as "a vessel for the flow of cultural meanings," promoting a paradigm shift in industrial heritage from static specimens to dynamic memory ecosystems within civilization.

Keywords: hexi corridor, industrial heritage, heritage corridor, layered landscape perspective, industrial memory, spatial narrative.

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Issues Related to the Protection of Cultural Heritage in a Small Historic Town, Using the Example of Sokołów Małopolski

Joanna BARTKIEWICZ[1,*], Anna KRUKOWIECKA-BRZĘCZEK[2], Patrycja BIAŁAS[3], Agata MIKRUT-KUSY[1,*]

[1]Rzeszow University of Technology, Faculty of Civil and Environmental Engineering and Architecture, Chair of Architecture and Cultural Heritage, Powstańców Warszawy Avenue 12, 35-959 Rzeszów, Poland
[2]Cracow University of Technology, Faculty of Architecture, Warszawska Street 24, 31-155, Cracow, Poland
[3]Voivodeship Office for Monument Protection in Cracow, Kanonicza Street 24, 31-002 Cracow, Poland

[*]joanna.bartkiewicz@ucl.ac.uk; [*]a.mikrut@prz.edu.pl

Abstract. This article presents the results of research on the preservation of the urban and architectural heritage of a small town. The authors discuss this issue using the example of the town of Sokołów Małopolski, located in the Podkarpackie Voivodeship. The town was founded in the modern era, has a rich history, and boasts many valuable examples of urban planning and architecture. These include, above all, the Renaissance urban layout based on the model of the ideal city, “la citta ideale,” as well as historic buildings such as the town hall, Roman Catholic churches (parish and branch), a synagogue, the former advance payment office building, and historic houses and tenement buildings. The protection of this historic heritage is one of the most important tasks of the local government; therefore, it is essential to continuously monitor the condition of these structures and to undertake prudent investment initiatives in the historic city center.

Keywords: historic city, Sokołów Małopolski, historic urban layout, ideal city "la citta ideale", architectural monuments.

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Comprehensive Post-War Reconstruction of Settlements with the Introduction of Modern Approaches to Sustainable Development, Using the Example of the Town of Borodianka

Oleksandr MOLODID[1,*], Volodymyr RASHKIVSKIY[1], Ruslana PLOKHUTA[1], Volodymyr SKOCHKO[1], Volodymyr PIPA[1], Ivan MUSIIAKA[1], Yevheniia NOVAK[2]

[1]Kyiv National University of Construction and Architecture, 31 Povitryanykh Syl Avenue, Kyiv, 03037, Ukraine
[2]Yuriy Fedkovych Chernivtsi National University, 2 Kotsiubynskoho Street, Chernivtsi, 58012, Ukraine

[*]molodid2005@ukr.net

Abstract. The study provides a comprehensive study of approaches to the sustainable energy-efficient reconstruction of settlements in Ukraine in the context of post-war recovery, using the example of the town of Borodianka. It has been established that as a result of military actions, numerous settlements have suffered various damage or destruction of entire residential complexes, streets, or even microdistricts/neighborhoods. Accordingly, the reconstruction of such settlements is a priority task for the Ukrainian government. Thus, starting in 2023, an experiment has been initiated to comprehensively restore six settlements in different parts of Ukraine (the town of Borodianka is included in their list). The experiment is about coming up with and putting in place solutions that are seen as a transformation of the urban environment and are based on the synergy of economic efficiency, social orientation, and environmental safety, taking into account global experience, compliance with regulatory requirements, and international environmental certification systems. As a result, the components of a comprehensive model for the reconstruction of settlements have been structured and identified, taking into account the requirements of modern regulatory documents and the principles of sustainable development, namely: architectural and urban planning; energy efficiency; environmental; engineering; social; recreational; economic; digital; and can be used in the implementation of reconstruction projects in other settlements of Ukraine.

Keywords: sustainable development, energy efficiency, reconstruction, comprehensive model of settlement reconstruction, territorial community, architecture, construction, systematic approach.

Analysis of the Destruction and Strategy for the Brickwork and Stone Décor Consolidation in the Bukovina and Dalmatia Metropolitans' Residence

Iryna KOROTUN[1,*], Ruslan YURIICHUK[1],
Oksana HALUNKA[1], Grzegorz TWARDOWSKI[2]

[1]Yuriy Fedkovych Chernivtsi National University, 2 Kotsiubynskoho Street, Chernivtsi, 58000, Ukraine
[2]Cracow University of Technology, Faculty of Architecture, 24 Warszawska Street, 31-155, Cracow, Poland

[*]i.korotun@chnu.edu.ua

Abstract. The Bukovina and Dalmatia Metropolitans' Residence in Chernivtsi is one of the most prominent historicist architectural ensembles in Central and Eastern Europe. Since 2011, this architectural ensemble has been listed on UNESCO's World Heritage List. The complex is distinguished by its exceptional artistic value, complex spatial organization, and unique synthesis of decorative materials. The article aims to systematize and critically analyze the technological and material science solutions used in the restoration process of the Residence, to comprehensively analyze the imperatives of implementing restoration work during the restoration of the Residence's facades in the context of international standards for the cultural heritage protection, and to assess their effectiveness from the standpoint of preserving the authenticity and long-term operation of the monument. The research methodology combines historical and architectural analysis, materials science research, non-destructive diagnostic methods, and comparative analysis of European experience in the restoration of World Heritage sites. As a result, the feasibility of an integrated approach combining traditional and modern materials, local craft practices, and modern, scientifically based conservation technologies has been substantiated. The conclusions obtained can be applied to the development of restoration strategies for other complex historical ensembles, provided the materials are suitable.

Keywords: conservation, consolidation, preservation strategy, stone decoration, brickwork, modern technology, UNESCO site, Residence of the Metropolitans of Bukovina and Dalmatia.

Museification of Ruins Integrated into Modern Building: Technological Challenges and Solutions (on the Example of the Ruins Exhibition in the Hotel at 9 Mickiewicz Square in Lviv, Ukraine)

Svitlana LINDA[1,2,*], Andrii PAVLIV[2], Anna FEDAK[2], Renata PRZEWŁOCKA-SIONEK[3]

[1]Opole University of Technology, 76 Prószkowska Street, 45-758 Opole, Poland
[2]Lviv Polytechnic National University, 12 Bandery Street, 79042, Lviv, Ukraine
[3]Lodz University of Technology, 116 Stefana Żeromskiego Street, 90-924 Łódź, Poland

[*]svitlana.m.linda@lpnu.ua

Abstract. The article focuses on the problems of conservation and museification of historical ruins integrated into the interior of a new building. Using the example of the construction of a new hotel in the historical part of Lviv (Ukraine), the article shows the challenges that architects faced when designing an exhibition of the remains of fortifications and roads of the 14th – 15th centuries, which were discovered during the construction process. It is demonstrated how, based on visual, instrumental, and laboratory research methods, the technical condition of the object was assessed, as well as its potential for museification and demonstration in the space of the newly designed hotel. The article materials are based on the results of archaeological research, as well as practical solutions of the Zelemin design bureau. The uniqueness of the presented solutions is reinforced by the fact that this is the first such experience in Ukraine.

Keywords: interior design, public space, museification, fragments of architectural objects, integration into development, conservation.

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Documentation and Reproduction of the Frescoes in The Bukovina and Dalmatia Metropolitans' Residence (Now – the Yuriy Fedkovych Chernivtsi National University Building)

Iryna KOROTUN[1,*], Tamara MARUSYK[1], Yevhen POPOVYCH[1], Marek POCZĄTKO[2], Tetiana ANTOSCHUK[1], Svitlana HEREHOVA[1]

[1]Yuriy Fedkovych Chernivtsi National University, 2 Kotsiubynskoho Street, Chernivtsi, 58000, Ukraine
[2]Cracow University of Technology, Faculty of Architecture, 24 Warszawska Street, 31-155, Cracow, Poland

[*]svitlana.m.linda@lpnu.ua

Abstract. The frescoes of the Bukovina and Dalmatia Metropolitans' Residence, partially lost and partially restored, are an integral part of the architectural ensemble, included in the UNESCO World Heritage List in 2011. During World War II and the post-war years, the decoration (including frescoes) of the complex's buildings and individual rooms suffered considerable losses. Since the 1970s, active restoration of the frescoes and interiors has been carried out using various techniques and materials. The article details the experience of professional restoration of the Three Saints' Seminary Church frescoes, carried out by leading Ukrainian restorers in the last quarter of the twentieth century, and the restoration of the destroyed painting of the restoration insert of the Metropolitan Palace Marble Hall. The sequence of conservation work, the composition and content of the project documentation, the results of chemical studies, painting technique, plaster composition, and pigment properties determining its physical and mechanical stability, and the nature of degradation processes are described. The impossibility of applying unified approaches to the frescoes' restoration and the need to substantiate conservation measures with preliminary material and technical studies are substantiated. It proved that a differentiated approach allows for ensuring material stability and preserving authenticity.

Keywords: Bukovina and Dalmatia Metropolitans' Residence, frescoes, documentation, restoration, reproduction, differentiated approach.

Material Heritage Protection: The Revitalization of the Skierniewice Railway Station as a Case Study

Katarzyna JANICKA-ŚWIERGUŁA[1,*]

[1]Institute of Architecture and Urban Planning, Faculty of Civil Engineering, Architecture, and Environmental Engineering, Lodz University of Technology, Poland

[*]katarzyna.janicka@p.lodz.pl

Abstract. An analysis of the architectural and functional transformation of the Skierniewice railway station shows that this building is a notable example of architectural multi-layering. Its current appearance is the result of over 150 years of stylistic layering, conflicting political ideas, and adapting infrastructure to evolving civilizational needs. Each of these phases has left a lasting impression on the structure of the monument, creating value that modern conservation efforts must interpret and preserve. A significant achievement of the completed work is the aesthetic harmony of the interiors while also respecting the historical layers. The opening of new commercial spaces and the ground floor's accessibility from the eastern side have transformed the building from a simple transit point into a multifunctional public space, integrated with the urban fabric and the Widok housing estate. The revitalized Skierniewice station proves that historic railway architecture, despite a difficult history of lost documentation and wartime destruction, can adapt and serve its original purpose in the 21st century. Through a well-balanced combination of technical, conservation, and functional efforts, the facility has not only restored its former glory but also redefined its role as a city landmark and a crucial junction on the historic Warsaw-Vienna Railway, serving multiple generations of users.

Keywords: Skierniewice, railway station, monument, monument conservation, architectural heritage.

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Repurposing of Architectural Monuments for Cultural and Artistic Functions

Oleksandr IVASHKO[1,*], Andrii DMYTRENKO[2], Aneta PAWŁOWSKA[3], Monika WIŚNIEWSKA-KIN[4], Aleksander SERAFIN[5]

[1]National University of Construction and Architecture, 31 Povitrianykh Syl Avenue, Kyiv, 03037, Ukraine
[2]National University "Yuri Kondratyuk Poltava Polytechnic", 24 Vitaliia Hrytsaienka Avenue, Poltava, 36011, Ukraine
[3]University of Lodz, Institute of Art History, 65 Narutowicza Street, Lodz, 90-131, Poland
[4] Department of Childhood, Pedagogy, Pomorska 46/48, Lodz, 91-408 Poland,
[5]Lodz University of Technology Institute of Architecture and Urban Planning, 116 Żeromskiego Street, Lodz, 90-924, Poland

[*]ghok2233@gmail.com

Abstract. The article analyzes the experience of modern use of the historical estate of Oskar Ziegler. The main problems in the re-profiling of low-rise historical buildings are identified: non-compliance with modern housing standards, emergency condition of structures, obsolescence of engineering networks, lack of inclusiveness, and lack of a garage. It is argued that the re-profiling of a historical industrial building or palace provides more opportunities than the re-profiling of a low-rise historical mansion of a smaller area. The purpose of the study was to analyze an example of the re-profiling of the estate of Oskar Ziegler for cultural, educational, and artistic functions and to highlight the architectural and decorative features of this development. The stages of the development of the estate and the stages of changing the architecture of the main building are presented; the architectural and artistic style of the object is analyzed. Based on the field research conducted in 2022-2026, the experience of holding modern exhibition events in the Wozownia 11 gallery in the estate is highlighted.

Keywords: repurposing; architectural monument; cultural and artistic function.

Acknowledgments: The article was prepared with the support of the grant "Zapatrzeni – zasłuchani – zaczytani. Dziecięce strategie uczenia się przez zdziwienie" ("Watched – listened – read. Children's learning strategies through wonder") [6/IGB/2024].

Innovative Management Aspects Necessary for Efficient Education Specificity of Materials Science

Ionela Luminita CANUTA (BUCUROIU)[1,*], Adrian IOANA[1], Ileana Mariana MATES[1] , Augustin SEMENESCU[1], Lucian PAUNESCU[1]

[1]National University of Science and Technology POLITEHNICA Bucharest, Science and Engineering Materials Faculty, Spl. Independentei 313, Bucharest, Romania

[*]ionela.canuta@gmail.com

Abstract. The article presents several definitions of management, all subscribed to the quote of the so-called "Father of Scientific Management", Peter Drucker: "Management does things right, leadership does the right things." The article also analyzes the quantification of managerial potential and capabilities. In this sense, the Managerial Potential (MP) is the primary factor necessary for the internal (organizational) economic environment of any enterprise (business). The article presents two variants of analysis and quantification of managerial potential, namely: by applying the configurative theory; by applying reductionist theory. The content of the forecasting function related to managerial capability is also presented. In correlation with the managerial potential and capabilities, the article also presents management elements specific to the design of metallurgical sectors. The article also presents management elements specific to the design of metallurgical sectors, with a focus on the organization and management of storage activities. Aspects related to the sizing and organization of warehouses, establishing the storage capacity and optimizing the use of space are analyzed. The article also includes the formula for calculating the capacity of a warehouse, but also the schematic representation of a storage stack, used to highlight the way of arranging materials and to optimize handling and storage flows. These elements highlight the role of management in the design and efficient organization of the storage sectors within the metallurgical units.

Keywords: management, metallurgical sectors, resource, storage.

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A Materials Science Approach to Medieval Thimbles Revealing Manufacturing and Corrosion Pathways

Ana DROB[1,*], Otilia MIRCEA[2], Viorica VASILACHE[1]

[1]"Alexandru Ioan Cuza" University of Iași, Institute of Interdisciplinary Research, Department of Exact and Natural Sciences, Arheoinvest Centre, Iași, Romania
[2]National Museum Complex Neamț, Restoration–Conservation Laboratory, 19 Cuza Vodă Street, Roman, Romania

[*]ana.drob@uaic.ro; [*]anadrob1@gmail.com

Abstract. This study examines medieval thimbles from a materials science perspective, focusing on the relationship between composition, microstructure, and degradation mechanisms in small metallic artifacts linked to textile production. A set of nine thimbles from Neamț County [1] was analyzed using a non-invasive, multi-analytical approach. The methodology integrates stereomicroscopic examination with SEM–EDX elemental analysis, enabling the characterization of surface morphology, compositional variability, and corrosion layers without affecting artifact integrity. The novelty of this research lies in correlating material composition and manufacturing techniques with specific degradation patterns identified in frequently used objects. The results provide insights into alloy selection, fabrication processes, and use-wear traces, while also clarifying corrosion mechanisms associated with burial and post-depositional environments. These findings contribute to the development of targeted conservation strategies based on material behavior. The paper presents detailed results for one representative thimble and conservation interventions applied to four artifacts selected according to preservation state, degradation type, and typology.

Keywords: material composition, microstructure, corrosion mechanisms, SEM–EDX analysis, degradation processes.

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Techno-Economic Evaluation of Reconstruction Projects for Damaged Residential Structures

Evgeni LANDO[1], Ann MURAKHTANOVA[2], Liliia DADIVERINA[3], Dmytro LAUKHIN[3], Viktoriia KOZECHKO[4], Izabela MAJOR[4,*]

[1]Ukrainian State University of Science and Technologies, Educational and Scientific Institute «Prydniprovska State Academy of Civil Engineering and Architecture», Arkhitektora Oleha Petrova Str., 24A, 49000, Dnipro, Ukraine
[2]TOV Ekspert+, Sicheslavska Naberezhna Str., 15A, office 406, 49102, Dnipro, Ukraine
[3]Dnipro University of Technology, av. Dmytra Yavornytskoho, 19, 49005, Dnipro, Ukraine
[4]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, Akademicka Street 3, Czestochowa 42-201, Poland

[*]izabela.major@pcz.pl

Abstract. As a result of the armed aggression of the Russian Federation, a significant portion of the housing stock in Ukraine has been damaged or destroyed. This has created an urgent need for the prompt determination of material costs for reconstruction or for providing compensation to owners of destroyed property. The process of obtaining compensation for reconstruction or the purchase of new property involves a clearly defined algorithm. This study analyzes the determination of the economic feasibility of restoring a residential building in the city of Dnipro, Ukraine, that has lost its operational suitability and, according to the technical inspection report, is classified as a damaged but not destroyed real estate property. The research included the determination of restoration costs, indirect development costs, land value, and the gross development value of the reconstructed property. These indicators were compared with the market value of the property prior to damage and with the compensation value calculated according to national legislation.

Keywords: economic feasibility, damaged real estate, destroyed real estate property, gross development value, market value.

Historical Outline and Modernization the Neo-Baroque with Neo-Renaissance Elements of the Częstochowa Sanctuary

Izabela ADAMCZYK[1,*], Kinga JEŻ[1]

[1]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, Akademicka Street 3, 42-201 Czestochowa, Poland

[*]izabela.major@pcz.pl

Abstract. This article presents a selected religious building located in Częstochowa, built in the early 20th century. Częstochowa is considered the spiritual capital of Poland, with the Jasna Góra Monastery, the most important pilgrimage center for Christians, serving as the country's pilgrimage center. St. Joseph the Craftsman, whose name is dedicated to the Sanctuary situated on a rocky outcrop in the Raków-Częstochowa district, also has a significant impact on Christians' daily work and family life. Due to the unique character of the Sanctuary of St. Joseph in Częstochowa, which is designed in a neo-Baroque style combined with neo-Renaissance elements, this historical outline of the building is presented, along with the successive stages of its construction, as well as some of the renovation, modernization, and conservation work carried out over the years. The richly decorated interior, along with its furnishings, Baroque-style figures, Byzantine polychrome, exceptional details, and natural finishing elements of pink granite and golden travertine, create a unique atmosphere within the sacred building. Taking into account the fact that it is an architecturally interesting monumental object of local religious culture, which is constantly being adapted to current practical realities, an attempt was made to record it in literature.

Keywords: protection of religious heritage, sanctuary, modernization.

Conservation Monitoring of the Historic St. Valentine Church in Konopiska Using 3D Scanning as a Supporting Documentation Tool

Damian JOŃCZYK[1,*], Anna JASKOT[1], Bartłomiej JEŻ[2]

[1]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, ul. Akademicka 3, Czestochowa 42-201, Poland
[2]Czestochowa University of Technology, Faculty of Mechanical Engineering, Department of Technology and Automation, Al. Armii Krajowej Street 21, Częstochowa 42-201, Poland

[*]damian.jonczyk@pcz.pl

Abstract. Conservation monitoring constitutes an important element in the management of works related to historic buildings. This paper presents an approach to conservation monitoring using 3D scanning technology. Based on the conducted measurements and the acquired point cloud, simplified geometric models of the structure were developed. The resulting models were used as a tool for archiving past renovation and conservation works, as well as for assessing future intervention needs. Based on the analyses performed, areas requiring further observation were identified. The application of digital technologies in conservation monitoring improves the documentation process and supports the assessment of the scope of necessary restoration works.

Keywords: sacred object, church, 3D laser scanning, point cloud, conservation monitoring.

The Use of Point Clouds for Developing a BIM Model in Conservation Documentation: A Case Study of a Historic Sacred Structure

Przemysław PALACZ[1,*], Paweł KANIA[1],
Szymon KRAWCZYK[1], Adrian PODPORA[1]

[1]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, Akademicka Street 3, Czestochowa 42-201, Poland

[*]przemyslaw.palacz@pcz.pl

Abstract. This paper presents the development of a BIM model of the historic parish church in Borowno based on a point cloud obtained from 3D laser scanning. The study focuses on the use of point cloud data in conservation documentation and on modelling architectural elements in a BIM environment. The building, constructed between 1845 and 1846, is a monumental Neo-Baroque, single-nave structure featuring a semicircular presbytery and a two-tower façade. The study discusses subsequent stages of preparing measurement data, importing the point cloud into Revit, and modelling architectural elements while maintaining geometric consistency with real-world conditions. A key aspect of the workflow involved the use of parametric families enabling the creation of repetitive components such as windows, doors, and selected architectural details. Particular attention was given to challenges arising from structural irregularities and the difficulties associated with reproducing details characteristic of historic buildings. The resulting BIM model facilitated the preparation of technical documentation and serves as a foundation for further analyses and activities related to conservation, modernization, and digital archiving of the structure. The findings indicate that combining 3D scanning technologies with BIM tools constitutes an effective approach to supporting the preservation and digital documentation of heritage buildings.

Keywords: scan-to-BIM, HBIM, point cloud modelling, BIM modelling, conservation documentation, digital heritage, heritage building, historic sacred architecture.

The Need for Conservation of Filial Churches as Exemplified by the Częstochowa Pastoral District

Aleksandra REPELEWICZ[1], Izabela MAJOR[1,*], Marcin NABIAŁEK[2]

[1]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, Akademicka Street 3, Czestochowa 42-201, Poland
[2]Czestochowa University of Technology, Faculty of Production Engineering and Materials Technology, Department of of Physics, Al. Armii Krajowej Street 19, Częstochowa 42-201, Poland

[*]izabela.major@pcz.pl

Abstract. This study analyzed the filial churches located in the Częstochowa District of the Archdiocese of Częstochowa (Poland), with particular emphasis on the need for their conservation, especially preventative conservation. The study covered all filial churches built, completed, and in use between 1945 and 2019 in the aforementioned district. For each church, a building inventory, photographic documentation, and an architectural and structural analysis were prepared, conducted during a site visit and inventory measurements. Interviews were held with parish administrators to obtain additional information about the investment process and the history of the church's construction, and, in most cases, access to parish archives was obtained. The archives focused on preserved archival copies of church designs and construction diaries, as well as parish chronicles from the construction period. Furthermore, a search was conducted at the Archives of the Metropolitan Curia in Częstochowa, which allowed for a detailed trace of the history of the church authorities' efforts to build new churches.

Keywords: filial churches, preventive conservation, building inventory, sacred architectural heritage.

Assessment of Urban-Architectural Coherence in Historic Urban Fabric: A Case Study of Aleja Najswietszej Maryi Panny in Czestochowa

Jacek NAWROT[1,*], Katarzyna BŁOCH[2]

[1]Czestochowa University of Technology, Faculty of Civil Engineering, Department of Civil Engineering, Akademicka Street 3, Czestochowa 42-201, Poland
[2]Czestochowa University of Technology, Faculty of Production Engineering and Materials Technology, Department of Physics, Al. Armii Krajowej Street 19, Częstochowa 42-201, Poland

[*]izabela.major@pcz.pl

Abstract. In most urban centers, a distinctive historic area can be identified, often located along the main representative avenue, which, due to its unique character, serves as the city's calling card. In Paris, this includes the Champs-Élysées with the Arc de Triomphe; in Barcelona, Passeig de Gràcia with Antoni Gaudí's Casa Batlló and Casa Milà; in Budapest, Andrássy Avenue with its historic villas and palaces from the late 19th century; and in Berlin, Unter den Linden with the Brandenburg Gate. The area is located along Aleja Najswietszej Maryi Panny in Czestochowa and includes residential, commercial, and religious buildings, the most notable of which is the Jasna Gora Monastery. Many of these buildings are historic. This study analyzes how the urban layout of this area of the city has changed over the years. The impact of new developments over the last 80 years on the urban-architectural coherence of this part of the city was assessed. The factors that have shaped the current form of Aleja Najswietszej Maryi Panny were also identified.

Keywords: historic urban buildings, historical buildings, Czestochowa, expansion of cities.

Adaptive Methodologies and Digital Implementations with the Aim of Reducing the School Dropout Risk

Stefania Andreea BITU[1,*], Eduard Iuliu OLARIU[2]

[1]Doctorand in Management Deparment of Bucharest University of Economic Studies, Piața Romană 6, 010374 Bucharest, Romania
[2]Department of Research&Development AITEH SRL, Banu Manta 60, Bucharesti, Romania

[*]stefania.bitu@aitehglobal.com

Abstract. Contemporary education systems present deficits in the adaptability of learning paths to labor market dynamics, a factor that exacerbates the risk of school dropout. This research explores the potential of digital transformation and data-centric management as fundamentals for effective institutional retention strategies. Adopting the Design Science Research (DSR) methodological framework and a systematic literature review (2022–2026), the study proposes the Company-Driven Learning Pathway (CDLP) model. The innovation lies in the paradigm shift of curating educational content from academia to industry actors, transforming the process into a system of career paths validated through micro-certifications. This real-time alignment reduces the skills gap and optimizes employability in higher education. The results indicate that adaptive systems significantly increase student engagement by personalizing pedagogical experiences. Additionally, the use of predictive machine learning models and learning analytics allows for early identification of signs of disengagement, facilitating preventive interventions. Through this framework, school dropout is approached not only as a social challenge, but as a manageable variable through algorithmic and strategic management, still in current economic realities.

Keywords: school dropout, design science research, competency brokerage, teleological alignment, learning analytics, learning pathways.

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Assessing Water and Sediment Quality for Black Sea Romanian Tributaries and Coastal Lagoons in the Context of Armed Conflict

Alexandra HARABAGIU[1,2], Maria CARACHICIU[1], Georgeta TUDOR[1,2], Petrache Ionut GHEORGHE[1], Monica MATEI[1,*], Madalina BOBOC[1], Elena HOLBAN[1], Petrica VIZUREANU[3], Andrei Victor SANDU[1,3], György DEÁK[1,2]

[1]National Institute for Research and Development in Environmental Protection 294 Splaiul Independenței Blv, District 6, RO-060031, Bucharest, Romania
[2]Doctoral School of Biotechnical Systems Engineering, National University of Science and Technology POLITEHNICA of Bucharest, Splaiul Independenței 313, Bucharest, 060042 Romania
[3]Faculty of Material Science and Engineering, Gheorghe Asachi Technical University of Iași, 700050 Iași, Romania

[*]monicamatei06@gmail.com

Abstract. The overlap of armed conflict-related activities with industrial and domestic human actions is raising serious environmental concerns about potential contamination in the studied area and surrounding regions. This study assessed the quality of water and sediment quality in the Razim-Sinoe lagoon complex, as well as the Danube River mouths - Sulina, Sfântul Gheorghe, and the Chilia/Bystroe located in close proximity to the conflict zone and the ecologically sensitive Danube Delta. Water and sediment samples were collected during field campaigns conducted between 2024 and 2025 and subsequently analyzed in the laboratory to determine physicochemical parameters. This pattern is likely driven by reduced biological activity, including denitrification and plant uptake, associated with lower temperatures and shorter daylight periods. Additionally, significant variations in heavy metal concentrations were detected in sediments, particularly for copper (Cu), nickel (Ni), lead (Pb), and zinc (Zn). Beyond the physicochemical assessment, the study integrates an evaluation of potential impacts on biodiversity and habitats, with particular attention to aquatic and coastal ecosystems influenced by the proximity to the Danube Delta, which may include alterations in species composition, habitat degradation, and increased ecological vulnerability due to contaminant exposure. The paper also examines forms of pollution directly associated with the armed conflict, particularly oil pollution affecting the marine ecosystem and the coastal zone, further exacerbating risks to biodiversity and ecological integrity. Based on these findings, several recommendations are proposed for the management and protection of affected areas for biodiversity conservation.

Keywords: water quality, sediment quality, pollution, Black Sea.

Mapping Structural Heterogeneity for Nature-Based Solutions in the Lower Danube

György DEÁK[1,2], Alexandra CHIRESCU[1,2,*], Lucian LASLO[1], Natalia ENACHE[1], Bogdan MACO[1], Monica MATEI[1], Madalina BOBOC[1]

[1]National Institute for Research and Development in Environmental Protection 294 Splaiul Independenței Blv, District 6, RO-060031, Bucharest, Romania
[2] Doctoral School of Biotechnical Systems Engineering, National University of Science and Technology POLITEHNICA of Bucharest, Splaiul Independenței 313, Bucharest, 060042 Romania

[*]alexandra.chirescu@incdpm.ro

Abstract. The Lower Danube represents a geomorphologically complex fluvial corridor of high geoheritage and ecological value, where local-scale structural heterogeneity governs biogeochemical functioning and ecosystem resilience. Despite being included in protected networks, such as Natura 2000, conservation strategies often rely on assessments that ineffectively capture spatial variability relevant to ecosystem vulnerability. This study investigates the integration of UAV-LiDAR-derived structural data with the DNDC (DeNitrification–DeComposition) model to assess how ecosystem structure affects carbon fluxes in river ecosystems. High-resolution UAV-LiDAR data were used to generate a canopy height model (CHM) and a digital elevation model (DEM) for selected areas. Based on these datasets, the study area was classified into landscape units defined by combinations of vegetation height and elevation, representing key aspects of structural heterogeneity. The DNDC model was applied to simulate GHG fluxes, including CO_2 and N_2O emissions, under consistent soil and climate conditions. Results indicate notable differences in emissions among landscape units, with low-elevation, densely vegetated areas exhibiting distinct carbon and nitrogen dynamics compared to higher or sparsely vegetated areas. Thus, the approach supports the definition of conservation areas and provides a scientific basis for implementing targeted Nature-based Solutions (NbS) and adaptive land-use management.

Keywords: UAV-LiDAR, GHG dynamics, Lower Danube River, biogeochemical processes, canopy height model.

Interpretable Facial Emotion Recognition via Facial Landmark Geometry and Action Unit Modeling: An Operationalized Four-Class Framework for Happiness, Anger, Sadness, and Joy

Leonard Shanji LEE[1,*], Matthis Shanshu LEE[1]

[1]Taiwan Math Science Circle, 2F., No. 390, Beitun Rd., Beitun Dist., Taichung City, Taiwan

[*]leo701347@gmail.com

Abstract. Facial Emotion Recognition (FER) is an important research topic in Affective Computing and Human–Computer Interaction. Although recent studies have achieved high classification accuracy using deep learning and computer vision techniques, many end-to-end models still lack interpretability, making it difficult to explain which facial movements and local features contribute to emotion recognition. This study proposes an interpretable FER framework that combines facial landmark geometry with Facial Action Coding System (FACS)-based Action Unit (AU) modeling to classify four emotional states: happiness, anger, sadness, and joy. To reduce the conceptual overlap between happiness and joy, this study adopts an operational definition in which happiness represents low-arousal positive emotion, while joy represents high-arousal positive emotion. This improves label consistency and class separability in supervised learning. The proposed system includes face detection and alignment, facial landmark localization, AU-based feature extraction, and supervised classification. Geometric descriptors from the eyebrows, eyes, nose, and mouth are used to capture facial deformation patterns related to emotional expression, while AU features strengthen the connection between classification results and observable facial actions. Model performance will be evaluated using public FER datasets and, when necessary, controlled facial image samples. Evaluation metrics include accuracy, precision, recall, F1 score, and confusion matrix analysis, with additional discussion of robustness under variations in lighting, pose, and partial occlusion. This study aims to improve both classification performance and interpretability, providing potential applications in intelligent tutoring systems, digital health monitoring, and real-time human-computer interaction.

Keywords: facial emotion recognition, affective computing, facial landmark localization, facial action coding system, action units, interpretable machine learning, human-computer interaction.

Deep Learning-Assisted Chemical Pattern Recognition of Disease in Harumanis (Mangifera Indica) Leaves Using Visible Imaging

Uswatul Wahida MOHD SHARIF[1,*], Fathinul syahir AHMAD SAAD[1], Muhamad Khairul ALI HASSAN[1], Sukhairi SUDIN[1]

[1]Faculty of Electrical Engineering and Technology, Universiti Malaysia Perlis, Arau 02600, Perlis, Malaysia

[*]uswatulwahida.mohdsharif@gmail.com

Abstract. Harumanis mangoes (Mangifera indica), renowned for their distinctive fragrance and sweetness, are primarily cultivated in Perlis, Malaysia. However, Harumanis leaves are highly susceptible to various diseases caused by fungal, bacterial, and environmental factors. Common leaf diseases include anthracnose, canker, dieback, gall midge, leaf spot, powdery mildew, and sooty mould, which can significantly affect plant health and productivity if not detected at an early stage. This study proposes an image-based chemical pattern recognition framework for detecting and classifying Harumanis leaf diseases using deep learning techniques. Visible images of infected leaves were first processed using DeepLabV3 semantic segmentation with a ResNet101 backbone to remove background noise and isolate the leaf region for analysis. Subsequently, transfer learning with pre-trained convolutional neural networks (CNNs), namely EfficientNetB0 and ResNet50, was employed to classify disease patterns associated with fruit rot and related symptoms. The dataset was divided into 70% training, 15% validation, and 15% testing subsets. Experimental results show that both models achieved a classification accuracy of 96.9%, with high precision, recall, and F1-score values. Data augmentation and controlled image acquisition were implemented to address variations in illumination, camera angles, and image quality. The results demonstrate that deep learning-based chemical pattern recognition using visible imaging provides an effective approach for early disease detection and supports sustainable Harumanis mango cultivation.

Keywords: chemical pattern recognition, convolutional neural networks (CNN), semantic segmentation, transfer learning, image class, deep learning.

The Preservation of Romanian Vernacular Urban Heritage Through Social Entrepreneurship. A Debate Based on University–Research Center–Community Collaboration

Cornelia BAERA[1,2,*], Anca DRAGHICI[1,*], Aurelian GRUIN[1,2,*], Ion SANDU[3,4,5], Raul ZAHARIA[1], Claudiu-Sorin DRAGOMIR[2,6], Ana-Cristina VASILE[1,2], Caius LUMINOSU[1], Alina-Cristina NEGRU[7], Vlad STANCIU[8], Luiza VARGA[10]

[1]Politehnica University of Timisoara, 300191 Timisoara, Romania
[2]URBAN-INCERC, Bucharest, Romania
[3]Academy of Romanian Scientists AOSR, Bucharest, Romania
[4]INCDPM, Bucharest, Romania
[5]Romanian Inventors Forum, Iasi, Romania
[6]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
[7]West University of Timisoara, Timisoara, Romania
[8]ECO LIVING PROJECT ltd., 300185 Timisoara, Romania
[10]"Ion Mincu" University of Architecture and Urban Planning, Bucharest,Romania

*cornelia.baera@upt.ro; *anca.draghici@upt.ro; *aurelian.gruin@incd.ro

Abstract. The paper explores the transition from sustainable entrepreneurship (SuE) to social entrepreneurship (SE) in Romania, focusing on the role of collaborative networks between universities, research centers and local communities, generating the Triple Helix model (supported by a collaborative ecosystems). The scientific debate considers the importance of enterprises operating in the field of vernacular architecture and traditional earth-based building materials, highlighting the potential of integrating cultural heritage conservation with social impact objectives. Furthermore, innovative conservation methods in Romanian vernacular urban heritage and digital self-learning content for developing self-learning skills, provided by higher education institutions (HEIs), are explored. Thus, it is demonstrated how research and academic expertise can effectively strengthen sustainable business practices that also address social inclusion, community empowerment and environmental stewardship. Furthermore, the critical role of HEIs in promoting digital self-learning and social entrepreneurship education to bridge the gaps between knowledge production and community needs is explored. The paper proposes a strategic roadmap for the development of SE, supported by policy analyses, feasibility-impact matrices and key performance indicators. The research conclusions suggest that SE can play a transformative role in preserving cultural heritage, promoting sustainable lifestyles and fostering social cohesion - provided that structural challenges and resource constraints are addressed.

Keywords: Social entrepreneurship (SE); Sustainable entrepreneurship (SuE); Traditional housing heritage conservation.


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Section 2: Procedures and Technologies for Materials Engineering

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