PRR Plano de Recuperação e Resiliência
REPÚBLICA PORTUGUESA
Financiado pela União Europeia NextGenerationEU

3rd International Conference on Nanotechnology Research and Innovation

November 18-21, 2025
University of Aveiro, Portugal
Book of Abstracts

dem universidade de aveiro department of mechanical engineering
tema centre for mechanical technology and automation

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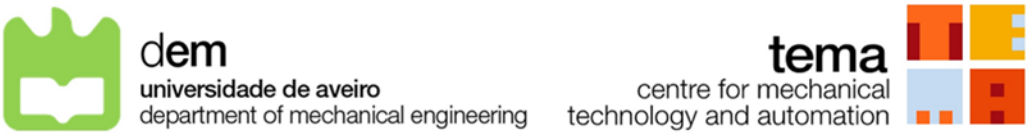

Title
3rd International Conference on Nanotechnology Research and Innovation
Book of Abstracts

Editors
Igor Bdikin
Gil Alberto Batista Gonçalves
Martina Kocijan
Francisco Loureiro
Zhi Jiang

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3rd International Conference on Nanotechnology Research and Innovation, University of Aveiro, Portugal, November 18-21, 2025 (ICNTRI-2025)

ICNTRI-2025 looks for significant Modern Problems of Nanomaterials Research and Innovation, to provide a platform to the global researchers and practitioners from both academia as well as industry to meet and share cutting-edge development in the Nanotechnology science theories, modelling, experiments, industrial implementations.

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Conference Contacts:

info-ICNTRI-2025@icntri.org

Telefone: +351 234 370 830

Conference Web:

https://icntri.org/

ICNTRI2025 program

November 18, 2025 (Tuesday)

Auditorium 1		Auditorium 2	
WCSDOCR-2025 **2nd Workshop on Challenges and Strategies in Degradation of Organic Contaminants Research** **SMALL MOLECULES, BIG PROBLEMS** **18 November 2025, University of Rijeka, Croatia**		**WNCBM-2025** **4th Workshop New Challenges of Bionanomaterials: Science, Technology, Application** **University of Aveiro, Portugal,** **18 November 2025**	
9:00 - 9:15	**WELCOME ADDRESS** **Dr. Martina Kocijan** **Dr. Matejka Podlogar,** **Prof. Dr. Ivna Kavre Piltaver**	**10:00 - 10:10**	**WELCOME ADDRESS** Dr. Igor Bdikin, Dr. Gil Gonçalves
9:15 - 9:40	***Chair: Dr. Matejka Podlogar*** ***Keynote talk*** **Prof. Dr. Iva Šarić Janković** (W1-I1) Faculty of Physics and Centre for Micro- and Nanosciences and Technologies, University of Rijeka, Croatia ***Title:* From Principles to Applications: Atomic Layer Deposition of Photocatalytic Materials**	**10:10 - 11:10**	CHAIR: Dr. Igor Bdikin **Dr. Gil Gonçalves** **Carbon-Based Nanostructures Driving Innovation in Biomedical and Environmental Applications** Centre for Mechanical Technology and Automation (TEMA)-University of Aveiro, Portugal
9:40 - 10:00	**Ivan Prološčić** (W1-O1) Faculty of Physics, University of Rijeka, and Specialty Hospital Radiochirurgia Zagreb, Sveta Nedelja, Croatia ***Title:* Light-Driven Degradation of Pollutants on ZnO-Coated γ-Fe_2O_3 Films**		
10:00 - 10:20	**Dr. Maria Kolympadi Markovic** (W1-O2) Faculty of Physics and Centre for Micro- and Nanosciences and Technologies, University of Rijeka, Croatia ***Title:* Development of vapor phase organic reactions for applications in surface modification and thin film deposition**	**11:10 - 12:10**	CHAIR: Dr. Gil Gonçalves **Dr. Igor Bdikin** **Atomic Force Microscopy Methods for Characterization of Organic and Biology Materials** Centre for Mechanical Technology and Automation (TEMA)-University of Aveiro, Portugal

10:20 - 10:45	*Keynote talk* **Prof. Dr. Ivana Jelovica Badovinac** (W1-I2) Faculty of Physics and Centre for Micro- and Nanosciences and Technologies, University of Rijeka, Croatia ***Title:* Scanning electron microscopy analysis of photocatalytic materials for organic pollutant breakdown**		
10:45 - 11:05	**Sandra Martín-García** (W1-O3) Laboratory of Parasitology, Faculty of Pharmacy and Aquatic One Health Research Center, University of Santiago de Compostela, Santiago de Compostela, Spain ***Title:* Enhanced Cryptosporidium inactivation using photocatalytic g-C3N4-PVDF membranes for water treatment**		
11:05 - 11:25	**Katarina Hainz** (W1-O4) Department of Chemistry, Biochemistry and Environmental Protection, University of Novi Sad Faculty of Sciences, Novi Sad, Serbia ***Title:* The efficiency of photocatalytic degradation of metformin in aqueous suspension using simulated solar irradiation**		
11:25 - 11:35	***Coffee break***		
11:35 - 12:00	***Chair: Dr. Andre Tores Pinto*** *Keynote talk* **Prof. Nevena Ćelić** (W1-I3) Department of Physics, Faculty of Sciences, University of Novi Sad, Trg D. Obradovića 4, 21000 Novi Sad, Serbia ***Title:* Advanced Metal Oxide/PMMA Nanocomposite Foils for Sustainable Wastewater Purification**		

12:00 - 12:20	**Dr. Szabolcs Bognár** (W1-O5) Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia ***Title:*** **Green ZnO photocatalysts for emerging pollutant removal: Powder vs. coating approaches**		
12:20 - 12:40	**Klara Laura Cokan** (W1-O6) Department for Nanostructured Materials, Jožef Stefan Institute, and Jožef Stefan International Postgraduate School, Ljubljana, Slovenia ***Title:*** **Development of Efficient ZnO Photocatalysts for Water Remediation**		
12:40 - 13:00	**Jose R. M. Barbosa** (W1-O7) LSRE–LCM, ALiCE, Faculty of Engineering, University of Porto, Porto, Portugal ***Title:*** **Macrostructured 3D-printed carbon materials for catalytic ozonation of oxalic acid**		
13:00 – 13:30	Lunch		
Auditorium 1 **WCSDOCR-2025** **2nd Workshop on Challenges and Strategies in Degradation of Organic Contaminants Research** **SMALL MOLECULES, BIG PROBLEMS** **18 November 2025, University of Rijeka, Croatia**			
13:30 - 13:55	***Chair: Dr. Mariana Rocha*** *Keynote talk* **Dr. Iwona Kuźniarska-Biernacka** (W1-I4) REQUIMTE/LAQV, Department of Chemistry and Biochemistry, Faculty of Science, University of Porto, Porto, Portugal ***Title:*** **From Waste to Treasure: The Use of Industrial Ashes in Wastewater Treatment**		

13:55 - 14:15	**Amanda Fujita** (W1-O8) LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Porto, Portugal ***Title:*** **Biochar Electroactivation in Suspension for Organic Contaminant Degradation**		
14:15 - 14:35	*Keynote talk* **Dr. A. Sofia G. G. Santos** (W1-I5) LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Porto, Portugal ***Title:*** **Innovative Advanced Catalytic Integrated System for Organic and Inorganic Pollutants Abatement**		
14:35 - 14:55	**Rúben Feiteira** (W1-O9) REQUIMTE/LAQV, Department of Chemistry and Biochemistry, Faculty of Sciences of the University of Porto, Porto, Portugal ***Title:*** **Highly robust hybrid carbon@metal sulfides/oxides for the photocatalytic degradation of Rhodamine B**		
14:55 - 15:05	Coffee break		
15:05 - 15:30	***Chair: Dr. Mariana Rocha*** *Keynote talk* **Dr. Arlete Apolinário** (W1-I6) REQUIMTE/LAQV, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Porto, Portugal ***Title:*** **Nanostructured Oxide Semiconductors for Solar Water Splitting and Green Hydrogen**		
15:30 - 15:50	**Joana J. M. Dele** (W1-O10) LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Porto, Portugal ***Title:*** **Urea-assisted immobilisation of activated carbon for venlafaxine removal from water**		

15:50 - 16:10	**Oumayma Bouhajeb** (W1-O11) Laboratory of Applied Mineral Chemistry (LCMA), Faculty of sciences of Tunis, University of Tunis El Manar, Tunis, Tunisia ***Title:*** **Ternary perovskite composites as efficient photocatalysts for the simultaneous removal of cationic and anionic dyes under visible irradiation**		
16:10 - 16:35	*Keynote talk* **Dr. Marija Egerić** (W1-I7) Vinča Institute of Nuclear Sciences, Beograd, Serbia ***Title:*** **Natural Solar Irradiation Induced Removal of Congo Red Dye Using UiO-66 MOF, Activated Carbon and Their Composites**		
16:35 - 17:00	**Final Discussion and Workshop Closing Ceremony**		

November 19, 2025 (Wednesday)

International Conference on Nanotechnology Research and Innovation (ICNTRI-2025) (*online*)	
9:00-9:10	**Auditorium 1** **WELCOME ADDRESS**: Dr. Igor Bdikin, Prof. Dr. Ajay Lad, Dr. Gil Gonçalves, Dr. Vikram Uttam Pandit
9:10-9:50	CHAIR: Dr. Natália Barroca, Dr. Gil Gonçalves Session: Engineering & Technology ***Plenary Lecture*** Prof. Dr. Henrikas Cesiulis **The challenges of eco-friendly precious metals recovery from secondary raw materials in the industry** *Faculty of Chemistry and Geosciences, Vilnius University, Lithuania* *JSC Elektronikos Perdirbimo Technologijos, Lithuania*
9:50-10:20	Session: Nanotechnology ***Keynote talk*** Prof. Dr. Natalia Tsyntsaru **(I4)** **DESIGN OF SUSTAINABLE ELECTROCHEMICAL SYSTEMS** *Institute of Applied Physics, Moldova State University, Chisinau, Moldova* *Department of Physical Chemistry, Vilnius University, Vilnius, Lithuania*
10:20-10:30	Coffee break
10:30-10:50	Session: Sensor Materials Prof. Dr. Onur Çetinkaya **(O8)** **BaTiO3 Nanoparticles for Glucose and Paracetamol Fluorescence Sensing** *Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Kocaeli Health and Technology University, Kocaeli, Türkiye*
10:50-11:10	Session: Nano Materials, Nanotechnology, Environmental Friendly Materials Prof. Dr. Catherine Dendrinou-Samara **(O12)** **A Cutting-Edge Approach to Sustainable Tomato Plant Protection by Hybrid ZnO-Based Nanomaterials** *Laboratory of Inorganic Chemistry, Department of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece*

11:10-11:25	Session: New Energy Materials Hafiz Muhammad Naeem **(O13)** **Boosting the Alkaline Catalytic Performance of MoS_2 via Electrochemically Deposited MoS_2@$Co(OH)_2$ Hybrid Structures** *Center for Physical Sciences and Technology (FTMC), Saulėtekio ave. 3, Vilnius, Lithuania*
11:25-11:40	Session: Hydrogen and Fuel Cell Science Muhammad Adeel Tariq **(O14)** **Investigating the Electrocatalytic Behavior of Pd-Decorated $Ni(OH)_2$/CuO Catalyst for Methanol Oxidation Reaction** *Department of Catalysis, Center for Physical Sciences and Technology (FTMC), Vilnius, Lithuania*
11:40-12:00	Session: Hydrogen and Fuel Cell Science Dr. Allan J. M. Araújo **(O18)** **Elucidating the kinetics of the oxygen evolution reaction in multicationic oxides through different approaches to determining the Tafel slope** *TEMA – Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal* *LASI – Intelligent Systems Associate Laboratory, 4800-058 Guimarães, Portugal*
12:00-12:30	Session: New Methods of Modeling Properties Materials Dr. Alla Sapronova **(O20)** **Integrating Large Language Models and Agentic AI into Molecular Modeling for Functional Materials Development** *PetraOS AS, Bergen, Norway*
12:30-12:45	Session: Engineering & Technology Esra DUMAN **(O31)** **Design and Fabrication of an EEG-Controlled Elbow Orthosis with Physiological Kinematics** *Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey*
12:45-13:00	Session: Engineering & Technology Douaa KOUCHAIRI **(O33)** **Integrated Physiological Signal Monitoring for Comprehensive Sleep Apnea Detection** *Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey*
13:00-14:00	Lunch

14:00-14:15	CHAIR: Dr. Vanessa Graça, Dr. Martina Kocijan Session: New Materials and Advanced Materials Ali Emre TUT **(O38)** **An Investigation of Self-Healing Chemical Systems** *Sakarya University, Chemistry, Institute of Natural Sciences, Esentepe Campus, 54187, Sakarya, Türkiye*
14:15-14:45	Session: Biomaterials ***Keynote talk*** Dr. Nathalie Barroca **(I5)** **Decellularized extracellular matrix - graphene hybrid scaffolds for tunable tissue engineering platforms** *TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, Aveiro, Portugal* *LASI, Guimarães, Portugal*
14:45-15:15	Session: New Methods of Modeling Properties of Materials ***Keynote talk*** Dr. Anuraag Gaddam **(I17)** **Understanding Glass Structure through NMR Spectroscopy and Atomic Simulations** *CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Aveiro, Portugal*
15:15-15:45	Session: Thin Films ***Keynote talk*** Dr. Venkata Eskilla **(I8)** **Tunable magnetic heterostructures for hybrid multifunctional response** *i3N-Aveiro, Department of Physics, University of Aveiro, 3810-193, Aveiro, Portugal*
15:45-16:00	Coffee break
16:00-16:30	Session: Ceramics ***Keynote talk*** Dr. Milan Vukšić **(I16)** **Additive manufacturing of ceramic monoliths suitable for magnetic heating** *Department for Nanostructured Materials, Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia*
16:30-17:00	Session: Protective Coatings and Corrosion of Materials ***Keynote talk*** Dr. Aleksey D. Lisenkov **(I10)** **Hierarchical PU/LDH Coating System on Aluminum for Enhanced Corrosion Resistance** *Department of Materials and Ceramics Engineering / CICECO, University of Aveiro, 3810-193, Aveiro, Portugal*

17:00-17:30	Session: Hydrogen and Fuel Cell Science ***Keynote talk*** Dr. Laura I.V.Holz **(I6)** **Development of proton-conducting electrolytes for protonic ceramic fuel cells: A case study of yttrium doped barium zirconates stannates** *TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal* *LASI - Intelligent Systems Associate Laboratory, Portugal*
17:30-17:45	Session: Nanotechnology -- Metal alloy Materials Marouane Mejres **(O17)** **Nanotechnologies for probing the microstructure evolution with aging in metallic glass** *Groupe de Physique des Matériaux, Université de Rouen Normandie, Rouen, France*
17:45-18:15	Session: Hydrogen and Fuel Cell Science ***Keynote talk*** Dr. Francisco J. A. Loureiro **(I7)** **Mixed ionic and electronic conductors for Solid Oxide Cells** *TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal* *LASI - Intelligent Systems Associate Laboratory, 4800-058 Guimarães, Portugal*

November 20, 2025 (Thursday)

International Conference on Nanotechnology Research and Innovation (ICNTRI-2025) (*online*)	
8:00-8:10	CHAIRs: Dr. Igor Bdikin, Dr. Laura Holz, Dr. Pavel Zelenovskii Session: Nanotechnology/Nanocomposites Ganesh Jadhav **(O36)** **Facile Fabrication and Solar-Driven Photocatalytic Activity of Pr_6O_{11}–g-C_3N_4 Nanocomposite** *Department of Chemistry, The PGK Mandal's Haribhai V. Desai College, Pune-411002, India*
8:10-8:20	Session: Nanocomposites Abhijeet Sonone **(O44)** **Graphene-based ternary nanocomposites for Multifunctional Applications** *Modern College, Shivajinagar, Pune, India* *Vidya Mandir Prashala and Junior College, Miraj, India*
8:20-8:35	Session: Composites Dr. In Tae Kim **(O7)** **A Study on the Mechanical Properties and Environmental Evaluation of TPV/PVDF/MMT Composites** *Korea Testing & Research Institute, 14, Haeryongsandan 4-ro, Haeryong-myeon, Suncheon-si, Jeollanam-do, Republic of Korea*
8:35-8:50	Session: New Energy Materials Prof. Dr. Duy Thanh Tran **(O5)** **Synergistic CoNi and PtCoNi Dual-Alloy Catalyst Design for pH-Universal Outstanding Hydrogen Evolution** *Department of Nano Convergence Engineering, Jeonbuk National University, South Korea*
8:50-9:20	Session: Composites ***Keynote talk*** Prof. Dr. Vikram Uttam Pandit **(I22)** **Multifunctional Organic Photocatalysts: Hydrogen Production & Water Purification** *PGK Mandal's Haribhai V. Desai Arts, Science & Commerce College, Pune-411002, India*
9:20-10:00	Session: Ceramics ***Plenary Lecture*** Prof. Dr. Andrei Kovalevsky **Designing functional ceramic thermoelectrics: bridging composition and processing** *CICECO – Aveiro Institute of Materials, Department of Materials and Ceramic Engineering, University of Aveiro, 3810-193 Aveiro, Portugal*
10:00-10:10	Coffee break

10:10-10:40	Session: Optical/Electronic Materials ***Keynote talk*** Dr. Suresh Kumar Jakka **(I13)** **Chalcogenide glasses for MIR gas sensing** *i3N and Department of Physics, University of Aveiro, Aveiro, 3810-193, Portugal*
10:40-11:10	Session: Thin films ***Keynote talk*** Prof. Dr. Ivna Kavre Piltaver **(I15)** **From Structure to Function: Engineering ZnO/γ-Fe_2O_3 Interfaces for Advanced Photocatalysis** *Faculty of Physics, University of Rijeka, Radmile Matejčić 2, 51 000 Rijeka, Croatia* *Center for Micro- and Nanosciences and Technologies, University of Rijeka, Radmile Matejčić 2, 51 000 Rijeka, Croatia*
11:10-11:50	Session: Materials Science ***Keynote talk*** Prof. Dr. Yulian Vysochanskii **(I20)** **2D ferrielectric CuInP2S6 and 3D ferroelectric Sn2P2S(Se)6: topology of phase** *Uzhhorod National University, Uzhhorod, Ukraine*
11:50-12:20	Session: Optical/Electronic Materials ***Keynote talk*** Dr. Krishnapuram Pavani **(I9)** **Development of rare earth free far-red broad emitters for optoelectronic applications** *i3n Nano Photonics & Optoelectronics, Department of Physics, University of Aveiro, Portugal*
12:20-12:35	Session: Biomaterials Tuğçe Neslihan DENİZ **(O40)** **Investigation of PCL/PLA/PVP/NaAlg-Based Shape Memory Hydrogel Film System for Controlled Transport of Doxorubicin** *Sakarya University, Chemistry, Institute of Natural Sciences, Esentepe Campus, 54187, Sakarya, Türkiye* *Sakarya University, Biomedical, Magnetic and Semiconductor Materials Research and Application Center (BIMAS-RC), 54187, Sakarya, Türkiye*
12:35-12:50	Session: Biomaterials Mohmad ABOBAKER **(O43)** **Development and Characterization of New Generation Hydrogel Systems based on Pluronic123-Chitosan-Sodium Alginate** *Biomedical Engineering, Institute of Natural Sciences, Sakarya University, Esentepe Campus, 54187 Sakarya, Türkiye*
12:50-13:00	Session: Engineering & Technology Neziha ÇILLI **(O16)** **Development and Evaluation of Tactile Probes for Breast Cancer Diagnosis** *Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey*

13:00-13:10	Session: Polymeric Composites Prof. Dr. Anatoliy Onanko **(O21)** **Strains-deformations in nanocomposites of multiwalled carbon nanotubes and polymers, SiO2** *National University of Kyiv, Kyiv, Ukraine*
13:10-13:20	Session: Engineering & Technology Beyza SERDAR **(O30)** **Development of an EEG-Controlled Active Ankle–Foot Orthosis for Neurorehabilitation** *Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey*
13:20-13:30	Session: Micro / Nano Materials Mina ÇOLAK **(O32)** **Innovative Multi-Lumen SiC-Based Microneedle Development for Efficient Transdermal Applications** *Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey*
13:30-14:00	Lunch
14:00-14:30	CHAIRs: Dr. Francisco Loureiro, Dr. Andrei Kovalevsky , Dr. Pavani Krishnapuram Session: New Energy Materials ***Keynote talk*** Dr. Vanessa Graça **(I11)** **Exploring Cubic Niobium Oxynitride as a Potential Electrode Material for Proton Ceramic Membrane Reactors** *TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal* *LASI - Intelligent Systems Associate Laboratory, Portugal*
14:30-15:00	Session: Biomaterials ***Keynote talk*** Dr. Pankaj Bharmoria **(I18)** **Shifting the Action Spectrum of Azobenzene into Phototherapeutic Window** *Institute of Materials Science of Barcelona, ICMAB-CSIC, Bellaterra, Barcelona, 08193, Spain.* *Department of Chemical Engineering, Universitat Politècnica de Catalunya, EEBE, Eduard Maristany 10–14, 08019 Barcelona, Spain*
15:00-15:30	Session: Biomaterials Prof. Dr. Patricia E. Oliveira **(O1)** **Transforming Forestry Waste into Nanostructured Membranes: A Nature-Inspired Strategy for Graywater Treatment** *Departamento de Procesos Industriales, Núcleo de Investigación en Bioproductos y Materiales Avanzados, Universidad Católica de Temuco, Chile*
15:30-16:00	Session: Thin films ***Keynote talk*** Prof. Dr. Robert Peter **(I21)** **Atomic Layer Deposition of Cu-modified TiO_2 Thin Films for Improved Photocatalytic Performance under Simulated Sunlight** *University of Rijeka, Faculty of Physics, Radmile Matejčić 2, Croatia* *University of Rijeka, Center for Micro- and Nanosciences and Technologies, Radmile Matejčić 2, Croatia*

16:00-16:15	Coffee break
16:15-16:45	Session: Thin films Dr. Martina Kocijan **(O2)** **TiO2 and Nitrogen-Doped TiO2 Thin Films Grown by Atomic Layer Deposition for Photocatalytic Water Purification** *Faculty of Physics, University of Rijeka, Radmile Matejčić 2, 51 000 Rijeka, Croatia*
16:45-17:00	Session: Polymeric Composites Prof. Dr. Zulfiqar Ahmad Rehan **(O4)** **Electrically Conductive Silver-Polyaniline Core-Shell Nanoparticle Composite Membranes for Enhanced Water Filtration and Biofouling Mitigation** *Department of Chemistry, College of science, Sultan Qaboos University, Al-khoud 123, Muscat, Oman*
17:00-17:15	Session: New Materials and Advanced Materials Prof. Dr. Mariana Neamțu **(O3)** **Novel photochromic Fe-based highly active ionic liquids, spiropyrans, phthalocyanine and porphyrin functionalized nanomaterials for pollutants removal** *Department of Exact and Natural Sciences, Institute of Interdisciplinary Research, Alexandru Ioan Cuza University of Iasi, Bv. Carol I, no. 11, 700506, Iasi, Romania*
17:15-17:30	Session: Biomaterials Muhammet Kamil Kerim **(O9)** **Multifunctional Hydrogel Dressings with Plant-Based Antimicrobial Extract to Accelerate Diabetic Wound Healing** *Sakarya University, Institute of Natural Sciences, Department of Biomedical Engineering, 54187, Sakarya, Turkiye* *Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano & Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research & Development Group (BIOENAMS R&D Group), 54050 Sakarya, Turkiye*
17:30-18:00	Session: Biomaterials ***Keynote talk*** Dr. Pavel Zelenovskii **(I3)** **Supramolecular peptide-based nanostructures for energy storage and harvesting applications** *Department of Physics and CICECO, University of Aveiro, 3810-193 Aveiro, Portugal*
18:00-18:15	Session: Sensor Materials Dr. André Girão **(O25)** **Electrospinning of gasochromic nanofibers for visual hydrogen sensing** *TEMA, Department of Mechanical Engineering; University of Aveiro, Aveiro, Portugal*
18:15-18:30	Session: Thin films Carlos Matos **(O29)** **An experimental study on laser deposition of Inconel-loaded polymer films** *CICECO, Aveiro Institute of Materials, Department of Materials and Ceramic Engineering, University of Aveiro, Aveiro, Portugal*

November 21, 2025 (Friday)

International Conference on Nanotechnology Research and Innovation (ICNTRI-2025) (*online*)

8:45 9:00	CHAIR: Dr. Joana Mesquita-Guimaraes, Dr. André Girão, Dr. Suresh Kumar Jakka Session: Nanotechnology Ganesh Dawange **(O37)** **Green copper oxide nanocatalyst synthesis using plant extract for antibacterial and photocatalytic applications** *Haribhai V. Desai College, Pune, India* *Sanjivani College of Engineering, Kopargaon, India*
9:00- 9:15	Session: Composites Oumayma BOUHAJEB **(O10)** **Effect of MAPbCl3 modification on LaCoO3/g-C3N4 for electrochemical sensing of ascorbic acid** *Laboratoire de Chimie Minérale Appliquée (LCMA) LR19ES02, Faculté des Sciences de Tunis, Université Tunis El Manar. Campus Universitaire Farhat HACHED, 2092, El Manar –Tunis, Tunisie* *Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano and Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability, Sakarya, Turkiye*
9:15- 9:30	Session: Biomaterials Zeynep Ziyade ÖZACAR **(O11)** **Biodegradable packaging design with blueberry extract and characterization** *Sakarya University, Institute of Natural Sciences, Department of Chemistry, 54187, Sakarya, Turkiye.* *Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano & Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research & Development Group (BIOENAMS R&D Group), 54050 Sakarya, Turkiye*
9:30- 9:45	Session: Nanotechnology/Biomaterials Younes Tadjouri **(O15)** **Comparative Study of Cerium Oxide Nanoparticles and Conventional Radioprotective Agents in Cancer Treatment** *Département des sciences de la matière, Université Adrar, Algérie*
9:45- 10:15	Session: Bio-nanocomposites ***Keynote talk*** Prof. Dr. Ana L. Daniel-da-Silva **(I19)** **Rational Design of Biopolymer-Functionalized Magnetic Nanomaterials for Water Purification** *Chemistry Dep./CICECO-Aveiro Institute of Materials, University of Aveiro, Aveiro, Portugal*
10:15- 10:30	Coffee break

10:30-10:45	Session: Biomaterials Zinaida Shakel **(O19)** **Bridging Nanoscience and Skin Biology: β-Carotene Nanocarriers to Sustain Hyaluronic Acid and Counteract Ageing** *LAQV, REQUIMTE, Department of Chemistry, Faculty of Pharmacy, University of Porto, Portugal*
10:45-11:00	Session: Biomaterials, Engineering & Technology Dr. Merve Keyf **(O26)** **Network Morphology, and Swelling Kinetics of Alginate Hydrogels Prepared by Sol-Gel Method** *Sakarya University, Biomedical Engineering, Institute of Natural Sciences, Esentepe Campus, 54187, Sakarya, Türkiye*
11:00-11:15	Session: Materials Science Mouna Sbai Idrissi **(O24)** **Structural and mechanical properties of alkali silicate glasses: Insights from molecular dynamics simulations and artificial intelligence** *Laboratoire de Physique de la Matière Condensée, Faculté des Sciences Ben M'sik, University Hassan II of Casablanca, Morocco*
11:15-11:30	Session: Materials Science Dr. Ahmed EL HAMDAOUI **(O23)** **The impact of TiO2 on the structural, mechanical, and dynamical properties of alkali silicate glasses** *University Hassan II, Av Driss El Harty, BP 7955, Casablanca, Morocco*
11:30-11:45	Session: Engineering & Technology Walaa ALMAHALMI **(O34)** **Advanced Smart Cane for Autonomous Navigation and Enhanced Mobility of Visually Impaired Individuals** *Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey*
11:45-12:15	Session: Nanotechnology ***Keynote talk*** Dr. Zhi Jiang **(I12)** **The Influence of Ferrocene and Silicon in controlling Growth and Morphology of Diamond in Liquid Gallium** *Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Aveiro 3810-193, Portugal* *Intelligent Systems Associate Laboratory (LASI), Guimarães 4800-058, Portugal*
12:15-12:30	Session: Biomaterials/ Nanotechnology Dr. Awantika Singh **(O6)** **Role of Metal Cation Transporter Families in Bacteria Mediated Nanoparticle Synthesis for Enhanced Biomedical Applications** *School of Biotechnology, Jawaharlal Nehru University, New Delhi, India 110067*

12:30-12:45	Session: Biomaterials Teymur GULIYEV **(O41)** **Comparative Evaluation of Functional Hydrogels for Diabetic Wound Healing** *Sakarya University, Biomedical Engineering, Institute of Natural Sciences, Esentepe Campus, 54187, Sakarya, Turkey*
12:45-14:00	Lunch
14:00-14:40	CHAIR: Dr. Anuraag Gaddam, Dr. Igor Bdikin Session: Energy Storage Materials ***Plenary Lecture*** Dr. D. Pukazhselvan **Promising Multifunctional Characteristics of Magnesium Hydride for Clean Energy Storage Applications** *Department of Mechanical Engineering, TEMA - Centre for Mechanical Technology and Automation, University of Aveiro, Aveiro 3810-193, Portugal* *LASI - Intelligent Systems Associate Laboratory, Guimarães 4800-058, Portugal*
14:40-15:10	Session: Materials Science ***Keynote talk*** Prof. Dr. S. Shanmuga Sundari **(I14)** **Ion irradiation induced changes in BaSnO3 ceramics** *Department of Physics, Seethalakshmi Ramaswami College, Trichy, 620002 India*
15:10-15:40	Session: Thin Films ***Keynote talk*** Prof. Dr. Aleksandr Bagmut **(I1)** **Electron microscopic study of density changes and crystallization kinetics of amorphous film of Al2O3** *National Technical University "Kharkiv Polytechnic Institute", NTU "KhPI" 2, Kyrpychova str., 61002, Kharkiv, Ukraine*
15:40-16:10	Session: Micro / Nano Materials, Nanofluid ***Keynote talk*** Prof. Dr. Abdelkadir Belhadj **(I2)** **Investigating Nanofluid Heat transfer in Microchannels using Artificial Intelligence** *MECACOMP Laboratory, Department of Mechanical Engineering, University of Tlemcen, Tlemcen, Algeria*
16:10-16:20	Coffee break
16:20-16:35	Session: Sensor Materials Dr. Ferial Krid **(O27)** **Smart Conducting Polymer-Based Sensor for Heavy Metal Detection** *Department of Process Engineering, Faculty of Technology, Chemical and Environmental Engineering Research Laboratory, LGCE, Universite 20 Aout 1955, El Hadaik Road, Skikda 21000, Algeria*

16:35-16:50	Session: New Methods of Modeling Properties of Materials Nihad Mekarba **(O28)** **DFT Investigation of Boric Acid–Macrocycle hosts interactions : Unveiling the Role of Hydrogen Bonding in complex stabilization** *Department of Process Engineering, Faculty of Technology, LRPCSI-Laboratoire de Recherche sur la Physico-Chimie des Surfaces et Interfaces, Universite 20 Aout 1955, El Hadaik Road, Skikda 21000, Algeria*
16:50-17:05	Session: Micro / Nano Materials Léane Marques **(O35)** **Development of anti-icing surfaces by laser modification for aircraft wings** *Sir Frank Whittle Building, Coventry University, Gosford St, Coventry CV1 5DL, UK*
17:05-17:25	Session: Ceramics, fuel cells Alfredo S. B. Luemba **(O22)** **Stannate-based anodes for proton ceramic fuel cells** *TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal;* *LASI - Intelligent Systems Associate Laboratory, 4800-058 Guimarães, Portugal*
17:25-17:40	Session: Nanotechnology Zhang Xueying **(O39)** **Study on shock-induced phase transformation of CsPbBr3 through pulsed discharge of cylinder wire array** *Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Aveiro 3810-193, Portugal* *Intelligent Systems Associate Laboratory (LASI), Guimarães 4800-058, Portugal*
17:40-17:55	Session: Stimuli Responsive Biomaterials Dr. Münteha ÖZSOY **(O42)** **Development of a patch-like hydrogel formulation for ibuprofen and its in vitro evaluation** *Kocaeli Health and Technology University, Faculty of Pharmacy, Department of Toxicology, Kocaeli, Türkiye*
17:55-18:10	**Conference Closing Ceremony**

Plenary lectures

Design of Carbon-Based Functional Materials from Allomelanin Precursors with Dual Anti-Oxidant, Anti-Bacterial and other Properties

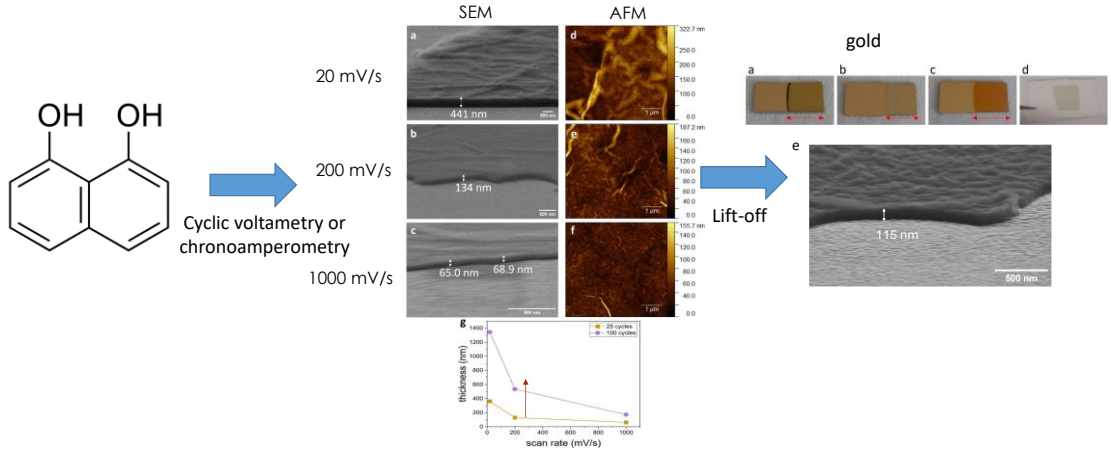
Vincent BALL[1,2,*]

[1]*Unité Mixte de Recherche 1121, « Biomatériaux et Bioingénierie », Institut National de la Santé et de la Recherche Médicale, 1 Rue Joseph Boeckel, Strasbourg 67084 Cedex, France*

[2]*Faculté de Chirurgie Dentaire, Université de Strasbourg, 8 Rue Sainte Elisabeth, Strasbourg 67000, France*

* vball@unistra.fr

The deposition of conformal films from redox-active biological molecules such as catechols, catechol amines and other polyphenols, has demonstrated great versatility in terms of the substrate used. Precursors of allomelanins, mainly found in fungi, have been largely overlooked as precursors for designing conformal and robust coatings. Moreover, their potential application for electrodeposition of films on conductive substrates has not yet been investigated. Here, the electrodeposition by cyclic voltammetry and chronoamperometry of 1,8-dihydroxynaphthalene (1,8-DHN), a precursor of allomelanin, onto gold and carbon electrodes and also onto Co-Cr alloys from aqueous solutions-ethanol mixtures yields films with potential sweep rate tunable thickness and swelling. [1] The electrodeposition of 1,8-DHN will be compared to that of its isomers and will be shown to be unusual in the sense that films up to µm thickness can be obtained without electrode passivation. The resulting films are antioxidant and the reservoir of antioxidant moieties is not limited to their surface but also extends into in the bulk of the film reflecting a high porosity and film swellability which was confirmed by means of spectroscopic ellipsometry. In addition, the films produced after a limited energy supply (in the potential window -1 V to +1 V vs Ag/AgCl) are strongly antimicrobial against two strains of *Pseudomonas aeruginosa* without further post- deposition treatment. In addition, their excellent mechanical properties (Young modulus around 600 Mpa in the wet state) allow them to be detached from their substrate as free-standing films (see Figure below), opening new avenues for diverse applications in biomedicine, energy storage, catalysis, sensing, and optoelectronics.



*Films of tunable thickness and morphology.
*Highly swellable
*antioxidant and prevents bacterial proliferation

[1] ZIEGLER, K.; BOECKER, M.; BALL, V.; SANCHEZ, C.; BOISSIERE, C.; ERSEN, O.; IHIAWAKRIM, O.; KISSMANN, A.-K.; MARCHESI d'ALVISE, T.; MOSER, J.; ROSENAU, F.; WEIL, T.; SYNATSCKE, C. *Multifunctional thick films obtained by Electrodeposition of 1,8-dihydroxynaphtalene, an Allomelanin Precursor. Langmuir* **2025**, *41*, 3971-3985.

The challenges of eco-friendly precious metals recovery from secondary raw materials in the industry

Henrikas Cesiulis[1, 2],
[1]*Faculty of Chemistry and Geosciences, Vilnius University*
[2]*JSC Elektronikos Perdirbimo Technologijos*
[*] henrikas.cesiulis@chgf.vu.lt

Recycling of critical raw materials (CRMs) is a pivotal step for sustainable green transition, and new technologies are needed in the market for that. Hydrometallurgy is widely used for PMs leaching and recovery, where the first stage is the leaching of PMs in some liquid media. Biggest enterprises acting in the metals recycling industry, the leaching is carried out in solutions containing HCl, HNO3, H2SO4, cyanide, etc., i.e., consuming cheap, but aggressive and toxic chemicals. However, the WEEE and WSA are collected in each country, and the demand for profitable recovery of Au, PGMs, by local enterprises using non-toxic and less aggressive constituents is growing.

There have been numerous successful attempts worldwide to recover precious metals in a less environmentally harmful manner. There are two key processes: metal leaching and wastewater treatment after recovery. These processes are continuously developing. The case study for the recovery of gold is discussed. The results using citric acid- and thiourea-based solutions for the recovery of gold from WEEE will be addressed. Some quantities of base metals are leached together with PMs; they can be recovered by electrowinning. Meanwhile, sufficient amounts of base metals (Cu, Sn, Pb, etc.) are left in the raw for further processing.

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Promising Multifunctional Characteristics of Magnesium Hydride for Clean Energy Storage Applications

D. Pukazhselvan[1, *], Duncan Paul Fagg[2]

[1]*Department of Mechanical Engineering, TEMA - Centre for Mechanical Technology and Automation, University of Aveiro, Aveiro 3810-193, Portugal*

[2]*LASI - Intelligent Systems Associate Laboratory, Guimarães 4800-058, Portugal*

**Email: dpukazh@ua.pt*

Magnesium hydride has emerged as a unique multifunctional material with leading roles reported across diverse clean energy storage domains. As a hydrogen storage medium, MgH_2 offers one of the highest theoretical gravimetric capacities among lightweight metal hydrides (7.6 wt.% H_2), satisfying the U.S. DOE targets for vehicular applications (5.5–6.5 wt.%) [1]. The cyclic endothermic and exothermic transformations between Mg and MgH_2 (ΔH ~74 kJ mol^{-1} H_2) enable this material to act also as a solid-state heat storage medium, opening additional possibilities in thermal energy management systems [2, 3]. Recent advancements have highlighted that MgH_2 effectively interacts electrochemically with lithium, forming Mg and LiH during charge–discharge cycles, thereby enabling a high theoretical capacity of ~2038 mAh g^{-1}. This is significantly greater than that of graphite anodes (372 mAh g^{-1}), underscoring its potential as an advanced anode material for next-generation lithium-ion batteries. Furthermore, our recent observations suggest that MgH_2 serves as a potential reducing agent capable of transforming graphene oxide (GO) into reduced graphene oxide (rGO). The resulting MgO–rGO hybrid frameworks exhibit improved Li storage kinetic features and structural stability, making them attractive anode architectures for both Li-ion and Na-ion rechargeable batteries (capacities: 447 and 217 mAh g^{-1}, respectively, at 100 mA g^{-1} for Li and Na ion batteries). With high application diversity and natural abundance MgH_2 will play a leading role in the future for supporting the global transition toward carbon-neutral and sustainable energy infrastructures.

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Designing functional ceramic thermoelectrics: bridging composition and processing

Andrei V. Kovalevsky[1, *], Diogo Lopes[1,2], Parisa Amirkhizi[1], Miguel A. Vieira[1], Nuno M. Ferreira[2], Florinda M. Costa[2], Aleksey A. Yaremchenko[1], Shahed Rasekh[1], Wenjie Xie[3,4], Anke Weidenkaff[3,4], Andres Sotelo[5]

[1]*CICECO – Aveiro Institute of Materials, Department of Materials and Ceramic Engineering, University of Aveiro, 3810-193 Aveiro, Portugal*

[2]*i3N, Physics Department, University of Aveiro, 3810-193 Aveiro, Portugal*

[3]*Materials and Resources, Department of Materials and Earth Sciences, Technical University of Darmstadt, Darmstadt 64287, Germany*

[4]*Fraunhofer Research Institution for Materials Recycling and Resource Strategies IWKS, Alzenau 63755, Germany*

[5]*INMA (CSIC-Universidad de Zaragoza). Mª de Luna, 3. 50018 Zaragoza, Spain*

[*] akavaleuski@ua.pt

Advances in functional ceramics are increasingly driven by the ability to design and control their composition, structure, and processing across multiple scales. Thermoelectric (TE) materials exemplify this approach, as their performance depends critically on the delicate balance between electrical and thermal transport, both strongly governed by microstructure and defect chemistry. Ceramic oxide TE stand out for their exceptional thermal and chemical stability, environmental compatibility, and compositional flexibility, features that make them potentially suitable for long-term operation under harsh, high-temperature conditions. Their promise extends beyond waste-heat recovery, as the same principles of structure-microstructure-property design underpin a wide range of functional applications, from catalysis to solid-state electrochemical devices. Recent progress demonstrates that coupling compositional design with advanced processing, including redox tailoring, defect and interface engineering, and composite architectures, can overcome many of the intrinsic limitations of ceramic TE. Emerging laser-based processing methods further expand this design space, enabling controlled cation redistribution, defect manipulation, and microstructural texturing in a single step. This lecture will discuss how the convergence of materials chemistry, microstructural control, and advanced processing paves the way towards the next generation of sustainable ceramic TE.

Acknowledgements

This work was supported by FEDER Funds through COMPETE 2030 and by National Funds through FCT – Fundação para a Ciência e a Tecnologia, under the project COMPETE2030-FEDER-00777900 (FCT Ref: 16602), and by the project CICECO-Aveiro Institute of Materials, UID/50011/2025 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC). Diogo Lopes acknowledges the PhD scholarship by FCT (grant 2020.06454.BD). Miguel Vieira acknowledges the PhD scholarship by FCT (grant 2022.12347.BD).

Invited lectures

I1. Electron microscopic study of density changes and crystallization kinetics of amorphous film of Al_2O_3

A. Bagmut

National Technical University "Kharkiv Polytechnic Institute"
NTU "KhPI" 2, Kyrpychova str., 61002, Kharkiv, Ukraine
e-mail: agbagmut@gmail.com

Amorphous films of Al_2O_3 are formed on substrates at room temperature in the process of pulsed laser sputtering of Al targets in an oxygen atmosphere. Irradiation of amorphous film with the electron beam initiates its crystallization. The amorphous alumina polymorphically passes into the crystalline one with cubic modification γ-Al_2O_3. The density of the crystalline film exceeds the density of the amorphous film. The relative change of the density of the film substance after crystallization is 10.4 ±1.7%.

Based on the frame-by-frame analysis of the video, the dependence on time t of the number density of crystals N was obtained. At a fixed electron dose rate N increases linearly with time:

$$N = 5.13 \cdot 10^9 t + 2.50 \cdot 10^9 \text{ cm}^{-2}. \quad (1)$$

The dependence on time of the average crystal diameter $\langle D \rangle$ correspond to the line equation:

$$\langle D \rangle = 0.013t + 0.026 \text{ μm}. \quad (2)$$

According to (1) and (2) the nucleation rate $\alpha = 5.13 \cdot 10^9$ cm^{-2}s^{-1} and average crystal growth rate $\langle v \rangle = 0.013$ μm·s^{-1}. The case α = const and $\langle v \rangle$ = const corresponds to the α-version of Kolmogorov's model [1].

The dependence on time of the fraction of the crystalline phase has an exponential character, described by the JMAK formula with a rate constant k=0.058 s^{-2} and Avrami exponent n = 2.01:

$$x = 1 - \exp(-0.058\, t^{2.01}), \quad (3)$$

that corresponds to the case of the continuous nucleation, when the system keeps adding nuclei with the same rate over the entire transformation period.

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I2. Investigating Nanofluid Heat transfer in Microchannels using Artificial Intelligence

Abdelkadir Belhadj[1,*], Rachid Saim[2]

[1] *MECACOMP Laboratory, Department of Mechanical Engineering*
University of Tlemcen, Tlemcen, Algeria
[2] *ETAP Laboratory, Department of Mechanical Engineering*
University of Tlemcen, Tlemcen, Algeria
**belhabdelkadir@gmail.com*

This study introduces a novel Artificial Intelligence (AI) model-based Physics-Informed Neural Network (PINN) framework for optimizing nanofluid-cooled microchannel heat sinks. The approach integrates fundamental conservation laws directly into neural network training, enabling accurate prediction of thermal-hydraulic performance without extensive experimental data or traditional computational methods.

The developed PINN architecture accurately solves the coupled mass, momentum, and energy conservation equations for Water/Al_2O_3 nanofluid flow in 2D microchannels heat sinks, incorporating realistic nanoparticle effects through established thermophysical models. The framework captures complex transport phenomena across Reynolds numbers (100-500) and nanoparticle concentrations (0-4%) relevant to practical electronic cooling applications. A case study lies in the implementation of asymmetric thermal boundary conditions that mirror real-world cooling scenarios, with heated bottom walls (350K) and cooled top walls (300K).

The mesh-free methodology offers substantial computational advantages over conventional approaches while maintaining high accuracy. This work establishes PINNs as an efficient tool for thermal management system design, with applications in electronics cooling, renewable energy, and advanced manufacturing. The framework provides engineers with a powerful approach for rapid optimization of nanofluid-based cooling systems.

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I3. Supramolecular peptide-based nanostructures for energy storage and harvesting applications

P. Zelenovskii[1,*], P. Brandão[2], A. Kholkin[1], S. Kopyl[1], F. Figueiredo[1]

[1] *Department of Physics and CICECO, University of Aveiro, 3810-193 Aveiro, Portugal*

[2] *Department of Chemistry and CICECO, University of Aveiro, 3810-193 Aveiro, Portugal*

[*] *E-mail address: zelenovskii@ua.pt*

Amino acids and peptides represent a convenient tool for construction of functional materials for biomedical, energy, and nanotechnological applications [1,2]. Interest in them originates from their natural biocompatibility, chemical diversity, and functionalization capabilities. A wide range of oriented non-covalent interactions allows peptides to organize into hierarchical supramolecular nanostructures of various dimensionality [2,3] with impressive physical properties.

In this work, we investigated structure and morphology of nanotubes and 2D layered crystals based on diphenylalanine (FF), dileucine (LL), and phenylalanine-glutamic acid (FE), and evaluated their cathodic and anodic properties. Estimations show an outstanding Li capacity of FF nanotubes about 375 mAh/g comparable with the capacity of graphite (372 mAh/g). Moreover, large-area (c.a. 500 mm^2) crystalline thin films of LL (thickness below 400 nm) created by the spin-coating technique, demonstrate high piezoelectric coefficient d_{33} c.a. 18 pm/V comparable to that of other organic materials. These results demonstrate the potential of peptide-based nanomaterials for various energy applications.

This work was developed within the projects CICECO-Aveiro Institute of Materials (UIDB/50011/2020, UIDP/50011/2020, LA/P/0006/2020) and “BioPiezoSensor” (2022.03781.PTDC, DOI 10.54499/2022.03781.PTDC) financed by national funds through the FCT and FCT/MEC (PIDDAC). The authors are grateful for the financial support granted by the Recovery and Resilience Plan (PRR) and by the Next Generation European Funds to Universidade de Aveiro, through the Agenda for Business Innovation “NGS - Next Generation Storage” (Project nº2 with the application C05-i01.01/2022) and by the Horizon Europe Framework Program (HORIZON-TMA-MSCA-SE, Project PIEZO 2D, No. 101131229).

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I4. DESIGN OF SUSTAINABLE ELECTROCHEMICAL SYSTEMS

Natalia Tsyntsaru [1,2]
[1]Institute of Applied Physics, Moldova State University, Chisinau, Moldova
[2]Department of Physical Chemistry, Vilnius University, Vilnius, Lithuania
* ashra_nt@yahoo.com

Sustainable electrochemical engineering signifies a shift towards cleaner, more efficient chemical processes for energy conversion and storage. This approach reduces environmental impact by employing electrochemical principles for precise control and increased efficiency, aligning with sustainability objectives.

The field seeks to innovate in chemical manufacturing and energy technologies, creating processes that are economically feasible, environmentally responsible, and socially beneficial. The innovation drives sustainability, focusing on minimizing environmental harm while creating long-term value.

We explored the potential of earth-abundant materials for applications like water splitting, methanol oxidation, and energy storage. By adjusting the pH of solutions, we can modify material properties, leading to various structures and efficiencies. With the global emphasis on sustainability, the development of new applications for these materials is likely to grow.

Although iron-based alloys with rare metals like platinum and palladium offer superior performance, their properties can be fine-tuned through synthetic parameter adjustments. Utilizing galvanic replacement reactions with waste-leaching solutions can provide a sustainable method for obtaining these materials, though further research is needed for effective, eco-friendly recovery techniques.

Acknowledgement: This research has received partial funding from H2020 “SMARTELECTRODES”, Moldavian National ANCD project 011204, and Lithuanian Research Council (project S-MIP-24-11).

I5. Decellularized extracellular matrix - graphene hybrid scaffolds for tunable tissue engineering platforms

Nathalie Barroca[1,2 *] and Paula A. P. P. Marques[1,2]

[1]TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, Aveiro, Portugal
[2]LASI, Guimarães, Portugal
[*] nbarroca@ua.pt

Decellularized extracellular matrices (dECM) have been extensively investigated for functional tissue regeneration owing to their native-like biochemical composition and architecture.[1] In this study, we focus on an adipose-derived extracellular matrix (adECM), which represents an abundant and easily obtainable source with a biochemical profile rich in preserved proteins such as laminin, fibronectin, and collagen. These components are well recognized as permissive elements in tissue regeneration. Although the coexistence of these proteins suggests a potentially favorable microenvironment for tissue repair, the biochemical resemblance between adECM and molecular compositions known to support regeneration does not necessarily guarantee that this adECM will recreate a similarly permissive environment for other tissue types. To address this question, we first explored multiple fabrication techniques to shape the adECM into three-dimensional (3D) scaffolds, including ice templating, electrospinning and gas foaming. In ice templated adECM scaffolds, we showed that the molarity of acetic acid for dissolving the adECM, a parameter commonly overlooked, has a significant impact on collagen organization, with potential implications for biological functionality.

Within the platforms shaped via ice templating [2] and electrospinning/gas foaming [3], adECM was combined with graphene-based materials—specifically reduced graphene oxide (rGO) and bioinspired polydopamine-functionalized rGO (PDA-rGO). These hybrid constructs supported neural stem cell (NSC) adhesion, growth, and migration throughout their interconnected microporous networks. Importantly, NSCs responded differently depending on the adECM-based architecture and composition, with special emphasis on the role of rGO and PDA-rGO in boosting neuronal differentiation and neurite outgrowth.

Building upon these promising results, we further demonstrate the feasibility of directly utilizing the decellularized matrix product as a photocrosslinkable macromer. Functionalization of the adECM with methacrylate groups (adECM-MA) enabled the creation of versatile tissue engineering platforms. Two configurations were evaluated: (i) cell-laden hydrogels supporting neural stem cell culture, and (ii) ice-templated foams promoting osteoblast-like differentiation, highlighting the potential of photocrosslinked adECM-MA for tunable, tissue-specific regeneration strategies.

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I6. Development of proton-conducting electrolytes for protonic ceramic fuel cells: A case study of yttrium doped barium zirconates stannates

Laura I.V.Holz * [1,2], Carlos M.R. Almeida[1,2], Vanessa C.D. Graça [1,2], Francisco J.A. Loureiro [1,2], Duncan P.Fagg [1,2]

[1]*TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal*

[2] *LASI - Intelligent Systems Associate Laboratory, Portugal*

Due to their distinct structural and chemical properties, barium stannates are considered as promising ceramic electrolytes for protonic ceramic fuel cells [1-2]. With an emphasis on the impact of Sn substitution on structural, microstructure, and high-temperature electrochemical properties, the present study examines the $BaZr_{0.8-x}Sn_xY_{0.2}O_{3-\delta}$ (x = 0.2, 0.4, 0.6, 0.8) perovskites. A standard solid-state reaction technique was used to produce the samples. The single-phase cubic perovskite structure produced by each composition was verified by powder X-ray diffraction with Rietveld refinement. The lattice parameter decreases as the Sn concentration rises, as would be expected as Sn^{4+} ions are smaller than Zr^{4+} ions.

Higher Sn incorporation results in improved densification, according to microstructural analysis and relative density measurements.

Electrochemical impedance spectroscopy (EIS) was used to assess the electrical conductivity under nominally dry (p_{H2O} ~10^{-7} atm) and wet (p_{H2O} ~10^{-2} atm) conditions (550 °C − 850 °C). A defect-chemistry model was used to calculate the partial conductivities of protons, oxygen ions, and electronic holes. As predicted by the acidity scale, the samples with a higher Sn concentration have a lower protonic transference number (i.e., lower hydration enthalpy).

The transport properties of $BaZr_{0.8-x}Sn_xY_{0.2}O_{3-\delta}$ family is an important new addition to the knowledge of the perovskite proton-conductors. From these data, one can quantitatively assess its applicability as an electrolyte membrane for fuel cells, electrolyzers, and other electrochemical-based applications under different working environments.

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I7. Mixed ionic and electronic conductors for Solid Oxide Cells

Allan J. M. Araújo[1,2], Laura I. V. Holz[1,2], Vanessa C. D. Graça[1,2], Duncan P. Fagg[1,2],
Francisco J. A. Loureiro[1,2,*]

[1]TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal

[2]LASI - Intelligent Systems Associate Laboratory, 4800-058 Guimarães, Portugal

*francisco.loureiro@ua.pt

Mixed ionic and electronic conductors (MIECs) have garnered increased attention due to their potential to enhance the performance of solid oxide cells (SOCs) applications, including solid oxide fuel cells (SOFCs) and solid oxide electrolysis cells (SOECs) [1]. This work presents a comprehensive study on the fabrication, characterization, and performance evaluation of different MIEC compositions as air electrodes. Emphasis is placed on their electrochemical properties, *i.e.*, oxygen reduction reaction (ORR) kinetics under various operational conditions. Advanced characterization techniques, such as X-ray diffraction (XRD), scanning electron microscopy (SEM), and electrochemical impedance spectroscopy (EIS), are employed to elucidate the relationship between microstructure and electrochemical performance. The implications of these findings for the design of next-generation SOCs are discussed, highlighting the critical role of MIECs in advancing sustainable energy technologies.

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I8. Tunable magnetic heterostructures for hybrid multifunctional response

E. Venkata Ramana *, and M. A Valente

i3N-Aveiro, Department of Physics, University of Aveiro, 3810-193, Aveiro, Portugal

Functional composite materials, capable of reversible thermal responses to external stimuli, are emerging as promising candidates for solid-state cooling and energy-efficient thermal management. Among these, magnetic-field-driven caloric materials have gained considerable attention as they provide an environmentally friendly alternative to conventional vapor-compression refrigeration. Concurrently, advances in magnetoelectric and multiferroic heterostructures have introduced new strategies to manipulate magnetic and caloric properties through electric fields by utilizing strain-mediated coupling between ferroelectric and magnetostrictive phases. Such cross-functional coupling offers a pathway toward tunable, low-power cooling elements and multifunctional devices that integrate thermal, magnetic, and electrical functionalities [1, 2].

In this study, we investigate a heterostructure consisting of a ferromagnetic shape-memory alloy (SMA) thin film deposited on a ferroelectric (Ba,Ca)TiO_3–Ba(Zr,Ti)O_3 (BCZT) substrate by RF magnetron sputtering. Detailed structural and magnetic characterization was characterized to assess structure-property correlatios. The analysis highlights that SMA undergoes a magnetostructural transition associated with pronounced variations in magnetization and entropy, which form the basis of its magnetocaloric behavior. Application of an electric field across the BCZT substrate generates piezoelectric strain that is elastically transferred to the SMA layer, thereby modulating its lattice parameters and magnetic switching characteristics. The presentation aims to demonstrate voltage-induced modulation of magnetic properties and strain-mediated control in the SMA/BCZT heterostructure

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I9. Development of rare earth free far-red broad emitters for optoelectronic applications

Krishnapuram Pavani
i3n Nano Photonics & Optoelectronics, Department of Physics, University of Aveiro, Aveiro 3810-193, Portugal

Rare-free emitters provide promising choices in terms of cost-effective synthesis with ease of large-scale production. Which also exhibits broad-band emission characteristics resulting from crystal-field effects and charge-transfer transitions. The present study focuses on detailed structural and spectroscopic investigations on Mn^{4+} doped poly-crystalline systems (*phosphors*) for thermal sensing and plant growth technology (*Photosynthetically Active Region - PAR region*). The presence of well-defined octahedral coordination sites within the selected host matrix facilitates the feasible substitution of Mn^{4+} ions. Such site-selective substitution promotes both optical characteristics and thermal stability, making the material highly suitable for optoelectronic applications such as phosphor-converted LEDs (*pc-LEDs*), optical thermometry, and plant growth lighting systems. Mn^{4+} ions are known for its strong absorption ($^4A_{2g} \rightarrow {}^4T_{1g}$, $^4T_{2g}$) and broad emission ($^2E_g \rightarrow {}^4A_{2g}$) characteristics in near-blue far-red regions respectively. By carefully tuning the crystal structure, local symmetry and host lattice environment, the luminescence efficiency and thermal stability of these materials can be optimized to achieve strong emission within the Photosynthetically Active Radiation (PAR) region (400 – 700 nm). Moreover, the thermal stability, energy transfer mechanisms and decay dynamics of these materials will be discussed in detail.

I10. Hierarchical PU/LDH Coating System on Aluminum for Enhanced Corrosion Resistance

Aleksey D. Lisenkov*, Kiryl Yasakau, João Tedim

Department of Materials and Ceramics Engineering / CICECO, University of Aveiro, 3810-193, Aveiro, Portugal

* *lisenkov@ua.pt*

The design of self-healing coatings for corrosion protection relies on the integration of functional nanocontainers capable of storing and releasing inhibitors. In this study, a layered double hydroxide (LDH) layer was directly grown on the surface of aluminum substrates, forming a nanocontainer sublayer intended for inhibitor storage. The LDH layer was subsequently modified by ion exchange with tannic acid to incorporate active inhibitor species. Finally, a non-modified industrial anaphoretic polyurethane (PU) coating was deposited onto the LDH-modified substrates.

Unlike previous strategies involving the direct incorporation of LDH particles into polymer matrices, which can compromise coating integrity and corrosion resistance, the present approach preserves the intrinsic properties of the PU coating. Structural characterization confirmed the formation of a well-defined hierarchical system. Scanning Electron Microscopy (SEM) revealed a compact LDH sublayer beneath a continuous PU film, while Energy Dispersive X-ray Spectroscopy (EDS) verified the elemental composition consistent with the LDH structure.

This architecture combines the mechanical and barrier performance of the industrial PU coating with the functional capacity of the LDH nanocontainers to store and release corrosion inhibitors. Although electrochemical testing is ongoing, the obtained structural results indicate a promising pathway toward self-healing, corrosion-resistant coatings suitable for industrial implementation.

I11. Exploring Cubic Niobium Oxynitride as a Potential Electrode Material for Proton Ceramic Membrane Reactors.

Vanessa Graça[1,2], Laura Holz [1,2], Allan Araujo[1,2], Sergey Mikhalev [1,2] , Francisco Loureiro [1,2], Duncan P.Fagg [1,2]
[1]*TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal.*
[2]*LASI - Intelligent Systems Associate Laboratory, Portugal.*vanessagraca@ua.pt

Proton Ceramic Membrane Reactors are increasingly recognized for their ability to operate on ammonia-based fuels to generate electricity or, conversely, to produce ammonia from electricity and steam or hydrocarbons at ambient pressure[1,2,3]. This electrochemical production approach offers advantages over the traditional Haber-Bosch process, such as cost savings and reduced carbon emissions[1,4]. However, a key limitation is the lack of suitable electrode materials. To fulfil this need, our study explores niobium (oxy)nitride (NbNxOy) as a potential electrode component in a composite with a perovskite proton-conducting ceramic for the aforementioned electrochemical processes[5].

A range of characterisation techniques, including XRD, TGA/DSC, SEM/EDS, dilatometry, and impedance spectroscopy (IES), were used to characterise the processed materials.

This work highlights the chemical compatibility of NbNxOy with a ceramic electrolyte and presents a fabrication method, alongside a mechanistic study of electrode behaviour in reducing atmospheres using a symmetrical cell arrangement. BCZY712 demonstrated chemical stability up to 850 °C, aiding the electrode film sintering process. Thermogravimetric experiments and X-ray diffraction revealed that NbNxOy decomposes into parent oxides in N_2 but retains phase purity in reducing conditions. The polarization behavior of the BCZY712-NbNxOy composite electrode was assessed via IES under varying potential atmospheres, suggesting a mechanism involving proton incorporation and water management, hydrogen adsorption/desorption, and interfacial transfer reactions of protons or oxide-ion vacancies.

The current work provides a systematical approach to processing, electrode fabrication, chemical stability, and electrochemical characterization of a new category of a composite electrode made of niobium (oxy)nitride (NbN_xO_y) and a proton-conducting perovskite.

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I12.The Influence of Ferrocene and Silicon in controlling Growth and Morphology of Diamond in Liquid Gallium

Zhi Jiang[1,2], Gil Gonçalves[1,2], Marco Peres[3]
[1.] Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Aveiro 3810-193, Portugal
[2.] Intelligent Systems Associate Laboratory (LASI), Guimarães 4800-058, Portugal
[3.] Instituto de Engenharia de Sistemas e Computadores – Microsistemas e Nanotecnologias, Rua Alves Redol, 9 – 1, 1000-029 Lisbon, Portugal

Liquid-metal–mediated chemical vapor deposition (LM-CVD) has recently emerged as an alternative pathway for diamond growth under ambient-pressure conditions. [1] In this approach, low-melting gallium–indium (Ga–In) alloys act simultaneously as catalytic solvents and carbon-dissolution media, enabling the stabilization of sp^3 carbon at temperatures as low as 900 °C, without the need for high-pressure conditions. The liquid metal surface provides an atomically dynamic interface where dissolved carbon atoms can be locally supersaturated and precipitated as diamond nuclei.

In the present study, ferrocene [$Fe(C_5H_5)_2$] was introduced into the Ga–In system as both a carbon precursor and a catalytic additive. Upon thermal decomposition, ferrocene forms reactive carbon species, while producing transient Fe clusters and Fe_3C/Fe–N_x intermediates. These iron-based centers enhance the conversion of sp^2 to sp^3 carbon by lowering the local activation barrier for diamond nucleation. Simultaneously, a balanced H_2:N_2 atmosphere (33 sccm: 33 sccm) provides hydrogen termination to stabilize sp^3 surfaces and a nitrogen source for the formation of Fe–N and GaN-like interfacial species, further tuning the surface chemistry of the liquid metal.

To tailor crystal morphology, 50 nm silicon particles are dispersed in the melt.[2] Silicon atoms participate in interfacial reactions, forming Si–C and Si–N bonds, which locally modify the surface energy anisotropy and diffusion dynamics. The combined catalytic and interfacial effects of ferrocene-derived Fe and nanosilicon result in diverse diamond morphologies, [3] including well-faceted cubic, tetrahedral, and octahedral crystals.[4] These morphologies differ markedly from those produced in conventional plasma-assisted CVD (MPCVD), indicating the unique role of the liquid-metal environment in controlling the morphology.

This liquid-metal-enabled CVD route represents a robust and scalable strategy for diamond growth at ambient pressure, combining process simplicity with tunable control over crystal morphology and grain enlargement. Beyond its technological convenience, this approach deepens the understanding of catalyst-driven sp^3 carbon stabilization and offers a promising foundation for large-area or single-crystal diamond production in liquid-phase CVD system.

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I13. Chalcogenide glasses for MIR gas sensing

Suresh Kumar Jakka

i3N and Department of Physics, University of Aveiro, Aveiro, 3810-193, Portugal

Low phonon glasses such as tellurite or chalcaogenide doped with photoluminescent (PL) active ions, specially trivalent rare earth (RE^{3+}) ions offer significant advancements in gas sensing due to their enhanced optical properties and high sensitivity. The RE dopants impart distinct PL characteristics, enabling gas detection across visible (VIS), infrared (IR), and mid-infrared (MIR) regions. Each RE^{3+} ion has a distinct feature that could be used in sensing in various regions. For instance, Eu^{3+}-doped glasses, which emit sharply in the VIS around 615 nm, are ideal for detecting oxygen (O_2), as O_2 presence quenches PL intensity. Er^{3+}-doped glasses are effective in the IR region around 1.5 µm, suitable for carbon dioxide (CO_2) detection, with PL intensity correlating to CO_2 concentration. Yb^{3+}-doped tellurite glasses, emitting strongly in the MIR around 1 µm, are effective for sulfur dioxide (SO_2) detection, enhancing sensitivity and selectivity. Chalcogenide glasses doped with Er^{3+} and Yb^{3+} show potential for methane (CH_4) detection due to their broad MIR transmission and high refractive index. These glasses fabricated into optical fibers, can detect gases through changes in PL emission upon exposure. This method allows remote sensing, high sensitivity, and operation in harsh environments, making it suitable for environmental monitoring and industrial applications.

The presentation will include a general introduction to glasses and their properties, an overview of PL through various dopants, and a discussion on different PL mechanisms. It will also cover the fabrication of glasses and fibers, especially chalcogenide glasses, and detail the mechanisms of gas detection using these advanced materials.

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I14. Ion irradiation induced changes in BaSnO3 ceramics

S. Shanmuga Sundari[1, *], S. Karthika[2], A. Durairajan[3], K. Asokan[4]

[1]Department of Physics, Seethalakshmi Ramaswami College, Trichy, 620002 India
[2]Department of Physics, PSGR Krishnammal College for Women, Coimbatore, 641004, India
[3]Department of Physics, Saveetha Engineering College (Autonomous), Chennai, Tamil Nadu 602105, India
[4]Department of Physics & amp; Centre for Interdisciplinary Research, University of Petroleum and Energy Studies (UPES), Dehradun, Uttarakhand, 248007, India

**Corresponding author email id* – shanmugi.s@gmail.com

Barium stannate ceramics ($BaSnO_3$) was synthesized using high-temperature mixed-oxide technique. The precursors barium carbonate ($BaCO_3$) and tin oxide (SnO_2) were calcinated at 500 °C for 6 hours and sintered at 1400 °C for 4 hours and made into pellets. They were irradiated with Lithium (Li^+) and Tungsten (W^+) ion of 100 MeV energy at a fluence of 5×10^{11}, 1×10^{12} , 5×10^{12} and 1×10^{13} ions/cm^2. XRD reveals crystalline nature and cubic structure of the prepared and irradiated $BaSnO_3$ ceramics. The morphology of both as prepared and irradiated ceramics were analysed using SEM images and the ceramics possess hexagonal cubic structure. To analyze the electrical properties, dielectric spectroscopy for the prepared $BaSnO_3$ ceramics and ion irradiated $BaSnO_3$ ceramics were recorded from room temperature to 400 °C in a frequency range of 1 kHz to 2 MHz for every 5 degrees. A. C. conduction mechanism of the ceramics was recorded and the activation energy of the sample before and after ion irradiation was calculated using Arrhenius plot. The activation energy was found to decrease as frequency increases for pristine and irradiated ceramics.

I15. From Structure to Function: Engineering ZnO/γ-Fe_2O_3 Interfaces for Advanced Photocatalysis

Ivna Kavre Piltaver [1,2,*], Slavko Kralj [3,4,5], Ivan Prološčić [1], Marko Perčić [2,6], Martina Kocijan [1], Daria Jardas Babić [1,2], Iva Šarić Janković[1,2], Blaž Jaklič [7,8], Robert Peter [1,2]

[1]*Faculty of Physics, University of Rijeka, Radmile Matejčić 2, 51 000 Rijeka, Croatia*
[2]*Center for Micro- and Nanosciences and Technologies, University of Rijeka, Radmile Matejčić 2, 51 000 Rijeka, Croatia*
[3]*Department for Material Synthesis, Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia*
[4]*Nanos SCI, Nanos Scientificae Ltd., Teslova ulica 30, 1000 Ljubljana, Slovenia*
[5]*University of Ljubljana, Faculty of Pharmacy, Department of Pharmaceutical Technology, Aškerčeva cesta 7, 1000 Ljubljana, Slovenia*
[6]*Faculty of Engineering, University of Rijeka, Vukovarska 58, 51000 Rijeka*
[7]*Advanced Material Department, Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia*
[8]*Jožef Stefan International Postgraduate School, Jamova 39, 1000 Ljubljana, Slovenia*

[*] *ivna.kvare@uniri.hr*

Industrial water pollution caused by persistent organic contaminants remains one of the most critical global environmental challenges, urging the development of advanced materials capable of efficient and sustainable pollutant removal [1]. Among emerging strategies, semiconductor-based photocatalysis has attracted increasing attention due to its ability to utilize light energy for decomposing organic pollutants into harmless by-products [2].

In this work, we present a comprehensive study on the design and optimization of ultrathin ZnO coatings deposited on microstructured γ-Fe_2O_3 films by atomic layer deposition (ALD), aiming to enhance photocatalytic efficiency through morphological and electronic engineering. The γ-Fe_2O_3 microstructured templates were fabricated via drop-casting of silica-coated γ-Fe_2O_3–SiO_2 core–shell microparticles with controlled geometry and silica shell thickness. The ALD growth rate of ZnO was found to depend strongly on the surface hydroxyl group concentration, influencing both film uniformity and photocatalytic performance [3].

Comprehensive structural, morphological, and chemical analyses—performed using SEM, TEM, AFM, XPS, and GIXRD—revealed that the photocatalytic enhancement originates from two complementary effects: (i) increased surface roughness and microstructured topography, which provide a larger density of active sites, and (ii) formation of a type-I heterojunction between ZnO and γ-Fe_2O_3, which facilitates efficient charge carrier separation and suppresses recombination. Under UV irradiation, the optimized ZnO/γ-Fe_2O_3 heterostructures achieved methylene blue degradation rates up to three times higher than reference ZnO films deposited on flat silicon substrates.

These findings demonstrate how rational control of nanoscale morphology and interfacial band alignment can synergistically enhance photocatalytic activity. The results highlight the potential of engineered ZnO/γ-Fe_2O_3 heterostructures as efficient, light-driven materials for environmental remediation and open new perspectives for the design of multifunctional oxide interfaces in photocatalytic and photoelectrochemical applications.

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I16. Additive manufacturing of ceramic monoliths suitable for magnetic heating

Milan Vukšić[1 *], Thomas Konegger[2], Martin Schwentenwein[3], Sašo Gyergyek[4], Sandra Drev[5], Andraž Kocjan[1], Aljaž Iveković[1]

[1] *Department for Nanostructured Materials, Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia*
[2] *Institute of Chemical Technologies and Analytics, TU Wien, Getreidemarkt 9, 1060 Vienna, Austria*
[3] *Lithoz GmbH, Vienna 1040, Austria*
[4] *Department for Materials Synthesis, Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia*
[5] *Center for Electron Microscopy and Microanalysis (CEMM), Jožef Stefan Institute, Jamova cesta 39, 1000, Ljubljana, Slovenia*
[*] *Presenter's contact details: +386 1 4773 895, milan.vuksic@ijs.si*

Additive manufacturing of SiOC ceramic structures with hierarchical porosity and embedded magnetic nanoparticles are attractive for the magnetic induction heating of a catalytical reactor. In this study, modified preceramic polymer was used to fabricate monolithic structures using Digital Light Processing 3D printing. The photosensitive resin formulation has been adopted to achieve hierarchical porosity by photopolymerization-induced phase separation of the resin blend, which is crucial for the final application of the printed structure as a catalytical reactor. The metalorganic compounds, i.e., Fe, Co, Ni acetylacetonates and ferrocene, were investigated as a magnetic additive. The monoliths containing various amounts of magnetic additives were successfully fabricated from the prepared photosensitive resin formulations. The subsequent pyrolysis of the printed parts was conducted under argon in a wide range of temperatures to achieve the polymer-to-ceramic conversion. During this process an amorphous SiOC ceramics is formed with *in situ* generated functional magnetic nanoparticles (MNPs). The thorough investigation of magnetic properties has been conducted as well as the determination of steady state temperatures of the fabricated monoliths under alternating magnetic field (234 kHz, 60 $kA \cdot m^{-1}$) revealing satisfactory magnetic heating up to 600 °C in 2 minutes for the Co/Ni doped monolith under nitrogen flow of 30 $cm^3 \cdot min^{-1}$.

I17. Understanding Glass Structure through NMR Spectroscopy and Atomic Simulations

Anuraag Gaddam

CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Aveiro, Portugal.

E-mail: anuraagg@ua.pt

The structural complexity of glassy materials poses a significant challenge for modern materials science. Unlike crystalline solids, glasses lack long-range periodicity yet exhibit intricate short-range and medium-range order that governs their macroscopic properties. This study presents a combined experimental and computational approaches to elucidate the atomistic structure of selected oxide glass systems using solid-state nuclear magnetic resonance (NMR) spectroscopy and advanced atomic-scale simulations. Quantitative information on coordination environments and network connectivity is obtained through ^{29}Si, ^{27}Al, ^{23}Na, ^{71}Ga, ^{93}Nb, ^{31}P, ^{11}B, and ^{25}Mg NMR spectroscopy, providing experimental fingerprints of local structural motifs.

Classical molecular dynamics (CMD) and *ab initio* molecular dynamics (AIMD) simulations are employed to generate model glass structures under realistic quenching conditions. The simulated models are validated and refined through comparison with experimental NMR results, enabling the resolution of structural ambiguities not accessible by diffraction methods.

Variations in composition and processing conditions lead to systematic changes in local geometry and connectivity, which correlate with macroscopic properties such as density, elastic moduli, and chemical durability. These results establish robust composition–structure–property relationships across multiple glass systems. The combined use of NMR spectroscopy and atomic-scale simulations enables detailed mapping of the complex structural motifs in glasses, bridging experimental observables and atomistic models. The findings provide a framework for the rational design of next-generation glass materials with tailored functionalities and highlight future directions, including the integration of machine-learning-based structural refinement for predictive modeling.

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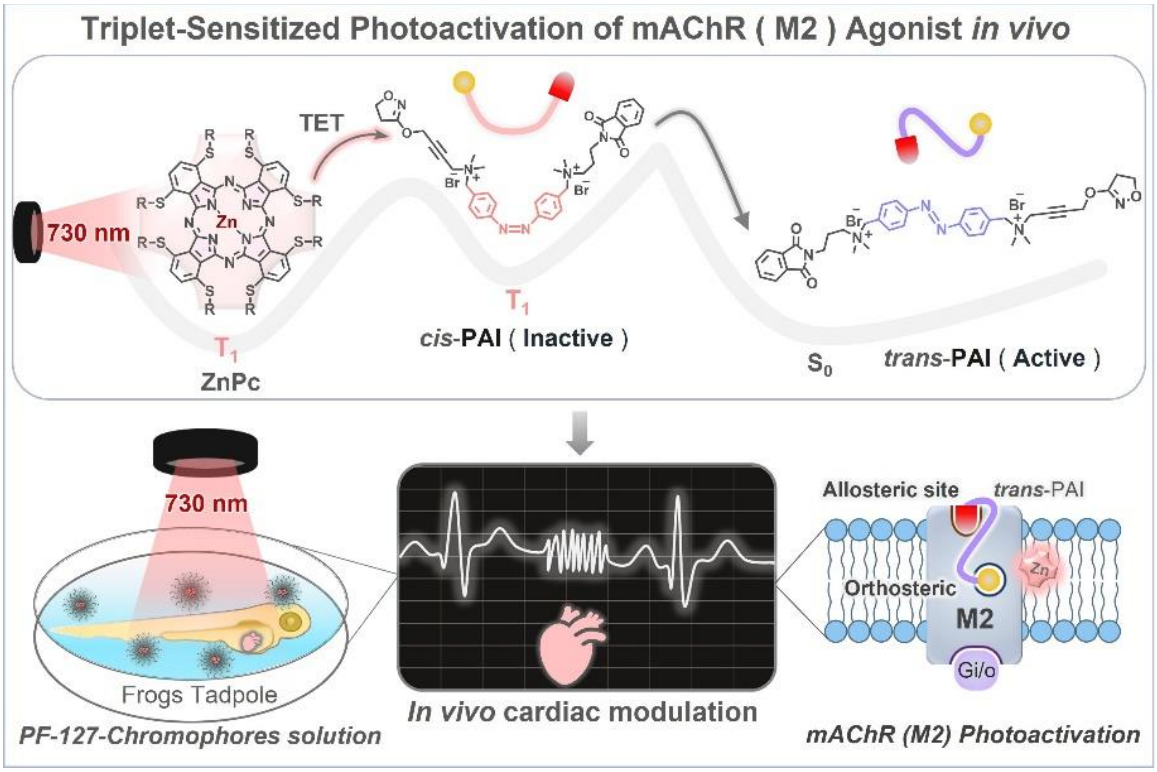
I18. Shifting the Action Spectrum of Azobenzene into Phototherapeutic Window

Pankaj Bharmoria*,[1,2] Mila Miroshnichenko,[1] Lukas Naimovičius,[1] and Kasper Moth-Poulsen*[1,2]

[1] *Institute of Materials Science of Barcelona, ICMAB-CSIC, Bellaterra, Barcelona, 08193, Spain.*

[2] *Department of Chemical Engineering, Universitat Politècnica de Catalunya, EEBE, Eduard Maristany 10–14, 08019 Barcelona, Spain*

Shifting the action spectrum of azobenzene into the phototherapeutic window have in photopharmacology due to its use as drug photoswitch.[1,2] We achieved bi-directional switching of the action spectrum of a newly synthesized azobenzene derivatives into the red and far-red region via singlet absorption and triplet-sensitization.[1,2] Subsequently triplet-sensitized photoswitching approach has been applied to control the heart rate of frogs tadpole upon excitation cis-to-trans isomerization of azo-based drug upon excitation with a 730 nm far-red light within the tolerance limits of the animal tissue.[2]



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I19. Rational Design of Biopolymer-Functionalized Magnetic Nanomaterials for Water Purification

Ana L. Daniel-da-Silva

Chemistry Dep./CICECO-Aveiro Institute of Materials, University of Aveiro, Aveiro, Portugal

* *ana.luisa@ua.pt*

Ensuring access to clean and safe water is a critical global challenge with significant implications for human health and sustainable development. However, numerous emerging contaminants are frequently found in drinking water sources, wastewater treatment plant effluents, and natural water bodies, often at concentrations that pose significant risks to public and ecological health. Nanotechnology has opened new avenues for enhancing water purification and wastewater reuse through the development of nanomaterials specifically designed for pollutant adsorption [1]. The combination of biopolymers of natural origin with magnetic nanoparticles yields bionanocomposites that are easily recovered through magnetic separation, making them very appealing for adsorption-based water treatment. Biopolymers introduce diverse chemical functionalities and tunable surface charge to the nanosorbent, both critical for achieving high adsorption capacities [2,3]. This work highlights novel chemical strategies for nanoparticle surface modification, with examples of systems tailored for specific water remediation applications. Emphasis is placed on the rational design of magnetic nanomaterial surfaces using natural-origin biopolymers, aiming to develop advanced nanosorbents with superior adsorption performance and reusability.

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I20. 2D ferrielectric CuInP2S6 and 3D ferroelectric Sn2P2S(Se)6: topology of phase diagrams and flexoelectricity

Yu. Vysochanskii, K. Glukhov, V. Liubachko, A. Kohutych,
M. Medulych, V. Hryts, A. Pogodin
Uzhhorod National University, Uzhhorod, Ukraine
vysochanskii@gmail.com

The occurrence of multicritical points on temperature – pressure (composition) phase diagrams signifies the presence of flexoelectricity and pronounced anharmonicity within crystal lattices. For 3D ferroelectrics such as $Sn_2P_2S(Se)_6$, these diagrams contain a line of tricritical points and a line of Lifshitz points that coincide at the tricritical Lifshitz point. In the case of the 2D ferrielectric $CuInP_2S_6$, the topology of the temperature – pressure diagram becomes more complicated due to the transformation of the tricritical point into a sequence of critical end points and bicritical end points. This transformation occurs when repulsive biquadratic coupling is enforced between the polar and antipolar order parameters in layered ferrielectrics.

We analyzed the flexoelectric coupling in 2D $CuInP_2S_6$ by studying its Raman spectra together with DFT calculations on its phonon spectra. Our analysis revealed the linear coupling between the low-energy sliding optical modes of the entire structural layers and the acoustic branches. We than compared the estimated values of the flexoelectric constant with earlier experimental and theoretical estimates. The appearance of flexoelectric coupling in 3D $Sn_2P2S(Se)_6$ crystals with the Lifshitz point and an incommensurate phase on the temperature – composition phase diagram of the $Sn_2P_2(Se_xS_{1-x})_6$ mixed crystal was compared to the flexoelectricity peculiarities of the 2D $CuInP_2S_6$ crystal. The latter has a possible spatially modulated distribution of spontaneous polarization above the ferrielectric-to-paraelectric I order phase transition at $T_C \approx 312$ K. The appearance of the crystal lattice instability relative to the incommensurate modulation follows from the flexoelectric coupling between the shear vibrations of neighboring entire structural layers and the transverse acoustic phonon branch. This “sliding flexoelectricity” is reinforced by compressing the $CuInP_2S_6$ crystal, and is related to the sensitivity of the interlayer van der Waals, ionic, and covalent mixed chemical bonding to the influence of external forces.

At application heating and at compression, the copper cations Cu^+ thermally throw from the quasitrigonal position Cu^I within of the structural layer to the quasitetrahedral position Cu^O outside the layers. The changes in the relative stability of these positions and associated variations in vibration spectra were traced by studying of the temperature dependence of polarized Raman spectra in different scattering geometries. Anomalies were observed in the frequency and intensity of the Cu^+ translations and $(P_2S_6)^{4-}$ anions internal vibrations at the first order ferrielectric transition near T_C, and further heating clearly demonstrates an additional anomaly in the 340–350 K range. This peculiarity correlates with the previously observed softening of ultrasound and hypersound velocities

upon cooling to T_C and is related to spatially modulated spontaneous polarization. In the presence of strong buckling of the structural layers, flexoelectric coupling creates spatial inhomogeneity in the spontaneous polarization, which can be related to the Cu^+ cation relaxation between the low polarization state at Cu^I positions and the high polarization state at Cu^O sites.

Acknowledgement

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I21. Atomic Layer Deposition of Cu-modified TiO_2 Thin Films for Improved Photocatalytic Performance under Simulated Sunlight

Robert Peter[1,2,*], Iva Šarić Janković[1,2], Karlo Veličan[1], Martina Kocijan[1], Krešimir Salamon[3], Matejka Podlogar[4], Ivana Jelovica Badovinac[1,2], Daria Jardas Babić[1,2], , Jasmina Lazarević[5], Ivna Kavre Piltaver[1,2]

[1]*University of Rijeka, Faculty of Physics, Radmile Matejčić 2, Croatia*
[2]*University of Rijeka, Center for Micro- and Nanosciences and Technologies, Radmile Matejčić 2, Croatia*
[3]*Ruđer Bošković Institute, Bijenička Cesta 54, Zagreb, Croatia*
[4]*Jozef Štefan Institute, Jamova cesta 39 Ljubljana, Slovenia*
[5]*Center for Solid State Physics and New Materials, Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, Belgrade, Serbia*
[*] *Phone: +385 51 584 621, e-mail: rpeter@uniri.hr*

Among metal oxide semiconductors, TiO_2 is recognized as highly effective photocatalysts due to the favorable energy alignment of its conduction (CB) and valence bands (VB), which promotes the strong redox activity of photogenerated electrons and holes. In addition, TiO_2 is characterized by low toxicity, high resistance to chemical and photo-corrosion, environmental compatibility, and relatively low production costs. However, its wide band gap restricts optical absorption primarily to the UV region. Moreover, as in many semiconductors, the rapid recombination of photogenerated charge carriers shortens the lifetime of photoinduced electrons and holes, limiting photocatalytic performance [1].

Band gap engineering through doping has proven effective in extending light absorption into the visible range. Dopant atoms can also enhance charge carrier lifetime by introducing localized energy levels within the band gap. Another strategy involves forming semiconductor–metal composites, where metallic nanoparticles (NPs) are deposited on the surface or incorporated into the oxide matrix. In such systems, localized surface plasmon resonance (LSPR) in the metallic NPs enhances optical absorption, while the formation of a Schottky barrier at the semiconductor–metal interface facilitates efficient separation of photogenerated electron–hole pairs [2].

In this work, TiO_2–Cu composite thin films were synthesized by atomic layer deposition (ALD). During film growth, Cu nanoparticles were directly incorporated into the TiO_2 matrix. The resulting polycrystalline films were characterized by X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), scanning and transmission electron microscopy (SEM/TEM), energy-dispersive X-ray spectroscopy (EDS), UV–vis spectroscopy, and photoconductivity measurements.

The photocatalytic activity of the TiO_2–Cu composites was evaluated via methylene blue (MB) degradation under simulated sunlight irradiation [3].

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I22. Multifunctional Organic Photocatalysts: Hydrogen Production & Water Purification

Vikram Uttam Pandit

PGK Mandal's Haribhai V. Desai Arts, Science & Commerce College, Pune-411002, India

(Email: vikramupandit@gmail.com)

Complex organic dyes and pigments are serious waste which damages the ecosystem as well as aquatic life. Researchers are working to overcome this serious issue for many years, but to developed cost-effective and eco-friendly method is unsolved challenge. Of late, inorganic based photocatalysis helps to treat industrial wastewater to some extent. Various inorganic semiconductor photocatalysts with high efficiency have been reported with different dyes degradation study.

We have synthesized 6,13-Pentacenequinone (PQ) an intermediate required to synthesize Pentacene which is well known organic semiconductor. After complete characterization we explored PQ for Industrial Dye degradation and photocatalytical H_2S splitting for the first time. We also synthesized the composite system of PQ-TiO_2 with inorganic semiconductor photocatalyst. Recently a report of PQ-MoS_2 photocatalyst also covers the water splitting area. This organic PQ photocatalyst has high potential in photocatalysis field which can be utilized for the clean environment and for Hydrogen generation.

Oral presentations

O1. Transforming Forestry Waste into Nanostructured Membranes: A Nature-Inspired Strategy for Graywater Treatment

Patricia E. Oliveira[1], Judith Vergara-Figueroa[2], William Gacitúa[2, 3], Freddy Valdés[5]

[1] *Departamento de Procesos Industriales, Núcleo de Investigación en Bioproductos y Materiales Avanzados, Universidad Católica de Temuco, Chile*
[2] *Centro de Biomateriales y Nanotecnología, Universidad del Bío-Bío, Concepción, Chile*
[3] *Departamento de Ingeniería en Maderas, Facultad de Ingeniería, Grupo de Investigación en Nanomateriales y Catalizadores para Procesos Sostenibles (NanoCatpPS), Universidad del Bío-Bío, Concepción, Chile*
[5] *Instituto Interdisciplinario del Agua - RUKAKO, Vicerrectoría de Investigación y Posgrado, Universidad Católica de Temuco, Chile*

Nanofibrillated cellulose is an innovative material obtained from cellulose, the main component of plant cell walls. In this case, nanofibrillated cellulose was elaborated from forest industry waste in Araucanía, Chile. Sawdust was used to obtain cellulose, which underwent a size separation process by granulometry to obtain an appropriate size fraction. Then, an oxidative treatment with peracetic acid was performed to obtain a high yield of delignified cellulose (maximum yield of 48%). Subsequently, the microfluidization process allowed the obtainment of nanofibrillated cellulose. This process consists of the mechanical disruption of cellulose in an aqueous medium, which allows obtaining cellulose fibers of nanometric size. Although it is difficult to measure the width and length of the nanofibers, in this case, they were estimated to be 15-44 nm and 1,500-2,000 nm, respectively.

To evaluate the performance of the cellulose acetate biotissue with cellulose nanocrystals in graywater filtration, several important parameters must be measured. Firstly, the filtration efficiency, which measures the number of contaminants the filter can remove from the water. This may vary depending on the quality of the inlet water and the pore size of the biotissue. Secondly, the water retention capacity of the filter, which measures the amount of water the filter can retain before becoming saturated and needing to be replaced. Thirdly, the filter's lifespan, which refers to the time the filter can function before needing to be replaced. This duration may vary depending on the quality of the inlet water and the pore size of the biotissue. Lastly, the cost of the filter, which includes both the initial cost of the biotissue and the maintenance and replacement costs. This factor is important to ensure that the filter is cost-effective and sustainable in the long run.

Regarding the results of graywater filtration, promising values have been obtained. In a domestic reverse osmosis system, a filtration efficiency of 70% has been achieved, which means that biotissue is capable of removing a large number of contaminants from graywater. Additionally, the filter has demonstrated good water retention capacity and a prolonged lifespan, thus reducing maintenance and replacement costs.

In terms of filtration efficiency, it has been found that the proposed biotissue has a rejection rate of 80-85% for particles with a size of 0.1 micrometers. Regarding water retention capacity, it has a water retention capacity of up to 110% of its dry weight. In

terms of lifespan, it has not yet been measured, however, studies indicate that cellulose acetate membranes can be stored in 20 different solutions for up to 45 months without losing their permeability properties.

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O2. TiO2 and Nitrogen-Doped TiO2 Thin Films Grown by Atomic Layer Deposition for Photocatalytic Water Purification

Martina Kocijan [1,*], Robert Peter [1,2], Iva Šarić Janković [1,2], Karlo Veličan [1,2], Mariana Rocha [3], André Pereira [3], Ivna Kavre Piltaver [1,2]

[1]*Faculty of Physics, University of Rijeka, Radmile Matejčić 2, 51 000 Rijeka, Croatia*
[2]*Center for Micro- and Nanosciences and Technologies, University of Rijeka, Radmile Matejčić 2, 51 000 Rijeka, Croatia*
[3] *IFIMUP – Institute of Physics for Advanced Materials, Nanotechnology and Photonics, Department of Physics and Astronomy, Faculty of Sciences of University of Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal*
[*] *martina.kocijan@uniri.hr*

The increased scarcity of clean water resources and the continuous increase of emerging pollutants, such as pharmaceuticals, dyes, and microplastics, have become urgent global concerns. These pollutants are chemically stable and resistant to conventional wastewater treatment, which demands the development of innovative and sustainable remediation methods. Among various advanced oxidation processes (AOPs), photocatalysis has emerged as a promising and environmentally friendly technology for degrading persistent organic contaminants by utilising solar energy to generate reactive oxidative species [1].

Titanium dioxide (TiO_2) is one of the most extensively studied photocatalysts due to its strong oxidative potential, chemical stability, and low cost. However, the efficiency of TiO_2 is limited by its wide band gap (~3.2 eV), which mainly restricts light absorption to the ultraviolet (UV) region. To extend the light response into the visible spectrum and enhance photocatalytic efficiency, nitrogen doping has been recognised as an effective approach. Nitrogen atoms can substitute oxygen sites in the TiO_2 lattice, narrowing the band gap and suppressing the recombination of photogenerated charge carriers [2-3].

In this study, pure and nitrogen-doped TiO_2 thin films were synthesised using thermal atomic layer deposition (ALD) on silicon substrates. Titanium isopropoxide (TTIP) and water vapour were used as the titanium and oxygen precursors, respectively, while ammonia (NH_3) gas was employed as the nitrogen source during the ALD cycles. Post-deposition calcination at 550 °C was carried out to improve crystallinity and activate photocatalytic sites. The structural, morphological, and chemical properties of the prepared thin films were analysed using X-ray diffraction (XRD), Raman spectroscopy, scanning electron microscopy (SEM), and X-ray photoelectron spectroscopy (XPS).

The photocatalytic activity was evaluated through the degradation of methylene blue (MB) under simulated solar irradiation. The results demonstrated that nitrogen-doped TiO_2 thin films exhibited enhanced photocatalytic efficiency compared to undoped TiO_2, attributed to improved visible-light absorption and reduced charge recombination. These findings confirm the potential of thermally deposited ALD TiO_2-based thin films as efficient and stable photocatalysts for solar-driven advanced oxidation processes in wastewater treatment.

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O3. Novel photochromic Fe-based highly active ionic liquids, spiropyrans, phthalocyanine and porphyrin functionalized nanomaterials for pollutants removal

Mariana Neamțu[1]*, Andreea Maftei[1], Fliur Macaev[2] and Andreea Paul[3]

[1]*Department of Exact and Natural Sciences, Institute of Interdisciplinary Research, Alexandru Ioan Cuza University of Iasi, Bv. Carol I, no. 11, 700506, Iasi, Romania*

[2]*Laboratory of Organic Synthesis and Biopharmaceuticals, Institute of Chemistry, 3 Academiei str., 2028 Chisinau, Republic of Moldova*

[3]*Bundesanstalt für Materialforschung und -prüfung (BAM), Unter den Eichen 87, 12205, Berlin, Germany*

* *mariana.neamtu@uaic.ro*

Current research and applied technologies for water treatment should be focused more towards greener and more sustainable approaches of environment remediation [1]. A sustained effort is also necessary to develop safe efficient materials able to both optimize water treatment and minimize the negative impact of technological processes in the environment. From the more recently developed water treatment strategies, advanced oxidation processes (AOPs) are powerful methods for wastewater remediation. The increasing use of nanomaterials in pollutant control proved to be an effective solution. AOPs, such as photocatalysis, have gained a major interest in the field of water remediation as a modern, viable technology for the complete photocatalytic mineralization and removal of a variety of organic pollutants from water [2]. We proposed several simple and efficient methods of synthesis of the *novel*, eco-friendly Fe-based highly active ionic liquids, phthalocyanine, spiropyrans and porphyrin functionalized nanocatalysts and their application through a viable, simple, greener and inexpensive procedure that leads to fast complete degradation of different emerging contaminants in aqueous solution under mild conditions. The ionic liquids based catalysts have found application in various chemical processes [3]. Our results showed that the newly developed Fe-based highly active ionic liquids containing an imidazolium salt and a Schiff base with paramagnetic properties are promising photocatalysts for the removal of micropollutants from contaminated wastewater [4]. The paramagnetic Fe-based highly active ionic liquid containing an imidazolium salt and a Schiff base are presented as promising photocatalysts for the removal of micropollutants from wastewater. Photochromic properties of ionic liquid functionalized spiropyrans have been investigated in solution and in various matrices [3]. Especially the combination of photochromic properties and photosensitizing properties make spiropyrans highly potent compounds that are able to generate Reactive Oxygen Species (ROS) [3]. The use of photoresponsive catalytic formulations based on spiropyrans is an eco-innovative and original solution, since, to our knowledge, no spiropyran has been used for application in water treatment. To the best of our knowledge, a limited number of studies investigate the iron phthalocyanine and porphyrin mechanism for the catalytic removal of emerging organic pollutants. The catalytic activity and dispersion properties of CNTs have been improved by their functionalization with phthalocyanine that can also generate reactive oxygen species (ROS) during the

oxidation process of common pollutants. Additionally, iron (II and III) phthalocyanine decorated on the multi-wall carbon nanotubes structure have enhanced the surface active sites, the chemical stability of the catalytic material, and FePc's oxygen transfer ability. In our study, the novel free-base-porphyrin-sensitized Fe_3O_4 magnetic nanoparticles have been tested for the first time for the degradation of the model pollutant Bisphenol A in aqueous solution. Moreover, quenching experiments have been carried out to further disclose the contribution of involved ROS in the process. One of the most exciting features of the project is that ROS have been seriously under-utilised until now, and yet they represent ideal tools across a range of modern chemical paradigms which universally insist that scientists find and exploit ever more highly effective and sustainable technology (clean, non-toxic to environment, reduced/zero waste, cheap etc.), which is also readily applicable across scales (research to industrial), sectors (academic, SME, technological, medicinal, industrial) and fields (traversing organic, physical, biochemical, analytical, commercially relevant chemistry). The obtained recyclable photocatalysts showed enhanced catalytic behaviour toward the photodegradation of BPA, Carbamazepine and dyes, due to a high yield of singlet molecular oxygen generated by porphyrin in the presence of UVA irradiation. Moreover, the photocatalysts were successfully used for pollutant removal in three consecutive runs, without significant loss of catalytic features. The Electron Spin Resonance (ESR) experiments pointed to an efficient formation of $^1O_2$ by the studied catalysts in aqueous suspension. Thus, it could be demonstrated that the developed catalysts are promising photocatalysts, e.g. for the removal of micropollutants from contaminated wastewater.

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O4. Electrically Conductive Silver-Polyaniline Core-Shell Nanoparticle Composite Membranes for Enhanced Water Filtration and Biofouling Mitigation

Huzaifa Rushan Aziz[1], Muhammad Zahid[2], **Zulfiqar Ahmad Rehan[3]**, Umar Farooq[2]

1 State Key Laboratory of Solidification Process, Northwestern Polytechnical University, Xi'an, Shaanxi, 710072, China

2 Department of chemistry, University of agriculture Faisalabad Pakistan

3 Department of Chemistry, College of science, Sultan Qaboos University, Al-khoud 123, Muscat, Oman

** Email: zarehanpk@gmail.com*

Herein, PANI@Ag nanoparticles (NPs) were synthesized for the first time via in-situ polymerization of Ag NPs for improving conductivity polyaniline (PANI) mainly to make it suitable as ECM. The DFT calculations confirmed the establishment of a conductive network via PANI and Ag. PANI@Ag NPs were embedded in polyvinylidene fluoride (PVDF) membranes by non-solvent induced phase separation (NIPS) to produce electrically conductive membranes (ECMs). The ECMs showed enhanced electrical conductivity, water flux (32 to 68 l/hm²), and BSA rejection (75% to 90%). To modulate biofouling, a voltage of 1.5 V was applied to boost flux and anti-fouling performance. In tensile strength, the ECMs also remained stable at 228% increase. These results indicate PANI@Ag NPs as promising nanofillers for fabrication of novel, sustainable water filtration membranes with in-built conductivity and anti-fouling properties.

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O5. Synergistic CoNi and PtCoNi Dual-Alloy Catalyst Design for pH-Universal Outstanding Hydrogen Evolution

Abhisek Majumdar[1], **Duy Thanh Tran[1]***, Nam Hoon Kim[1], Joong Hee Lee[1,2*]

[1] *Department of Nano Convergence Engineering, Jeonbuk National University, Jeonbuk National University*

[2] *Center for Carbon Composite Materials & Dept. of Polymer and Nano Science and Technology, Jeonbuk National University, Jeonju, Jeonbuk 54896, Republic of Korea*

* *Telephone: +82-10-4484-8419, fax:+82-63-270-4254, and e-mail address: dttran@jbnu.ac.kr.*

Reducing the reliance on platinum group metal (PGM) catalysts for the hydrogen evolution reaction (HER) is crucial for advancing practical proton exchange membrane (PEM) and anion exchange membrane (AEM) water electrolysis [1]. PGM single-atom catalysts (SACs) have emerged as a promising approach by maximizing atomic utilization, but their limited active sites, stability, and tunability of electronic structure constrain performance [2]. Alloying PGMs with earth-abundant transition metals offers an effective strategy to reduce PGM usage while enhancing activity and stability through electronic structure modulation and synergistic interactions [3]. Herein, we report a dual-alloy catalyst comprising CoNi and $Pt_3Co_{0.5}Ni_{0.5}$ alloy sites embedded within a carbon nanotube matrix. This design achieves outstanding HER activity in both acidic and alkaline media, delivering overpotentials as low as 14 and 17 mV, respectively, at 10 mA cm^{-2}. In full-cell electrolyzer tests, the catalyst operates stably at 500 mA cm^{-2} for 500 hours with minimal degradation in both PEM and AEM systems. Experimental and theoretical studies reveal that CoNi promotes water dissociation by modulating interfacial water structures, while Pt-CoNi alloying optimizes hydrogen adsorption free energy, accelerating the Heyrovsky step. The synergistic interaction between CoNi and $Pt_3Co_{0.5}Ni_{0.5}$ provides an effective balance between adsorption and reaction kinetics, offering a robust platform for pH-universal HER catalysis and scalable hydrogen production.

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O6. Role of Metal Cation Transporter Families in Bacteria Mediated Nanoparticle Synthesis for Enhanced Biomedical Applications

Awantika Singh, Anu Singh, Hemant R. Kushwaha

School of Biotechnology, Jawaharlal Nehru University, New Delhi, India 110067

* *Ph No. (+91) 7073252431, fax and e-mail address: awani867singh@gmail.com*

In recent years, bacteria nanofactories have emerged as remarkable systems for fabricating functional nanomaterials by utilizing both intracellular and extracellular mechanisms. This study focuses on engineering *Escherichia coli* as a microbial nanofactory for the biosynthesis of zinc oxide (ZnO) nanoparticles. This was achieved by modifying the expression of specific metal cation transporter families, including Cation Diffusion Facilitators (CDFs) and Na^+/H^+ antiporters. These transporters were optimized via genetic engineering to fine tune an optimal microenvironment for the controlled nucleation and growth of ZnO nanoparticles. The fine tuning of CDF protein in bacteria showed they play role in nanoparticles transporter across bacterial cell membrane. The NHX protein showed they have role in fine tuning shape and morphology of synthesized nanoparticles. After that, the synthesized nanoparticles were characterised via various analytical technique such as UV, XRD, EDX, HR-TEM, FTIR and also their biomedical application were evaluated for antibacterial, anticancer and antioxidant properties. The XRD spectrum suggests that pure, crystalline, hexagonal, wurtzite-type ZnONPs were formed when treated with zinc salt procurer concentrations (40 and 80 mM). The HR-TEM images showed the synthesis of spherical nanoparticles (26-39 nm range) were formed. The SEAD pattern also confirms the formation of polycrystalline ZnONPs at higher concentrations, validating XRD results. Biological entities present inside the bacterial cell and present at the surface plays significant role as reducing and stabilizing agents in nanoparticle formation which is clearly observed. The antibacterial activity of as-synthesized ZnONPs is noteworthy against gram-positive and gram-negative pathogenic bacteria, even at low concentrations of 50 µg/mL. Similarly, the significant anticancer activity against lung cancer A549 cells at similar doses of 50 µg/mL of as-synthesized ZnONPs was observed. This research outlines a solid strategy for harnessing microbial ion transport systems to enable programmable nanoparticle biosynthesis, highlighting the potential of *E. coli*-based engineering for the sustainable and self-regulating synthesis of advanced biomaterials.

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O7. A Study on the Mechanical Properties and Environmental Evaluation of TPV/PVDF/MMT Composites

In Tae Kim[1,*], Yeon-Jin Kim[2], Dong-sik Bae[2]

[1,2]*Korea Testing & Research Institute, 14, Haeryongsandan 4-ro, Haeryong-myeon, Suncheon-si, Jeollanam-do, Republic of Korea*

[*] *+82 61-750-8727, +82 61-750-8740 and intae2636@ktr.or.kr*

Recently, Study on sealing materials for ammonia propulsion ships is required for materials that can withstand cryogenic environments. Ammonia is corrosive, and when ammonia vapor comes into contact with moisture, it can corrode copper, zinc, its alloys, and rubber and plastic. For this reason, research is needed on highly corrosive reinforcing materials. In this study, the feasibility of producing this type of nanocomposite by direct injection molding was evaluated. The performance of actual injection-molded products made from PVDF compounded with thermoplastic vulcanizate(TPV) and organoclay(MMT) was analyzed and compared. The composite exhibits excellent resistance to ammonia environments, resulting in improved final product quality. The compounding of the nanofiller MMT enhances gas barrier properties under ammonia exposure, thereby protecting the polymer and helping to prevent cracks or deformation. The use of TPV/PVDF/MMT composites appears to be a promising approach for injection-molded.

O8. BaTiO3 Nanoparticles for Glucose and Paracetamol Fluorescence Sensing

Onur Çetinkaya [1]*, Elif Esra Altuner [2] Figen Varlioglu Yaylali[3] Havva Nur Tatli[4] Mahmut Özacar and[5,6] Safaa N Saud Al-Humairi[7]

[1] Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Kocaeli Health and Technology University, Kocaeli, Türkiye
[2]Program of Medical Laboratory Techniques, Department of Medical Services and Techniques, Vocational School of European, University of Kocaeli Health and Technology, Kocaeli, Turkiye
[3]Solar Energy Application and Research Center (METU-GUNAM), Middle East Technical University, Ankara, Turkiye
[4]Department of Property Protection and Security, Vocational School of Kulu, University of Selcuk, Konya, Turkiye
[5]Sakarya University, Faculty of Science, Department of Chemistry, 54050 Sakarya, Turkiye
[6]Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano & Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research & Development Group (BIOENAMS R&D Group), 54050 Sakarya, Turkiye
[7]Faculty of Information Sciences and Engineering, Management & Science University, Shah Alam, Selangor, Malaysia
** Presenter's e-mail address: Onur Çetinkaya, onur.cetinkaya@kocaelisaglik.edu.tr*

$BaTiO_3$ nanoparticles (BTNP) were synthesized via direct synthesis at room temperature and normal pressure, with average diameters tunable between 7 and 9 nm by varying the reaction time. The formation of the polycrystalline perovskite structure, and the morphological and optical properties of the synthesized nanoparticles were investigated using X-ray Diffraction (XRD), Selected Area Electron Diffraction (SAED), Transmission Electron Microscopy (TEM), Fourier-transform Infrared (FTIR) spectroscopy, and UV-Vis spectroscopy. These nanoparticles were successfully employed as fluorescence sensors for paracetamol and glucose detection. Notably, the stable fluorescence of the BTNP exhibited a concentration-dependent quenching upon interaction with these analytes. Quantitative analysis, primarily through Stern-Volmer plots, revealed distinct quenching efficiencies (Ksv), with glucose showing the highest efficiency (Ksv ≈ 2.66 x 10^4 μM^{-1}) followed by paracetamol (Ksv ≈ 1.30 x 10^4 μM^{-1}), demonstrating their potential as sensitive sensing probes. Further analytical performance metrics confirmed good sensitivity for both analytes, with low detection (LOD ≈ 1.0-1.2 ppm) and quantification limits (LOQ ≈ 3.5-4.0 ppm). While glucose exhibited a narrower linear range (~1.8 ppm), paracetamol showed a broader response (at least 30 ppm). Overall, the $BaTiO_3$ system demonstrates reasonably competitive analytical performance for organic molecule detection compared to existing literature, highlighting its promising utility.

O9. Multifunctional Hydrogel Dressings with Plant-Based Antimicrobial Extract to Accelerate Diabetic Wound Healing

Muhammet Kamil Kerim[1,2,*], Mahmut ÖZACAR[2,3]

[1] 1Sakarya University, Institute of Natural Sciences, Department of Biomedical Engineering, 54187, Sakarya, Turkiye
[2] Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano & Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research & Development Group (BIOENAMS R&D Group), 54050 Sakarya, Turkiye
[3] Sakarya University, Faculty of Science, Department of Chemistry, 54050 Sakarya, Turkiye
* Presenter's telephone, fax and e-mail address: +90 561 615 09 54, +90 264 295 59 50 and Mkamilkerim@gmail.com

Abstract

Managing diabetic wounds is particularly difficult because healing is slow, infection risk is high, and affordable options are limited. Here, we design multifunctional hydrogel dressings from biocompatible polymers, PVA and PVP, incorporating an antimicrobial plant extract (Alpinia galanga) to tackle these issues. Hydrogels were prepared by crosslinking and repeated freeze–thawing, then structurally characterized by SEM, FTIR, and mechanical tests to determine porosity, hydration capacity, and stability. Antibacterial activity was measured against representative pathogens, including S. aureus and E. coli, and biocompatibility was examined using fibroblast cultures. We also studied the controlled release of bioactive constituents from the plant extract to improve therapeutic performance.

Introduction

Diabetic wounds are chronic wounds that heal slowly and are prone to infection, making their treatment a significant challenge. Advanced wound dressings such as hydrogels help maintain a moist healing environment and can deliver therapeutic agents to the wound site. Hydrogels composed of biocompatible polymers are excellent for wound care because their porous, hydrated networks mimic the extracellular matrix and absorb wound exudate [1]. In fact, PVA/PVP-based hydrogels for wound treatments can be crosslinked by physical methods such as repeated freeze–thaw cycling, avoiding toxic chemical crosslinkers. Another promising strategy for improving wound healing is the incorporation of natural bioactive extracts into dressings. Plant-derived extracts often possess antimicrobial, anti-inflammatory, and antioxidant properties that can address multiple factors in chronic wound pathology [1,2]. *Galangal (Alpinia galanga), a rhizomatous plant in the ginger family, is widely recognized for robust antibacterial effects across diverse pathogens, notably the wound-associated species Staphylococcus aureus and Escherichia coli*. Galangal's phytochemical constituents (such as flavonoids like galangin and diarylheptanoids) contribute to its antimicrobial and anti-inflammatory effects. Given these advantages, loading galangal extract into a PVA/PVP hydrogel could yield a multifunctional dressing that both protects the wound and actively combats

infection. [3,4,5]. This study aimed to evolve a PVA/PVP hydrogel loaded with bioactive extract from Alpinia galanga (antimicrobial). The mechanical, structural, and biological features of the hydrogel were systematically evaluated to determine its suitability for diabetic wound management.

Method

Physically crosslinked PVA/PVP hydrogel structures were prepared using the freeze–thaw method. To form the hydrogel matrix, PVA and PVP were used at a 40:60 ratio (for a total of 4.0 g polymer). First, PVA (1.6 g) was heated at 90 °C under continuous stirring in approximately 16–20 g of deionized water (to yield an 8–10% w/w solution) until completely dissolved. PVP (2.4 g) was pre-dissolved in 16–20 g of deionized water (to yield a 12% w/w solution) by stirring continuously overnight at 50 °C until fully dissolved. This solution was then slowly added to the PVA solution at approximately 70 °C with stirring to obtain a homogeneous polymer mixture.

The resulting PVA/PVP solution was cast into a clean Petri dish (100 mm diameter) to form a film approximately 4 mm thick, and degassed while cooling at room temperature to remove air bubbles. The solution was then subjected to freeze–thaw cycling to achieve physical crosslinking. The mixture was frozen at –20 °C for about 16 hours and subsequently thawed at 25 °C (room temperature) for 4–8 hours. This procedure constituted of one freeze–thaw cycle, and it was repeated three times in succession. During freezing, ice crystals were formed and polymer phase separation occurred, thereby generating crystalline regions of PVA. During thawing, these crystalline regions acted as physical crosslinkers within the hydrogel network. After the final thawing step, a robust and transparent hydrogel layer was obtained. The PVA/PVP hydrogel was wrapped with Parafilm to prevent drying and stored at 4 °C in a humid environment until drug loading.

Incorporation of plant extract during hydrogel synthesis: The plant extract was incorporated into the PVA/PVP blend before initiating the freeze–thaw procedure. Following thorough mixing at 50 °C to ensure uniform dispersion, the blend was transferred into Petri dishes and left uncovered at room circumstances overnight to dissipate entrapped air bubbles. The hydrogel then underwent four sequential freeze–thaw cycles, consisting of freezing at −20 °C for 24 hours and thawing at 4 °C for 6 hours in each cycle.

Post-loading of plant extract into preformed hydrogel: In parallel, a separate extract-free portion of the PVA/PVP mixture was cast into a Petri dish, degassed overnight, and subjected to the same four freeze–thaw cycles to yield a blank hydrogel. After the final thaw, the preformed hydrogel was immersed in a solution of the antimicrobial plant extract at room temperature, allowing diffusion of the extract throughout the porous network matrix.

For both strategies, loading efficiency and subsequent release of the plant extract were quantified by UV–Vis spectroscopy over time. Finally, FT-IR spectroscopy was performed

to verify functional groups and confirm successful incorporation of the polymers and the antimicrobial agent within the hydrogel.

Results

Repeated freeze–thaw processing produced stable PVA/PVP hydrogels with sound mechanical strength and a porous architecture suitable for loading bioactive compounds. FT-IR spectra displayed characteristic bands of both polymers and confirmed successful incorporation of the antimicrobial plant extract using either method. UV-Vis measurements showed time-dependent release of the extract for both the in-synthesis and post-loading approaches, with method-dependent differences in release profiles and potential use cases. Taken together, these data indicate that the PVA/PVP hydrogel platform is well suited for delivering antimicrobial agents, offering flexible incorporation routes and sustained release for wound care and related biomedical applications.

Discussion

The PVA/PVP network formed by freeze–thaw cycles effectively supported both in-synthesis incorporation and post-loading of the antimicrobial plant extract. Pre-mixing during gelation yielded a more uniform distribution with a faster initial release, whereas post-loading favored a more prolonged release pattern. Therefore, these hydrogels are promising for adaptable wound care uses that require sustained antimicrobial efficacy.

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O10. Effect of MAPbCl3 modification on LaCoO3/g-C3N4 for electrochemical sensing of ascorbic acid

Oumayma BOUHAJEB [1,2,*], Ramzi HAMMAMI [1], Adel MEGRICHE [1], Mahmut ÖZACAR [2,3]

[1] *Laboratoire de Chimie Minérale Appliquée (LCMA) LR19ES02, Faculté des Sciences de Tunis, Université Tunis El Manar. Campus Universitaire Farhat HACHED, 2092, El Manar –Tunis, Tunisie*
[2] *Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano and Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research and Development Group (BIOENAMS R&D Group), 54050, Sakarya, Turkiye*
[3] *Sakarya University, Faculty of Science, Department of Chemistry, 54050, Sakarya, Turkiye*
[*] *Corresponding Author Tel.: +21624499567, e-mail address: oumayma.bouhajeb@etudiant-fst.utm.tn*

Abstract

In this work, we investigate the effect of $CH_3NH_3PbCl_3$ incorporation into $LaCoO_3$/g-C_3N_4 binary composite. Both binary and ternary composites were synthesized through an ultrasound assisted sonochemical route and characterized using XRD, FTIR, SEM, TEM, PL, UV-DRS, EIS and Mott-Schottky analyses. Cyclic voltammetry (CV) and differential pulse voltammetry (DPV) were effectuated to assess the composite's sensitivity for ascorbic acid. The calculated limits of detection (LOD) were 0.023 µM for the ternary and 0.035 µM for the binary composite. In addition, the durability and repeatability of both materials were systematically assessed.

Introduction

Lead-based hybrid perovskites with the general formula $MAPbX_3$ (where MA = $CH_3NH_3^+$ and X = Br^-, Cl^-, or I^-) have recently attracted significant attention in sensing technologies owing to their remarkable optoelectronic characteristics and highly tunable physicochemical properties. Beyond their well-established roles in photovoltaics, these materials have demonstrated promising performance in electrochemical and photocatalytic platforms. In this regard, nanocrystalline lead halide perovskites, such as $CH_3NH_3PbBr_3$ and $CsPbBr_3$, have been shown to promote efficient electron and hole injection through electrochemical redox processes, thereby broadening their applicability across diverse fields. These advances are primarily attributed to the creation of novel charge-transfer pathways and favorable interfacial interactions imparted by the halide perovskite phase. Extending this concept, the integration of $MAPbCl_3$ into an oxide/g-C_3N_4 composite is expected to establish additional electronic channels and catalytic active sites, potentially boosting the efficiency of ascorbic acid oxidation.

Method

In this study, composite materials were synthesized by combining $LaCoO_3$ (prepared via a sol–gel combustion route), $MAPbCl_3$ (synthesized through a simple sonochemical method), and g-C_3N_4 (obtained by thermal polymerization of melamine) in a 4:3:2 ratio. The components were dispersed in a minimal amount of water and subjugated to

ultrasonication for 30 min to ensure homogeneous mixing. The solvent was subsequently removed, and the resulting mixture was dried at 80 °C to obtain the final products.

Results

The XRD patterns of the heterostructures display the characteristic peaks of $LaCoO_3$, g-C_3N_4, and $MAPbCl_3$ confirming the successful acquisition of all individual components.
The FTIR spectrum of $LaCoO_3/MAPbCl_3$/g-C_3N_4 displays the main features of all constituents, confirming their successful integration. $MAPbCl_3$-related N–H and C–H vibrations are retained, overlapping with the C–N/C=N stretching region of g-C_3N_4 (1200–1650 cm^{-1}), while the triazine peak at ~807 cm^{-1} is also preserved. Also, Co–O vibrations from $LaCoO_3$ appear around 500–600 cm^{-1}. The coexistence of these characteristic bands evidences effective coupling among the three phases within the composites.
The HRTEM image reveals clear lattice fringes, with interplanar spacings of 0.32 nm (g-C_3N_4 (002)), 0.93 nm ($MAPbCl_3$) [1], and 0.38 nm ($LaCoO_3$ (012)), confirming the crystalline nature and coexistence of all three phases in the heterostructure.
The PL intensity is markedly lower in the $LaCoO_3/MAPbCl_3$/g-C_3N_4 compared to $LaCoO_3$/g-C_3N_4, indicating more efficient photogenerated charge carrier separation in these heterojunctions, corroborating band gap estimation.
A pronounced decrease in charge transfer resistance is observed upon incorporating $MAPbCl_3$ into the oxide/g-C_3N_4 heterostructure, demonstrating that $MAPbCl_3$ facilitates interfacial charge transfer by strengthening the electronic coupling between the perovskite oxide and g-C_3N_4.
Electrochemical studies clearly demonstrate the superior performance of the $LaCoO_3/MAPbCl_3$/g-C_3N_4 heterostructure. $LaCoO_3/MAPbCl_3$/g-C_3N_4 composite delivers the lowest LOD (0.023 µM) and LOQ (0.07 µM), surpassing $LaCoO_3$/g-C_3N_4 (0.035, 0.107 µM).

Discussion

The $LaCoO_3/MAPbCl_3$/g-C_3N_4 GCE modified electrode delivers exceptional sensitivity with a detection limit of 0.023 µM, lower than reported materials [2,3]. This superior performance is primarily attributed to the synergistic heterostructure, which facilitates efficient charge separation and transfer, enhances electron–hole mobility, and generates additional catalytically active sites at the interfaces, thereby promoting the electrochemical oxidation of ascorbic acid.

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O11. Biodegradable packaging design with blueberry extract and characterization

Zeynep Ziyade ÖZACAR[1,2,*], Gülnur Arabacı[3], Mahmut ÖZACAR[2,3]

[1]*Sakarya University, Institute of Natural Sciences, Department of Chemistry, 54187, Sakarya, Turkiye*

[2]*Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano & Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research & Development Group (BIOENAMS R&D Group), 54050 Sakarya, Turkiye*

[3]*Sakarya University, Faculty of Science, Department of Chemistry, 54050 Sakarya, Turkiye*

***Presenter's telephone, fax and e-mail address: +90 264 295 67 86, +90 264 295 59 50 and zeynep.ozacar@ogr.sakarya.edu.tr*

Abstract

This study investigated the potential use of industrial food waste blueberry peels as a biodegradable food film. Blueberry extract obtained by methanol extraction was added to films containing chitosan and gelatin at different ratios. The effects of films containing different amounts of blueberries on the film properties like contact angle, swelling capacity and antioxidant activity have been perused. The study found that films containing blueberry extract obtained using the 0.667% ratio had higher antioxidant activity.

Introduction

Films containing polymers that can be degraded by microorganisms are called biodegradable films. Non-toxic polymers such as chitosan, PVA, PVB, and gelatine are commonly used in the production of biodegradable films. Since these polymers do not have a toxic effect on living organisms and have limited interaction with food, their potential use as food packaging is being investigated [1], [2]. A biodegradable food film is expected to have good barrier properties, microbiological stability and mechanical properties. At the same time, it is desired that it does not release toxins, is safe for human health, decomposes in nature in a short time and has a low production cost [3], [4]. Chitosan (Ch) and gelatin (Gel) polymers are preferred in biodegradable food packaging research because they have these expected properties [5]. Blueberries are known to act as natural antioxidants owing to their high anthocyanin and flavonoid content [6]. The aim of this study is to design a biodegradable pH sensitive antioxidant film from chitosan, gelatin, blueberry extract (BE) and to evaluate its potential use as a food film.

Method

In this study, blueberry peel was used as the antioxidant source, and extraction was carried out according to the following procedure. 130 g of the sample (blueberry peel) was chopped and mixed in a blender at 60°C for 24 hours in a mixture of 260 mL of 70% methanol and 5% acid. The extract was filtered ~~via~~ 0.45 µm cellulose filter paper and utilized for analysis. Separate filtrates obtained from different extraction media were centrifuged separately at 6000 rpm for approximately 15 minutes to remove fine suspended particles. The resulting filtrate was collected as BE to be evaporated at about -1 atm pressure and 60°C temperature. To obtain the biodegradable film, 3% (w/v) chitosan and 3% (w/v) gelatin were dissolved separately in 15 mL of distilled water, and the mixture was stirred for 2 hours at 80°C and 250 rpm on a magnetic stirrer. At the end of 2 hours, the two mixtures were combined, 2% (v/v) glycerol was added, and stirred for another 1

hour. The final mixture was divided into three and BE was added at different ratios (0.165%, 0.333% and 0.667%) and mixed for another hour, then poured into petri dishes and allowed to dry for 2 days at room temperature. The contact angle measurement, FTIR analysis, swelling capacity, pH sensitivity and DPPH antioxidant activity tests were performed on the obtained films. To analyze the swelling capacity of the films, first, the dry weight of the films was weighed. The films were weighed again after being kept in a beaker containing 20 mL of distilled water for 6 hours. To determine the pH sensitivity of the films, solutions prepared at pH 2, 4, 6, 8, 10 and 12 were dropped onto the films sequentially and the changes in the films were observed. DPPH antioxidant analyses were conducted to determine the antioxidant activity of the films.

Results

When the contact angle analyses of Ch-Gel films containing at different ratios of BE were explored, it was seen that the contact angle of films containing BE at a ratio of 0.165% was more suitable for food packaging. FTIR spectra depicted characteristic bands of Ch and Gel polymers, confirming the successful incorporation of the BE into the films. Among the prepared films, the film containing BE at a ratio of 0.67% was determined to have the highest swelling capacity. Analysis showed that all films containing BE were sensitive to pH and the pH sensitivity of the films increased with the increase of BE ratio in the film. The DPPH antioxidant activity test results of the prepared films displayed that the film containing 0.667% BE had the highest antioxidant activity.

Discussion

Considering all test results, it can be concluded that the film containing 0.667% BE is more suitable for food packaging due to its high contact angle, low water retention capacity, and good antioxidant properties.

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O12. A Cutting-Edge Approach to Sustainable Tomato Plant Protection by Hybrid ZnO-Based Nanomaterials

Catherine Dendrinou-Samara[1]*, Kleoniki Giannousi[1], Ilektra Sperdouli[2], Julietta Moustaka[3], Stefanos S. Andreadis[2], Michael Moustakas[3]

[1]*Laboratory of Inorganic Chemistry, Department of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece*

[2]*Institute of Plant Breeding and Genetic Resources,Hellenic Agricultural Organization-Demeter, 57001 Thermi, Greece*

[3]*Department of Botany, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece*

**+306946123822 e-mail: samkat@chem.auth.gr*

The integration of nanotechnology into agriculture has emerged as a transformative approach to enhance the efficiency and effectiveness of agricultural inputs. Inorganic-based nanomaterials offer a promising solution to several challenges faced in modern farming. Among them, ZnO NPs have attracted considerable interest due to their stability, high surface area, electron mobility, ease of synthesis, and intrinsic biocompatibility. These features collectively highlight their promise for crop protection strategies. Beside the inherent properties of ZnO NPs (first generation), a second generation of more advanced nanoarchitectures designed by us to combine multiple functionalities as bimetallic, hetero-nanostructures, inorganic/organic nanocapsules [e.g.1,2]. These hybrids engineered nanomaterials combine different functionalities and have emerged as multimodal agents with new artificial properties. Herein, we report various hybrid ZnO-based nanostructures, created by combining ZnO NPs with bioactive molecules. Specifically, ZnO@PEG, ZnO@Pel, ZnO@Sal, and ZnO nanocapsules loaded with geraniol (ZnO@Ger) were successfully prepared by wet chemical approaches and physicochemically characterized. PEG influences photochemistry through its effects as a stabilizer or structural component while modulate reaction rates and alter the properties of photoreactive materials; Pelargonic acid (Pel), an acute herbicide, that prevents growth of weeds both indoors and outdoors; Salicylic acid (Sal), a crucial component of plant defense mechanisms against environmental stimuli; Geraniol(Ger) an essential oil with antimicrobial and insect-repellent properties. To evaluate their biological impact, we assessed their effects on tomato plant photosynthetic efficiency using chlorophyll a fluorescence imaging, which allowed us to quantify the light energy utilization efficiency of Photosystem II. In parallel, the insecticidal efficacy of these nanostructures was tested against *Tuta absoluta* and *Spodoptera exigua* major leaf-miner pests in tomato plants.

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O13. Boosting the Alkaline Catalytic Performance of MoS_2 via Electrochemically Deposited MoS_2@$Co(OH)_2$ Hybrid Structures

Hafiz Muhammad Naeem[1,*], Muhammad Adeel Tariq, Giedrius Stalnionis, Loreta Tamašauskaitė-Tamašiūnaitė, Eugenijus Norkus, Ramūnas Levinas

Center for Physical Sciences and Technology (FTMC), Saulėtekio ave. 3, Vilnius, Lithuania

[*] *+37064208372, hafiz.naeem@ftmc.lt*

The transition to sustainable energy requires efficient technologies for the production of green hydrogen. Among these, electrochemical water splitting is highly promising, but it requires the use of effective and durable electrocatalytic materials.

Molybdenum disulfide (MoS_2), a layered transition metal dichalcogenide, is a promising candidate in water splitting applications due to higher active sites, chemical stability, and abundance. However, lower conductivity and sluggish kinetics in alkaline media limit its widespread application in catalytic water splitting. In this study, a facile electrochemical method is used to synthesize the MoS_2@$Co(OH)_2$ hybrid structure. XRD confirms the formation of MoS_2@$Co(OH)_2$, and SEM observations of the surface morphology reveal the formation of sponge-like hybrid structures (Fig. 1). Different electrochemical measurements such as LSV, EIS and Tafel slope calculations are carried out in both acidic and alkaline media to characterize HER activity. Improved charge transfer kinetics and appreciable decrease in overpotential is observed in the optimized MoS_2-based catalysts. The enhanced activity is credited to interfacial interactions and higher density of active sites.

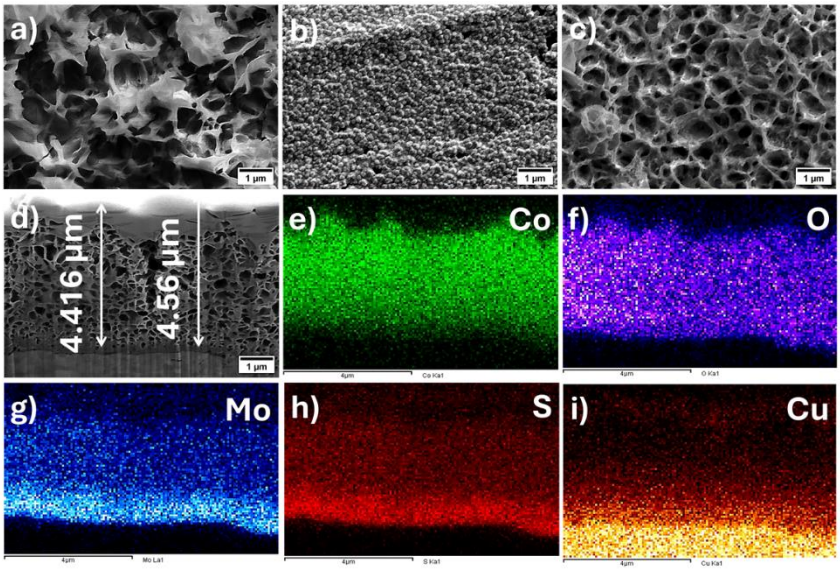

Fig. 1. SEM images of a) Co(OH)2 (C1), b) MoS2 (M1) and c) MoS2@Co(OH)2 (M1@C1). d) representing the cross-section image of M1@C1 hybrid structure using FIB (inset showing the coating thickness). e-i) showing the elemental area mapping of the cross-section to witness the atomic distribution

O14. Investigating the Electrocatalytic Behavior of Pd-Decorated $Ni(OH)_2$/CuO Catalyst for Methanol Oxidation Reaction

Muhammad Adeel Tariq, Hafiz Muhammad Naeem, Loreta Tamašauskaitė-Tamašiūnaitė, Eugenijus Norkus, Ramūnas Levinas
Department of Catalysis, Center for Physical Sciences and Technology (FTMC), Vilnius, Lithuania
+37063864741, adeel.tariq@ftmc.lt

Fuel cells (FCs) represent advanced electrochemical systems that address the growing global energy demand through clean, efficient, and sustainable electricity with low or zero emission of harmful gases. Within the fuel cell research direct methanol fuel cells (DMFCs) have gained significant attraction due to high energy density, compact design, low operating temperature, fuel availability and valuable commercial viability.

Although notable progress has been achieved, commercialization of DMFC technology is hindered by the slow reaction kinetics of methanol oxidation reaction (MOR) and poisoning of catalytic active sites due to formation of carbonaceous intermediates like CO which further reduce the oxidation of methanol. As a result, strategic design of significantly active and sustainable catalyst is essential for enhancing MOR activity and DMFC efficiency.

In this study Pd-decorated $Ni(OH)_2$/CuO composite catalyst material was synthesized through hydrothermal method for $Ni(OH)_2$/CuO base material and then decorated with Pd nanoparticles using solution base chemical reduction technique. Structural and morphological analysis using X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) confirmed the formation of catalyst material where uniformly dispersed Pd nanoparticles incorporated into the $Ni(OH)_2$/CuO framework.

Electrocatalytic behavior towards methanol oxidation was investigated through cyclic voltammetry (CV), chronoamperometry (CA), and electrochemical impedance spectroscopy (EIS) in an alkaline media (1.0M KOH containing 1.0M CH_3OH). Pd-decorated $Ni(OH)_2$/CuO material exhibited improved current density, long term electrochemical stability and enhanced tolerance toward carbonaceous intermediates relative to Pd/C and $Ni(OH)_2$/CuO materials. The improved electrocatalytic behavior of Pd-decorated $Ni(OH)_2$/CuO material is due to synergistic electronic and structural interactions among Pd, $Ni(OH)_2$, and CuO which provides faster electron transfer environment, enhanced density of active sites and facilitate the oxidation of methanol intermediates.

Overall, the obtained Pd–decorated $Ni(OH)_2$/CuO material presents a cost effective, promising, durable and stable anode catalyst for application in DMFCs, reducing dependence on precious noble-metals without affecting the methanol oxidation activity.

O15. Comparative Study of Cerium Oxide Nanoparticles and Conventional Radioprotective Agents in Cancer Treatment

Younes Tadjouri[1*], Abdelkadir Belhadj [2],
[1] Département des sciences de la matière, Université Adrar, Algérie
[2]MECACOMP Laboratory, Department of Mechanical Engineering, University of Tlemcen, Algeria
tadj.younes@univ-adrar.edu.dz

Abstract

Cerium oxide nanoparticles (CeO_2 NPs) have been emerged as promising nanomaterials in radioprotection for cancer therapy, due to their unique redox cycling ability between Ce^{3+} and Ce^{4+} states. These nanoparticles exhibit strong antioxidant properties that can protect healthy tissues from radiation-induced oxidative stress[1]. The use of CeO_2 NPs in combination with conventional therapies may enhance treatment efficacy while minimizing side effects.

Introduction

Radiation therapy is an essential tool in modern oncology [1]; however, its effectiveness is often limited by collateral damage to surrounding healthy tissues caused by the overproduction of reactive oxygen species (ROS) [2]. Cerium oxide nanoparticles have attracted considerable attention because of their remarkable ROS-scavenging ability and catalytic redox behavior [3]. Recent studies have shown their potential as a radioprotective agent that selectively shields normal tissues without reducing tumor sensitivity to radiation.

Method

The study proposes a multistage approach as followes:

1. Synthesis**:** CeO_2 NPs are synthesized using chemical routes such as co-precipitation, solution combustion, or laser ablation, with parameters (temperature, pH, and time) optimized to control size (1–100 nm) and morphology.
2. Surface Functionalization**:** Nanoparticles are coated with biocompatible polymers like polyethylene glycol (PEG) to enhance stability, biocompatibility, and targeting efficiency.
3. Biological Evaluation**:** In vitro toxicity assays on both normal and cancerous cells are followed by in vivo animal studies to evaluate radioprotective efficacy [4].
4. Clinical Assessment**:** Preliminary clinical trials are designed to establish the safety, dosage, and therapeutic potential of CeO_2 NPs in radiotherapy patients.

Results

Preliminary findings suggest that CeO_2 NPs significantly reduce radiation-induced oxidative stress by scavenging ROS and enhancing cellular antioxidant defenses.

When combined with chemotherapy or radiotherapy, CeO_2 NPs improve therapeutic outcomes and allow higher radiation doses while preserving healthy tissues.

Discussion

CeO_2 NPs demonstrate great potential as multifunctional agents in cancer radiotherapy. Their dual ability to protect normal tissues and enhance cancer cell radiosensitivity represents a major advancement in precision medicine. Future research should focus on optimizing synthesis parameters, understanding cellular mechanisms at the molecular level, and exploring novel delivery methods such as electromagnetic targeting to direct nanoparticles precisely to tumor sites.

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O16. Development and Evaluation of Tactile Probes for Breast Cancer Diagnosis

Hamid ASADI DERESHGI *, **Neziha ÇILLI**
Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey
* *+90 212 867 25 00 / 1140, hamidasadi@arel.edu.tr*

In 2025, the American Cancer Society projects that approximately 42,680 deaths (42,170 in women, 510 in men) will occur from breast cancer in the United States, reflecting a lifetime risk of death of about 1 in 43 (≈ 2.3 %) for women [1]. It is well documented that early detection is fundamental to improving breast cancer prognosis, with mammography serving as the primary diagnostic modality, whereas tactile probes present adjunctive potential through enhanced portability, immediate tactile feedback, and applicability in point-of-care diagnostics. There has been increasing clinical and research interest in tactile probes and tissue impedance sensors due to the capacity to detect subtle changes in tissue stiffness and electrical properties. Progression from rudimentary palpation tools to high-resolution, sensor-integrated devices has enabled rapid, minimally invasive assessment of neoplastic lesions, providing complementary information to standard imaging. In the open literature, extensive investigations were conducted in this field. For example, Yildiz et al. (2020) developed a single-point tactile probe with an embedded inductive sensor and silicone-metal array housing, which was calibrated and tested on soft tissue phantoms. The probe was compared with human palpation and demonstrated superior detection of small and deep inclusions, outperforming inexperienced subjects across the entire range of force levels [2]. Shaikh et al. (2020) developed a pen-like handheld device integrating a miniaturized piezoelectric tactile sensor and a portable readout module for quantitative tissue palpation in oral cancer screening. The system effectively differentiated tissue elasticity and demonstrated feasibility for early detection of oral abnormalities [3]. Presti et al. (2023) proposed a 3D-printed tactile probe with integrated fiber Bragg grating (FBG) sensors for noninvasive breast tumor detection. The probe accurately detected deep inclusions in silicone phantoms with high sensitivity and low thermal interference, demonstrating enhanced robustness, sterilization durability, and spatial resolution over conventional systems [4]. In continuation of these developments, the present study will focus on advancing tactile probe design and performance evaluation. The purpose of this study will be to detect the presence of hard tissue, representing a tumor, for the early diagnosis of breast cancer. It will involve the fabrication of silicone-based phantoms (Smooth-On Dragon Skin, USA) to simulate breast tissue. A rigid plastic inclusion will be embedded within the phantoms at three discrete depths—superficial, intermediate, and deep—representing tumors located at varying layers of breast tissue. There will be a tactile sensing probe, measuring 94 mm in length with a 60 mm × 60 mm contact surface, designed to facilitate comprehensive experimental investigation. The lower portion of the probe will be designed with a trapezoidal prism geometry, specifically crafted to securely integrate and position the tactile sensors. In this study, there will be two probe configurations with identical geometrical structures, differing

exclusively in their sensing mechanisms, with one integrating inductive sensor elements (TI LDC1000 EVM, Texas Instruments, USA) and the other utilizing a high-precision piezoelectric pressure sensor. The sensitivity will be enhanced by inserting metallic powder between the probe's contact surface and the sensors, which will be encapsulated within a silicone-filled trapezoidal cavity. The fabricated probes will be compared with human palpation to evaluate their accuracy, sensitivity, and general performance, providing valuable insights into the advantages and limitations of each sensing method for tumor detection.

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O17. Nanotechnologies for probing the microstructure evolution with aging in metallic glass

Marouane Mejres[1] *, Ronan Henry[1], Loïc Perriere[2], Ivan Blum[1], Francois Vurpillot[1], Yannick Champion[3], Nicolas Delpouve[1] & Allisson Saiter-Fourcin[1]

[1]Groupe de Physique des Matériaux, Université de Rouen Normandie, Rouen, France
[2]Institut de Chimie et des Matériaux de Paris-Est, Université Paris Est, Thiais, France
[3]Univ. Grenoble Alpes, CNRS, Grenoble INP, SIMAP, Grenoble 38000, France

Physical aging is a spontaneous phenomenon impacting the amorphous phase of the materials when they are kept below their glass transition temperature (T_g) [1]. During aging, the non-equilibrium glass moves towards more equilibrium states, which leads to macroscopic changes in properties such as mechanical and optical properties [2,3]. Despite decades of research, how glass approaches equilibrium remains a subject of debate in the scientific community.

For metallic glasses, physical aging occurs even at ambient temperature because of their high glass-transition temperatures. Their equilibration involves coupled processes that can be related to atomic-scale rearrangements [4]. In this work, to probe the physical aging in this type of glass, we combined three complementary nanotechnologies. The fast-scanning calorimetry (FSC) quantifies the enthalpy recovery, providing a calorimetric view of structural relaxation. The nanoindentation measurements probe aging-induced changes in the local mechanical response, revealing the length scale of the associated atomic rearrangements [5]. Finally, atom probe tomography (APT) maps the nanoscale chemical and structural evolutions, accompanying the physical aging process.

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O18. Elucidating the kinetics of the oxygen evolution reaction in multicationic oxides through different approaches to determining the Tafel slope

Pedro N. S. Neto[1], Rafael A. Raimundo[1,2], Pâmala S. Vieira[3],

Daniel A. Macedo[1], Francisco J. A. Loureiro[2,4], **Allan J. M. Araújo[2,4,*]**

[1] *Materials Science and Engineering Postgraduate Program – PPCEM, Federal University of Paraíba – UFPB, 58051-900 João Pessoa, Brazil*
[2] *TEMA – Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal*
[3] *Materials Science and Engineering Postgraduate Program – PPGCEM, Federal University of Rio Grande do Norte – UFRN, 59078-970 Natal, Brazil*
[4] *LASI – Intelligent Systems Associate Laboratory, 4800-058 Guimarães, Portugal*

[*] allan@ua.pt

The oxygen evolution reaction (OER) significantly impacts the efficiency of alkaline water electrolysis; therefore, the development of efficient and stable (electro)catalysts for OER is essential for advancing green hydrogen technologies [1]. In this study, we synthesised a multicationic spinel oxide $(Co_{0.25}Fe_{0.25}Mn_{0.25}Zn_{0.25})_3O_4$ and deposited it on a nickel foam (NF), comparing with Co_3O_4/NF as a reference. Linear sweep voltammetry (LSV) revealed that the quaternary oxide exhibited an overpotential of ~315 mV at 10 mA cm^{-2}, which is lower than that for Co_3O_4/NF (~338 mV), suggesting enhanced (electro)catalytic activity with the presence of different cations in the spinel lattice. Tafel slope analysis was then performed to identify the rate-determining step (RDS) and clarify the origin of this improvement. However, Tafel analysis requires steady-state conditions, which LSV cannot provide. Therefore, chronoamperometry (CA) and electrochemical impedance spectroscopy (EIS) were also employed. These techniques allowed more precise identification of the RDS and revealed relaxation frequencies aligned with the proposed mechanisms. The multicationic oxide/NF exhibited a predominantly chemical RDS with slopes of 54-65 mV dec^{-1} while Co_3O_4/NF displayed a mixed mechanism involving an initial electron transfer followed by a chemical step, resulting in steeper slopes of 74-85 mV dec^{-1} [2]. This improvement is attributed to the optimisation of the adsorption energies of intermediates (such as *OH, *O and *OOH) through the synergistic electronic effects of multiple cations [3]. Thus, our work provides a basis for reliable kinetic analysis in OER studies.

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O19. Bridging Nanoscience and Skin Biology: β-Carotene Nanocarriers to Sustain Hyaluronic Acid and Counteract Ageing

Zinaida Shakel *[1], Sofia A. C. Lima[2] and Salette Reis[1]

[1]*LAQV, REQUIMTE, Department of Chemistry, Faculty of Pharmacy, University of Porto, Portugal*

[2]*LAQV, REQUIMTE, ICBAS, School of Medicine and Biomedical Sciences, University of Porto, PT*
**zinaida.shakel@gmail.com*

Skin ageing, driven by intrinsic and extrinsic factors, leads to reduced elasticity and hyaluronic acid (HA) depletion.[1] Conventional treatments rely on exogenous HA or fillers with only temporary results.[2] This study developed a nanotechnology-based approach to enhance endogenous HA synthesis in skin cells.

Solid lipid nanoparticles (SLNs) were prepared using cacao butter or Imwitor K900 as lipid matrices and β-carotene as an antioxidant and photoprotective bioactive. Optimized SLNs showed sizes of 150-250 nm, PDI < 0.3, and zeta potentials between −17 and −24 mV, with 49-60% encapsulation efficiency and stability at 4°C for 28 days.

In HaCaT keratinocytes and human dermal fibroblasts, SLNs were biocompatible, efficiently internalized, and significantly increased intracellular and extracellular HA levels measured by AlphaLISA.

These results support β-carotene-loaded SLNs as a safe, non-invasive strategy to promote natural HA production and counteract skin ageing.

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O20. Integrating Large Language Models and Agentic AI into Molecular Modeling for Functional Materials Development

Alla Sapronova*

PetraOS AS, Bergen, Norway

* *+47 41488643, alla.sapronova@petraos.com*

Abstract

The design and development of functional nanomaterials—such as catalytic nanoparticles, semiconductor heterostructures, and energy-storage materials—require the integration of quantum chemistry, molecular dynamics, and data-driven analysis. While physics-based modeling remains the foundation of predictive nanomaterials science, recent advances in Large Language Models (LLMs) and agentic artificial intelligence (AI) show strong potential to improve and automate these workflows. LLMs can interpret molecular and structural representations, organize simulation tasks, and reason across diverse computational tools. When working as autonomous agents, they can support physically grounded research pipelines.

Introduction

Modern nanomaterials research depends on the ability to link atomistic-scale behavior with desired functional properties. Quantum-mechanical (QM) and molecular-dynamics (MD) simulations are powerful tools for this purpose but are computationally demanding and require expert intervention at each stage—from model setup to parameter adjustment and convergence analysis. As the chemical and structural complexity of nanomaterials increases, there is a growing need for intelligent workflow management that can adaptively combine physics-based modeling with data-driven reasoning.

The recent development of foundation models allowed wider application of LLMs in computational chemistry and materials science: from processing symbolic, structural, and numerical information, to effectively linking human reasoning with computational execution. If combined in multi-agent systems, this approach enables to design an AI-based frameworks for material development.

State of the Art

Recent studies demonstrate how LLMs and agentic systems are beginning to play an active role in the modeling and design of functional nanomaterials. The ChemCrow framework [1] showed how GPT-based reasoning can connect with chemistry toolkits to plan multi-step synthetic and modeling tasks relevant to nanoscale systems. This concept was extended by ChemGraph [2], which combines language-driven reasoning with graph-based molecular and crystal representations to manage and optimize simulation workflows dynamically.

To maintain physical validity, xChemAgents [3] introduced cooperative multi-agent mechanisms that enforce physical constraints during quantum-chemical property prediction—an essential step for accurate nanoscale electronic modeling. In parallel, AtomAgents [4] proposed a physics-aware multi-agent architecture linking AI reasoning with simulation control to accelerate the discovery of alloys and nanostructured materials. Tiwary et al. [5] provided an extended roadmap for integrating generative AI with physics-based models to accelerate nanomaterials discovery and design.

Collectively, all these studies show a major transition toward adaptive, AI-coordinated research environments operating across atomic-to-nanoscale regimes. In this paradigm, LLMs act as reasoning engines that interpret data, coordinate simulations, and guide successive computational steps.

Suggested Approach

Building on these developments, a framework AI4CMM (AI for Computational Material Modeling) is proposed to integrate reasoning-based AI with established molecular and materials modeling tools.

AI4CMM is designed as an interoperable and transparent control layer with hybrid architecture that combines the accuracy of physics-based modeling with the flexibility of AI-driven workflow orchestration. This approach enables automated yet physically interpretable simulations for the design of functional nanomaterials with targeted properties.

Conclusion

The convergence of LLMs, agentic AI, and traditional simulation represents a shift toward autonomous materials discovery. By coordinating computational tasks across scales and tools, AI-driven systems can reduce human workload, enhance reproducibility, and accelerate hypothesis testing. At the same time, maintaining physical accuracy and interpretability remains a key challenge.

The AI4CMM addresses these issues through modular design and embedded validation layers, ensuring that AI-generated decisions remain consistent with underlying physical models. Current work focus is on expanding the framework to incorporate experimental feedback and uncertainty quantification for developing next-generation functional nanomaterials.

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O21. Strains-deformations in nanocomposites of multiwalled carbon nanotubes and polymers, SiO2

A. P. Onanko*, L. V. Kuzmych, Y. A. Onanko, G. V. Voropai, M. V. Yatsiuk, S. A. Kuzmych, O. P. Dmytrenko, M. P. Kulish, A. P. Naumenko, T. M. Pinchuk-Rugal, A. G. Rugal, O. L. Pavlenko, L. I. Kurochka, P. P. Ilyin

National University of Kyiv, Kyiv, Ukraine, onanko@i.ua

Mechanical characteristics of nanocomposites based on multiwalled carbon nanotubes (MWCNTs) and polymers in Fig. 1 fundamentally differ from mechanical characteristics of macroscopically homogeneous systems.

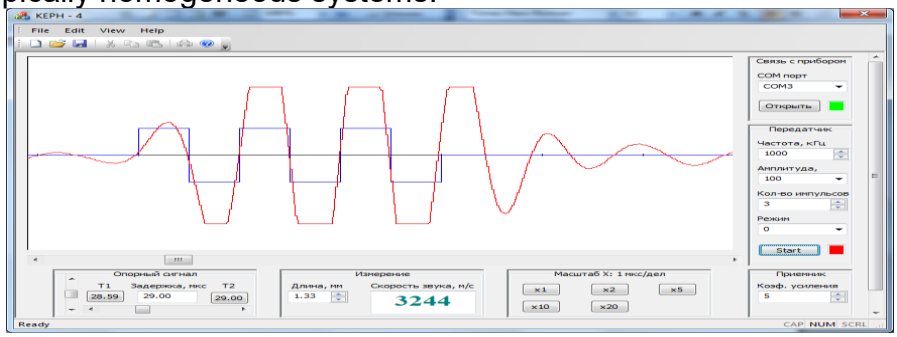

Fig.1. Illustration of the window for processing data of quasilongitudinal elastic waves velocity measuring $V_{\parallel}$ = 3244 m/sec in nanocomposite polyamide + 0,1% MWCNTs after electron irradiation.

Conclusion

1. The presence of the strong interaction for nanocomposites between polymers and multiwalled carbon nanotubes was confirmed.

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O22. Stannate-based anodes for proton ceramic fuel cells

Alfredo S. B. Luemba[a,b*], Allan J. M. Araújo[a,b], Laura I. V. Holz[a,b], Vanessa C. D. Graça[a,b], Duncan P. Fagg[a,b], Francisco J. A. Loureiro [a,b,**]

[a]*TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, 3810-193 Aveiro, Portugal*

[b]*LASI - Intelligent Systems Associate Laboratory, 4800-058 Guimarães, Portugal*

*buziluemba@ua.pt; **francisco.loureiro@ua.pt

Proton ceramic fuel cells (PCFCs) have become quite attractive in the market due to their high efficiency in both energy conversion and their low production cost, also presenting the flexibility to use a wide variety of fuels, making them an up-and-coming technology to produce electrical energy [1]. However, the lack of anode materials with suitable performance is one of the major drawbacks of this technology [2]. Hence, there is an urgent need to develop new materials to confront this challenge.

This study proposes the use of a stannate-based Ni-Ba_2SnO_4 (Ni-BSO, 40:60 vol%) composition in symmetric cells built on a $BaSn_{0.8}Y_{0.2}O_{3-\delta}$ (BSY) electrolyte substrate. BSY was prepared by a mechanochemical pre-activation route (under dry milling at 650 rpm for 7 h), followed by calcination in air at 1300 °C for 10 h. Conversely, BSO was prepared *via* a solid-state reaction route (by wet ball milling with 20 mL ethanol at 350 rpm for 8 h), followed by a drying step at 60 °C for 12 h. Then, BSO was calcined in air at 1300 °C for 10 h. The symmetrical cells were prepared by screen printing of a NiO-BSO slurry symmetrically on each side of a pre-densified electrolyte substrate (1600 °C for 10 h, in air), followed by sintering at 1000 °C (in air) for 4 h. Reduction of NiO to Ni was achieved at 700 °C overnight in a H_2 atmosphere.

The main outcome of this study is related to the electrochemical properties of the Ni-BSO anode, which were assessed by impedance spectroscopy in wet H_2 (p_{H2O} = 0.033 atm) in the temperature range 300 – 700 °C. The lowest total polarization resistance was achieved at 500 °C (6.45 Ω cm^2). Moreover, the results revealed that the rate-limiting processes were a combination of charge-transfer between BSO and Ni phases and hydrogen diffusion on the Ni grains. The understanding of the electrode mechanism will allow to further optimize the electrochemical response of this anode for future integration in PCFCs.

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O23. The impact of TiO2 on the structural, mechanical, and dynamical properties of alkali silicate glasses.

A. El Hamdaoui[1], M. Sbai Idrissi[1], A. Hassnaoui[2], S. Ouaskit[1]

[1]*University Hassan II, Av Driss El Harty, BP 7955, Casablanca, Morocco*

[2]*Université Sultan Moulay Slimane, 145 Khouribga principale, 25000, Khouribga, Morocco*

Silicate glass is one of the most important systems in glass families. In our recent works, we have focused on the investigation of the vibrational, thermal, and mechanical properties of silicate glasses from a chemical and physical standpoint. We particularly investigated the boson peak anomaly in some binary and ternary well known silicate glasses as well as the densification effect on the boson peak and properties of vitreous silica [1, 2]. On the other hand, ions mobility within the glass structure is critical for several applications of glassy materials such as for nuclear waste immobilization, ion exchange or solid-state electrolytes. To get insights into this issue, we have investigated alkali ions mobility in some silicate glasses with the effect of some oxide intermediates or formers in addition to the structural and mechanical properties.

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O24. Structural and mechanical properties of alkali silicate glasses: Insights from molecular dynamics simulations and artificial intelligence

SBAI IDRISSI Mouna[1, *], EL HAMDAOUI Ahmed [1], CHAFIQ Tarik [2], OUASKIT Said [1]

[1]*Laboratoire de Physique de la Matière Condensée, Faculté des Sciences Ben M'sik, University Hassan II of Casablanca*

[2] *LTI Laboratory, Faculté des Sciences Ben M'sik, University Hassan II of Casablanca*

[*] *+212617265670, mounasbaiid@gmail.com*

The properties of alkali silicate glasses can be effectively predicted using advanced artificial intelligence (AI) techniques, including machine learning (ML) and deep learning (DL). Since experimental data for many glass properties are often limited, molecular dynamics (MD) simulations can be employed to generate reliable datasets for training. Integrating these MD-derived datasets with AI algorithms significantly enhances model accuracy and generalization. In this study, various ML and DL models were developed to predict the structural and mechanical properties of three alkali silicate glass systems directly from their chemical compositions. Comparative evaluation of the models such as polynomial regression (PR), artificial neural networks (ANN), and gradient boosting trees (GBT) demonstrated excellent predictive performance, balancing accuracy and model complexity. The findings highlight the potential of AI-driven approaches as powerful tools for the rational design of next-generation glass materials with tailored properties [1].

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O25. Electrospinning of gasochromic nanofibers for visual hydrogen sensing

André F. Girão *, António Completo
TEMA, Department of Mechanical Engineering; University of Aveiro, Aveiro, Portugal
* *Corresponding author: andrefgirao@ua.pt*

Hydrogen sensors play a key role in guaranteeing safe and universal access to the forthcoming hydrogen economy. There is particular interest in developing gasochromic sensing platforms capable of providing intuitive readouts (*i.e.*, noticeable color change) without consuming energy or requiring auxiliary equipment [1]. Standard gasochromic nanomaterials such as tungsten oxide are highly competitive, but their integration into hydrogen sensors is often associated with significant environmental and economic costs. Among the available microfabrication techniques, electrospinning offers several advantages, including (1) the reproducible production and easy customization of nanofibers with high-to volume ratio, and (2) the well-established scalability and cost-efficiency.

In this work, green electrospinning principles were applied to fabricate gasochromic nanofibers capable of temporarily recording hydrogen leaks. Specifically, previously reported poly(vinyl alcohol)/Prussian blue (PVA/PB) gasochromic particles [2] were incorporated into PVA, polyethylene oxide, or polyvinylpyrrolidone nanofibers, with the aim of tailoring both the response and recovery characteristics of the resulting sensors. Hydrogen/air cycles showed that PVA-PVA/PB nanofibers exhibited the fastest color transition from pristine blue to white upon exposure to hydrogen (discernible bleaching after 40 s).

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O26. Network Morphology, and Swelling Kinetics of Alginate Hydrogels Prepared by Sol-Gel Method

Merve KEYF[1,*], Serbülent TÜRK[2,3], Burak ÜNLÜ[2,3], Güler Bengüsu TEZEL[4]

[1] *Sakarya University, Biomedical Engineering, Institute of Natural Sciences, Esentepe Campus, 54187, Sakarya, Türkiye*

[2] *Sakarya University, Biomedical, Magnetic and Semiconductor Materials Research and Application Center (BIMAS-RC), 54187, Sakarya, Türkiye*

[3] *Sakarya University, Faculty of Science, Department of Chemistry, 54187, Sakarya, Türkiye*

[4] *Bolu Abant Izzet Baysal University, Faculty of Engineering, Department of Chemistry Engineering, Golkoy Campus, 14030, Bolu, Türkiye*

** +90 (545) 285 09 84, mervekeyf421@gmail.com*

Alginate (Alg)-based hydrogels were prepared by sol-gel method and evaluated the morphology and hydration behavior. Morphological (SEM) and elemental mapping (EDS) analyses were employed to assess the microstructure and ion incorporation, while time-dependent swelling and water-retention behaviors were quantitatively determined. The difference observed between the two prepared systems is consistent with the “egg-box” mechanism.[1]

Swelling behavior analysis revealed a time-dependent increase in water uptake for all divalently crosslinked hydrogels. At 15, 30, 60, and 180 minutes, the wet masses were recorded as 0.4520–2.425 g (0.5%), 0.3630–1.954 g (1.0%), and 0.3950–1.250 g (2.0%). The highest normalized swelling capacity was obtained at the intermediate crosslinker concentration (1.0%), indicating an optimal balance between network stability and water permeability. In contrast, hydrogels prepared with a monovalent crosslinking system exhibited poor structural stability and completely dissolved within 15 minutes, preventing further swelling measurements. These findings confirm that crosslinking density and ion valency play critical roles in controlling hydrogel integrity and hydration performance.[2]

SEM/EDS analyses revealed that crosslinked hydrogels exhibited a denser and in samples prepared with crosslinker A, the formation of more stable “egg-box” junction zones through ion–guluronate interactions led to improved surface continuity and structural integrity.[3] At lower crosslinker concentration (0.5%), partially loose and fine porous domains were observed, while the 1.0% sample exhibited a more homogeneous and well-balanced microstructure. At higher concentration (2.0%), the network became tighter and more compact, resulting in reduced porosity. In contrast, B-crosslinked hydrogels showed discontinuous, wrinkled, and collapsed surface morphologies, which

can be attributed to the inability of ions to form stable coordination bonds and maintain a robust network.

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O27. Smart Conducting Polymer-Based Sensor for Heavy Metal Detection

Ferial Krid[1*], Djihane Slimane ben ali[2], Nihed Mekarba[2,3] , Amira Gharbi[4]

[1]*Department of Process Engineering, Faculty of Technology, Chemical and Environmental Engineering Research Laboratory, LGCE, Universite 20 Aout 1955, El Hadaik Road, Skikda 21000, Algeria*

[2]*Department of Process Engineering, Faculty of Technology, LRPCSI-Laboratoire de Recherche sur la Physico-Chimie des Surfaces et Interfaces, Universite 20 Aout 1955, El Hadaik Road, Skikda 21000, Algeria*

[3]*Laboratory of Catalysis, Bioprocess and Environment, Department of Process Engineering, Faculty of Technology, University of 20 August 1955, 21000 Skikda, Algeria*

[4]*Laboratory of Physics of Matter and Radiation (LPMR), Faculty of Science and Technology, University Mohamed Cherif Messaadia, BP 1553-41000 Souk Ahras, Algeria*

[*] *+213 793 31 66 68 ,* f.krid@univ-skikda.dz

Because of their toxicity, persistence, and bioaccumulation in the food chain, heavy metals like cadmium (Cd^{2+}), lead (Pb^{2+}), and mercury (Hg^{2+}) pose a significant risk to the environment as they contaminate aquatic ecosystems. The development of sensitive, selective, and low-cost electrochemical sensors offers an efficient alternative to conventional analytical methods, which are often time-consuming and expensive. This work presents a novel and cost-effective carbon paste electrode (CPE) elaborated from pencil graphite and modified with polyaniline (PANI) and copper oxide nanoparticles (CuONPs) green-synthesized using *Ficus elastica* leaf extract. The electrode was characterized by FT-IR and FEG-SEM analyses. Its electrochemical properties were evaluated using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). The results showed that modification with PANI and CuONPs significantly enhanced the electrode's conductivity, active surface area, and affinity toward metal ions. The CuONPs/PANI–CPE sensor enabled the sensitive and simultaneous detection of Cd^{2+}, Pb^{2+}, and Hg^{2+} in 0.01 M HCl, with very low detection limits of 0.11, 0.16, and 0.07 µg L^{-1}, respectively. These values are below the regulatory limits set by the WHO, confirming the effectiveness of the proposed approach for environmental monitoring. Furthermore, the sensor exhibited excellent selectivity toward interfering ions, good reproducibility, and long-term stability. Its successful application to real environmental samples confirms its practical potential. These findings suggest that the CuONPs/PANI–CPE sensor represents a simple, cost-effective, and sustainable electrochemical platform capable of meeting current needs for rapid and reliable detection of toxic heavy metals in water.

O28. DFT Investigation of Boric Acid–Macrocycle hosts interactions : Unveiling the Role of Hydrogen Bonding in complex stabilization.

Nihad Mekarba[1,2*], Ferial Krid[3], Youghourta Belhocine[2], Amira Gharbi[4]

[1]*Department of Process Engineering, Faculty of Technology, LRPCSI-Laboratoire de Recherche sur la Physico-Chimie des Surfaces et Interfaces, Universite 20 Aout 1955, El Hadaik Road, Skikda 21000, Algeria*

[2]*Laboratory of Catalysis, Bioprocess and Environment, Department of Process Engineering, Faculty of Technology, University of 20 August 1955, 21000 Skikda, Algeria*

[3]*Department of Process Engineering, Faculty of Technology, Chemical and Environmental Engineering Research Laboratory, LGCE, Universite 20 Aout 1955, El Hadaik Road, Skikda 21000, Algeria*

[4]*Laboratory of Physics of Matter and Radiation (LPMR), Faculty of Science and Technology, University Mohamed Cherif Messaadia, BP 1553-41000 Souk Ahras, Algeria*

[*] *+213 793 31 66 68 ,* f.krid@univ-skikda.dz

The interaction processes between boric acid (BA) and multiple macrocyclic host molecules were investigated through density functional theory (DFT). These interactions are energetically favorable. since the computed complexation energies were negative. Structural analysis revealed the formation of multiple hydrogen bonds, particularly in the BA complexes with β-cyclodextrin (β-CD), pillar[5]arene (P[5]), and pyrogallol[5]arene (P[5]G). The hydroxyl (OH) groups of BA were found to play a key role in establishing intermolecular hydrogen bonds, thereby enhancing the stability of the BA/β-CD and BA/P[5] systems. These findings were further supported by natural bond orbital (NBO) and intermolecular gradient model based on Hirshfeld partition (IGMH) analyses. Moreover, the computed HOMO–LUMO energy gaps for the BA/β-CD, BA/P[5], and BA/P[5]G complexes were higher than those of the isolated hosts, indicating increased kinetic stability upon complexation. Overall, the investigated host systems exhibit strong potential for improving the bioavailability of boric acid and mitigating its toxicity through effective host–guest molecular recognition.

O29. An experimental study on laser deposition of Inconel-loaded polymer films

Carlos Matos[1,*], Duncan Fagg[2], Georgina Miranda[1]

1-CICECO, Aveiro Institute of Materials, Department of Materials and Ceramic Engineering, University of Aveiro, Aveiro, Portugal

2-TEMA - Centre for Mechanical Technology and Automation, Department of Mechanical Engineering, University of Aveiro, Aveiro, Portugal

Material deposition techniques provide practical solutions for repair and maintenance while enabling the fabrication of multi-material components with tailored surface properties. The development of high-performance coatings with superior wear and corrosion resistance is crucial for strategic industries such as aerospace and automotive. Among these techniques, laser-based processes—particularly laser cladding using powder feeding or preplaced powder systems have been extensively investigated for producing protective layers. These techniques present some limitations such as difficulty in processing non-planar surfaces, powder material management and thickness control. In this work, an alternative approach is proposed based on metal–polymer composite films integrating Inconel 625 alloy, designed to conform to non-planar surfaces. After fabrication and characterization of the films, laser processing is employed to generate coatings on stainless steel substrates. The resulting layers are evaluated in terms of densification and microstructural evolution, highlighting their potential for both industrial coating and repair applications.

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O30. Development of an EEG-Controlled Active Ankle–Foot Orthosis for Neurorehabilitation

Hamid ASADI DERESHGI[1, *], Busra CELIK[2], Dilan DEMIR[3], Buse Ayse Gul YILMAZ[1], **Beyza SERDAR[1]**

[1]*Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey*
[2]*Artificial Intelligence Studies, Application and Research Center (ArelMED-I), Istanbul Arel University, 34537 Istanbul, Turkey*
[3]*Department of Electronics and Automation, Vocational School, Nişantaşı University, 34030 Istanbul, Turkey*
[*] *+90 212 867 25 00 / 1140, hamidasadi@arel.edu.tr*

Ankle–foot orthoses (AFOs) are essential in the rehabilitation of patients with neuromuscular impairments, providing external support to restore gait stability and functional mobility. These orthotic devices prevent foot drop, improve balance, and promote proper joint alignment during ambulation. Based on their control strategy, AFOs are categorized as passive, semi-active, or active. Active AFOs, equipped with intelligent sensing and actuation systems, offer superior adaptability by dynamically assisting joint motion and enhancing motor recovery throughout the rehabilitation process. There is a substantial body of literature on active AFOs, highlighting their critical role in advancing rehabilitation practices. For example, Marconi et al. (2024) designed and validated a novel hybrid AFO that combined soft pneumatic actuators and traditional motors to provide active dorsiflexion assistance for footdrop rehabilitation. The device was lightweight, compliant, and unrestrictive, while allowing adjustable assistance to promote muscular engagement and prevent disuse. Preliminary testing demonstrated its capability to support functional gait, improve ankle range of motion, and enhance rehabilitative effectiveness [1]. Moon et al. (2025) developed a real-time gait mode detection system for actuated AFOs using only two foot-mounted inertial measurement units (IMUs) and a long short-term memory (LSTM)–based algorithm. The system accurately identified five daily living gait modes and was integrated with a task-oriented control strategy to adjust assistive torque dynamically. Experimental testing demonstrated high classification accuracy, robust performance in varied environments, and improved gait assistance while reducing dorsiflexor and plantar-flexor muscle activation [2]. There was limited reporting in the literature on systems controlled via electroencephalography (EEG), despite extensive research on active AFOs. It was regarded as crucial in this area to enable patients to perform exercises voluntarily and to enhance comfort and usability during the rehabilitation process.

In this study, an AFO driven by EEG signals was developed and implemented. The system was designed to perform dorsiflexion and plantar flexion exercises based on neural commands. An Emotiv Insight 2 five-channel EEG headset was utilized to acquire the user's brain signals. These signals were transmitted via an HC-06 Bluetooth serial communication module to an Arduino Uno microcontroller, which served as the control unit of the system. The Arduino Uno then regulated the movement of an Actuonix L16-

100-35-12-P micro linear actuator with position feedback. The actuator operated at 12 V and generated a maximum force of 50 N, enabling smooth and precise foot motion. The AFO housing was composed of two main parts. The first part was a foot section designed to be worn like a shoe, while the second part was the posterior calf segment, which supported the control components. The Arduino Uno and the actuator body were embedded within the housing of the posterior calf part, each positioned in specially designed compartments to ensure secure placement and compact integration. The tip of the actuator was fixed to the foot section of the AFO, allowing it to translate linear motion into controlled ankle articulation. Through this configuration, the user was able to execute ankle exercises intuitively by generating specific EEG patterns associated with movement intention. The system thus demonstrated the feasibility of EEG-based neural control for active orthotic devices aimed at neurorehabilitation and motor function restoration.

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O31. Design and Fabrication of an EEG-Controlled Elbow Orthosis with Physiological Kinematics

Hamid ASADI DERESHGI[1, *], Dilan DEMIR[2], Irem Aze YUKSEL[1], Meltem EKSI[1], **Esra DUMAN[1]**

[1]*Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey*
[2]*Department of Electronics and Automation, Vocational School, Nişantaşı University, 34030 Istanbul, Turkey*
[*] *+90 212 867 25 00 / 1140, hamidasadi@arel.edu.tr*

Elbow orthoses are externally applied medical devices designed to support, align, or restore neuromuscular and musculoskeletal function of the upper limb. Classified as passive, semi-active, or active systems, active elbow orthoses are of paramount importance in rehabilitation for their capacity to provide controlled assistance, enhance motor relearning, and optimize functional recovery performance. Notably, the open literature documents extensive and impactful research conducted by scholars in this discipline. For example, Dindorf and Wos (2019) developed a wearable elbow orthosis actuated by a bimuscular pneumatic servo-drive (PSD) and controlled via bioelectric signals (BES) including electroencephalography (EEG) and electromyography (EMG). A distributed control system (DCS) was implemented to decode BES into control signals, enabling precise and natural elbow movements. The system was reported to provide safe, effective, and visually guided rehabilitation for users with impaired muscular function [1]. Ferdiansyah et al. (2020) conducted research focused on the development of an elbow orthosis control system based on EEG and EMG signals. These biosignals were processed using a Raspberry Pi 3 B+ platform integrated with the ADS1299EEG-FE acquisition module. Wavelet Transform and Support Vector Machine (SVM) were applied for signal feature extraction and movement classification. It was reported that the integration of EEG and EMG signals yielded training and testing accuracies of 90.3% and 85.2%, respectively [2]. There was a growing recognition that EEG-controlled elbow orthoses were essential, as research in this field was still limited, while such systems provided a direct neural connection enabling motion control in individuals with severe muscular dysfunction. It was considered significant that there was notable progress in the design and functionality of active elbow orthoses, which this study further advanced.

In this study, an EEG-controlled elbow orthosis was developed to convert cortical signals into precise upper-limb movements. Cortical signals were obtained through the Emotiv Insight 2 five-channel EEG headset. The signals were transmitted to an Arduino Uno microcontroller via an HC-06 Bluetooth Serial Module, allowing real-time communication between the user's intent and the orthosis movement. Actuation was achieved using a DS3120MG waterproof servo motor that produced a torque of 19 kg·cm at 5 V. The motor drove a hinge-based mechanism aligned with the anatomical elbow axis to provide physiologically accurate flexion–extension movement. The mechanical components were fabricated from PLA material using a rapid prototyping technique. This process provided a balanced combination of structural strength, low weight, and ergonomic compatibility.

The resulting orthosis was able to replicate natural elbow kinematics with accurate and stable control. This system represented a notable improvement in EEG-based assistive technology. It provided a compact and cost-effective platform for neurorehabilitation, which is expected to support motor recovery in patients with neuromuscular impairments in future studies. This next stage will evaluate the orthosis in clinical scenarios, highlighting its potential for effective neurorehabilitation. These experiments will ultimately help refine the orthosis for broader clinical application.

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O32. Innovative Multi-Lumen SiC-Based Microneedle Development for Efficient Transdermal Applications

Hamid ASADI DERESHGI *, **Mina ÇOLAK**
Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey
* *+90 212 867 25 00 / 1140, hamidasadi@arel.edu.tr*

Microneedles enable precise microfluidic control for localized transdermal delivery in biomedical engineering. This technology surpasses conventional hypodermic needles and transdermal patches. It enables minimally invasive, precise, and controllable administration of medicinal compounds. Patient discomfort is reduced and delivery efficiency is improved. The combination of safety, precision, and versatility has attracted significant research interest. Scientific interest in microneedles increased after the study by Henry et al. (1998) revealed their potential for painless and efficient transdermal delivery [1]. Subsequent progress in material selection, structural design, and fabrication methods enhanced mechanical stability and expanded biomedical applications [2]. In recent years, studies were carried out to improve microneedle design, material selection, and functionality, highlighting key developments in the literature. For example, Jaman and Samad (2023) designed and analyzed a hollow silicon carbide (SiC) microneedle with four lumens for ibuprofen delivery. It was evaluated in COMSOL Multiphysics to assess its fluidic behavior and structural integrity under axial and transverse loading conditions. The results showed that the optimized SiC microneedle provided effective skin insertion with minimal deformation and enhanced drug delivery efficiency [3]. The same researchers, in 2024, developed a reservoir-based controllable SiC microneedle with two lumens for efficient transdermal drug delivery. Structural and fluidic simulations were conducted using COMSOL Multiphysics and Ansys Workbench, demonstrating that the valve-integrated design enabled precise flow regulation with minimal stress and deformation during skin insertion. The results confirmed the microneedle's mechanical stability and effectiveness for advanced drug delivery applications [4]. Sahin et al. (2025) analyzed an eight-lumen SiC-based microneedle with an optimized conical configuration to examine its mechanical resilience and controlled fluid transport. Comprehensive finite element analyses revealed its stability under axial and bending stresses, along with a precise, linear fluid delivery profile across a broad viscosity spectrum. These findings underscored the microneedle's potential as a next-generation platform for reliable and efficient transdermal drug administration in biomedical applications [5]. There was extensive research on microneedles in the open literature, but multi-lumen designs with different diameters remained uninvestigated. In this study, a novel twenty-lumen SiC-based microneedle will be designed by adopting the general geometric configuration—diameter, length, and conical profile—of the model proposed in [5]. The primary distinction of the present design will consist in the number and geometric arrangement of the lumens. Specifically, eight parallel lumens will be positioned near the conical tip and twelve within the needle body, symmetrically distributed to ensure structural balance and uniform stress distribution under loading. The tip lumens will have smaller diameters than those in the

body, allowing higher local flow velocities for an equivalent total flow rate. This configuration is expected to enhance jet penetration and diffusion efficiency during transdermal delivery. The combination of narrow lumens at the tip and wider lumens in the body will help regulate hydraulic resistance, maintain optimal pressure gradients, and improve clogging tolerance. Moreover, the parallel multi-lumen layout will facilitate a more homogeneous fluid dispersion across the tissue, while preserving mechanical integrity and minimizing stress concentrations through a gradual lumen transition along the microneedle length. The proposed multi-lumen microneedle design will provide enhanced performance for potential medical applications.

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O33. Integrated Physiological Signal Monitoring for Comprehensive Sleep Apnea Detection

Hamid ASADI DERESHGI *, Sirina MIRZA, **Douaa KOUCHAIRI**
Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey
* *+90 212 867 25 00 / 1140, hamidasadi@arel.edu.tr*

Sleep apnea is a prevalent sleep disorder characterized by recurrent pauses in breathing, resulting in intermittent hypoxia and disrupted sleep architecture. Timely and precise detection is essential, as the condition significantly elevates the risk of cardiovascular disease, metabolic dysfunction, and neurocognitive impairment. This subject was extensively explored by researchers, and multiple studies were reported in the open literature. For example, He et al. (2025) developed a novel method for detecting heart rate variability (HRV) and sleep posture using a flexible sleep monitoring belt (FSMB) integrated with a microelectromechanical systems (MEMS) inertial measurement unit and pressure sensor array. The system was tested with electrocardiography, ballistocardiography, and gyrocardiography signals, and a lightweight convolutional neural network was utilized to classify sleep postures. The results demonstrated that HRV and sleep posture were detected with high accuracy, indicating that the proposed method was effective, feasible, and suitable for both home and clinical sleep monitoring applications [1]. Dang et al. (2025) proposed an automated algorithm for detecting moderate to severe obstructive sleep apnea (OSA) using abdominal movement signals from a capacitive sensor and acceleration data from a three-axis accelerometer integrated into a wireless abdomen-worn device (Soomirang). It monitored thirty-seven subjects and accurately estimated total sleep time and apnea–hypopnea index, demonstrating high sensitivity and specificity. The study demonstrated that the proposed system was effective and feasible for accessible OSA screening and follow-up [2]. There were recent studies in the open literature that demonstrated wearable sensor technologies enabled innovative applications in healthcare. However, existing monitoring systems were often focused on a single bioparameter or were designed in ways that restricted user mobility, and therefore a system based on multi-sensor integration was considered necessary.

In this study, respiratory, motion, and sound data will be collected simultaneously using an inertial measurement unit (IMU), piezoelectric, and MEMS sensors to enable comprehensive and reliable sleep apnea analysis. Multi-sensor modules will be placed under the chest to monitor breathing and body movements, with the collected data visualized and recorded through a mobile application. A semi-athletic, comfortable wearable prototype adaptable to different body types will be designed and manufactured by integrating these sensors. Sensor data will be gathered in real time via an Arduino-based microcontroller and converted into digital signals. Furthermore, an analysis

algorithm capable of accurately detecting apneic events will be developed and integrated into a user-friendly mobile interface, providing detailed reporting, archiving, and easy access to historical data for both patients and clinicians.

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O34. Advanced Smart Cane for Autonomous Navigation and Enhanced Mobility of Visually Impaired Individuals

Hamid ASADI DERESHGI[1, *], Busra CELIK[2], Zeynep ALNAJJAR[1],
Walaa ALMAHALMI[1]

[1]Department of Biomedical Engineering, Istanbul Arel University, 34537 Istanbul, Turkey
[2]Artificial Intelligence Studies, Application and Research Center (ArelMED-I), Istanbul Arel University, 34537 Istanbul, Turkey
[*] +90 212 867 25 00 / 1140, hamidasadi@arel.edu.tr

The World Health Organization reports that over 2.2 billion people worldwide live with some degree of visual impairment, and millions rely on assistive mobility devices for independent navigation [1]. The development of smart canes represents a transformative advancement in assistive technology, integrating sensors and haptic feedback to enhance spatial awareness and safety. The smart cane serves as a pivotal innovation that bridges human-centered design and advanced technology, enabling greater independence and social integration for individuals with visual impairments. Therefore, smart canes have attracted significant attention in recent years as a major focus of scientific research. For example, Gad et al. (2023) developed a flexible, foldable, and lightweight smart cane designed to enhance the independence of visually impaired individuals. The cane was equipped with ultrasonic, Radio-Frequency Identification (RFID), and Artificial Intelligence (AI) vision sensors, along with voice and vibration alerts, enabling reliable obstacle detection and classification. Its integrated SOS system and mobile application were tested successfully, demonstrating improved safety and navigation in diverse environments [2]. Mai et al. (2024) designed an intelligent smart cane system equipped with 2D LiDAR and RGB-D camera sensing to enhance navigation for visually impaired individuals. The cane was integrated with the Cartographer algorithm and improved YOLOv5 for real-time mapping, localization, and obstacle recognition, achieving accurate indoor and outdoor guidance. It was confirmed through field tests that the system achieved precise obstacle detection, autonomous navigation, and consistent performance in complex indoor and outdoor environments [3]. There were many studies on smart canes in the literature; however, opportunities remained for further advancement in real-time sensor integration, user-centered feedback, and autonomous navigation capabilities.

In this study, an advanced smart cane will be developed to enhance spatial awareness and navigation safety for visually impaired individuals through the integration of precise sensing and feedback mechanisms. There will be a strategic placement of an HC-SR04 ultrasonic sensor near the cane tip, which will be positioned to provide reliable obstacle detection within a 2 cm to 4 m range, operating at 5 V and 40 Hz. The cane will deliver immediate tactile feedback through two vibration motors embedded in the handle, upon detection, ensuring that alerts are intuitive and easily perceivable by the individual. The cane will also incorporate a SIM808 GSM/GPRS/GPS module to provide continuous real-time positioning and seamless communication with a mobile application. The module

integrates a GPS antenna for accurate satellite-based localization and a GSM antenna to transmit location and alert data to the network. Centralized control and data processing will be executed by a Raspberry Pi 5, interfacing with all sensors and actuators to maintain synchronized operation and rapid system responsiveness. Consequently, this integrated design will be expected to promote safer, autonomous navigation and significantly enhance the independence of visually impaired individuals.

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O35. Development of anti-icing surfaces by laser modification for aircraft wings

Léane Marques[1,*], Carlos Matos[2,3], Indrani Coondoo[2,3], Georgina Miranda[2,3]
[1] *Sir Frank Whittle Building, Coventry University, Gosford St, Coventry CV1 5DL, UK.*
[2] *CICECO-Aveiro Institute of Materials, University of Aveiro, Portugal*
[3] *Department of Materials and Ceramic Engineering (DEMaC), University of Aveiro, Portugal*
** +44 7789 213723, +351 935 194 214, leane.marques@outlook.pt*

The ice formation on aircraft wings alters the surface aerodynamic shape and the weight [1], thus being considered a critical safety concern due to performance and reliability concerns [2]. Nowadays, anti-icing methods mainly rely on electric heating and surface chemical treatments, which display limitations, namely inefficiency, increased weight, and environmental impacts [3]. This study explores the creation of surface structures by applying laser texturing as an innovative alternative to reduce and mitigate ice formation [1]. This procedure is considered a passive anti-icing method, eliminating the dependence on continuous periodic treatments [4]. Surface wettability can be minimized through precise topography adjustment by laser irradiation, hindering ice adhesion or facilitating its removal during flight operations by jointly using low-power active systems. Superhydrophobic surfaces typically gather properties, such as low surface energy, which is obtained through controlled modulation of microroughness. In this investigation, several patterns were idealized, some of them applying biomimicry, and the combination of laser parameters (power, speed, and scanning strategy) was evaluated to modify an aluminium alloy (Al 1050). The results show a significant reduction in wettability on the treated surfaces, pointing to this route as a credible way to enhance aircraft safety and efficiency.

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O36. Facile Fabrication and Solar-Driven Photocatalytic Activity of Pr_6O_{11}–g-C_3N_4 Nanocomposite

Ganesh Kavita Parshuram Jadhav, Vikram Rama Uttam Pandit *

Department of Chemistry, The PGK Mandal's Haribhai V. Desai College, Pune-411002, India

Corresponding author E-mail: *vikramupandit@gmail.com*

Pr_6O_{11}–g-C_3N_4 nanocomposite was successfully synthesized via a facile hydrothermal route and systematically investigated for its photocatalytic performance. X-ray diffraction confirmed the crystalline nature of the composite, indicating the coexistence of orthorhombic Pr_6O_{11} and graphitic g-C_3N_4 phases without impurity peaks. The FTIR spectrum displayed characteristic bands corresponding to Pr–O stretching and C–N heterocycles, validating the integration of both components. Morphological analysis by SEM revealed a sheet-like g-C_3N_4 matrix uniformly anchored with Pr_6O_{11} nanoparticles of 20–40 nm size. Under simulated solar irradiation, the nanocomposite exhibited enhanced photocatalytic degradation efficiency check for 60 minutes. The improved activity is attributed to the synergistic interaction between Pr_6O_{11} and g-C_3N_4, which promotes charge separation and suppresses recombination. The composite displayed excellent structural stability and recyclability over multiple cycles, highlighting its promise for sustainable environmental remediation applications. Future studies will focus on optimizing compositional ratios and exploring heterojunction engineering to further enhance photocatalytic efficiency.

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O37. Green copper oxide nanocatalyst synthesis using plant extract for antibacterial and photocatalytic applications

Ganesh Dawange, [1,2] Vikram Pandit[1] *

[1]*Haribhai V. Desai College, Pune, India*

[2]*Sanjivani College of Engineering, Kopargaon, India*

*Email: vikramupandit@gmail.com

Photocatalysis is an effective technique utilized for wastewater treatment. The CuO nanoparticle photocatalyst was made using the precipitation method with an extract from a Mitragyna parviflora plant leaf. Its effectiveness was tested in photocatalytic applications. XRD, FTIR, EDX, SEM, and UV-Vis spectroscopy were used to characterize the produced CuO nanomaterials. Monoclinic CuO nanoparticles with average crystalline sizes between 25.3 and 10.5 nm were revealed by the X-RD analysis. The optical band gaps were between 2.6 and 1.7 eV, and the FT-IR spectrum displayed the stretching vibration bands characteristic of Cu-O bonds. Energy-dispersive X-ray (EDX) analysis of copper (Cu) nanoparticles reveals their elemental composition, confirming the presence of Cu. SEM imaging shows the shape, size, and distribution of nanoparticles. The catalytic efficiency of CuO nanoparticles containing leaf extract was tested for antibacterial activity against Escherichia coli, Pseudomonas aeruginosa, and Staphylococcus aureus. Methylene blue (MB) is degraded using varying concentrations of CuO. The effects of various parameters, such as CuO concentration, pH, and MB solution concentrations (5, 10, 20, 50 ppm), as well as the influence of sunlight radiation, were examined.

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O38. An Investigation of Self-Healing Chemical Systems

Ali Emre TUT[1], Burak ÜNLÜ[2,3],Serbülent TÜRK[2,3]

[1] Sakarya University, Chemistry, Institute of Natural Sciences, Esentepe Campus, 54187, Sakarya, Türkiye
[2] Sakarya University, Biomedical, Magnetic and Semiconductor Materials Research and Application Center (BIMAS-RC), 54187, Sakarya, Türkiye
[3] Sakarya University, Faculty of Science, Department of Chemistry, 54187, Sakarya, Türkiye

GSM:+905318445206 – e-mail: ali.tut@ogr.sakarya.edu.tr

Self-healing polymers constitute an advanced class of materials capable of autonomously repairing mechanical damage, thereby enhancing durability and functional lifespan. These materials employ diverse mechanisms, including dynamic covalent bonds, metal-ligand coordination, host-guest interactions, ionic interactions, and supramolecular assemblies. Recent studies have emphasized the critical role of polymer chain diffusion in hydrogels in facilitating self-repair processes. Various synthesis strategies, ranging from covalent crosslinking to supramolecular design, enable the fabrication of polymers with tunable mechanical properties and responsiveness to external stimuli such as pH, temperature, and light.

Applications span soft robotics, flexible electronics, biomedical devices, and sustainable materials, demonstrating the transformative potential of self-healing polymers. Despite significant advances, challenges remain in achieving rapid, efficient, and repeated self-healing under ambient conditions while maintaining mechanical robustness. Future research is directed towards optimizing molecular design, understanding healing dynamics, and broadening practical applications.

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O39. Study on shock-induced phase transformation of $CsPbBr_3$ through pulsed discharge of cylinder wire array

Zhang Xueying[A] and Gil Gonçalves [A, B*]

[A] Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Aveiro 3810-193, Portugal
[B] Intelligent Systems Associate Laboratory (LASI), Guimarães 4800-058, PortugalClique ou toque aqui para introduzir texto.

Perovskite materials, with their ABX_3 structure, show immense potential in optoelectronics and energy due to their tunable bandgap and excellent carrier mobility.[1] $CsPbBr_3$, a layered metal halide perovskite, possesses an intrinsically tunable structure. This allows its bandgap to be precisely engineered through pressure or strain control, thereby enabling the preparation of metastable materials with diverse properties.[2]

However, conventional static high-pressure methods face a significant challenge: the metastable phases generated under pressure typically revert during slow decompression, preventing their retention and detailed investigation. Dynamic high-pressure loading techniques can overcome this limitation. As a clean and efficient dynamic loading method, pulsed discharge technology utilizes high-density pulsed currents passing through conductive wires to deposit substantial energy within extremely short durations. This process induces rapid wire melting, vaporization, and expansion, generating explosive shockwaves.[3] This approach enables precise control over crystal structures and material properties with exceptional accuracy.

To address the challenge of metastable phase retention caused by insufficient unloading rates in static high-pressure techniques, the underwater loading approach is adopted due to its capacity to enhance energy deposition efficiency through water's incompressibility and high breakdown field strength. The electrical explosion method is employed to achieve microsecond-scale rapid energy release and ultrahigh quenching rates (~10^9 K/s). Simultaneously, a cylindrical wire array configuration is implemented to realize shock wave convergence and pressure amplification, thereby improving energy transfer efficiency.[4] The crystal structure of $CsPbBr_3$ was successfully induced to transition from the tetragonal phase to the monoclinic phase within a pressure range of 2.00-2.77 GPa, thereby enabling effective recovery of the metastable phase material.

An innovative underwater pulsed discharge shock loading technique was developed in this study, characterized by two key advantages: precise control over loading pressure through tunable energy deposition, and the attainment of ultrahigh quenching rates via shock loading to retain metastable phases, thereby enabling the preparation of metastable materials. A controllable phase-engineering technique has been established, providing a viable pathway for the preparation and recovery of valuable metastable $CsPbBr_3$ materials.

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O40. Investigation of PCL/PLA/PVP/NaAlg-Based Shape Memory Hydrogel Film System for Controlled Transport of Doxorubicin

Tuğçe Neslihan DENİZ[1,2*], Burak ÜNLÜ[2,3],Serbülent TÜRK[2,3],Hüseyin ALTUNDAĞ[2,3]

[1] *Sakarya University, Chemistry, Institute of Natural Sciences, Esentepe Campus, 54187, Sakarya, Türkiye*
[2] *Sakarya University, Biomedical, Magnetic and Semiconductor Materials Research and Application Center (BIMAS-RC), 54187, Sakarya, Türkiye*
[3] *Sakarya University, Faculty of Science, Department of Chemistry, 54187, Sakarya, Türkiye*

[*] *+90 507 719 8595, tneslihandeniz@sakarya.edu.tr*

Controlled drug delivery systems have gained increasing importance in recent years with the aim of enhancing the efficacy of drugs used in medicine, reducing dosage frequency, and minimizing systemic side effects. In traditional dosage forms, the active ingredient typically enters the systemic circulation rapidly and is eliminated within a short period of time. This situation requires frequent dosing to maintain therapeutic efficacy and reduces patient compliance [1]. Controlled release systems increase treatment efficacy and reduce side effects by ensuring that the drug is released at the desired rate in the target area over a specific time interval [2]. The polymer materials used in these developed systems play a decisive role in directing drug release. Shape-memory polymers (SHPs), in particular, have ushered in a new era in drug delivery technologies thanks to their ability to change shape in response to an external stimulus (temperature, pH, light, magnetic field, ion concentration, etc.) and return to their original form when the stimulus is removed [3]. In shape memory polymers, this property arises from a two-phase structure, typically consisting of “permanent segments” and “temporary segments.” While the rigid segments maintain the material's permanent form, the flexible segments respond to external stimuli to enable shape change [4]. This behavior adds a dynamic control element to the drug release mechanism, allowing the drug release rate to be adjusted according to environmental conditions.

Shape-memory polymers are materials that can temporarily retain a shape when an external stimulus is applied and return to their original shape when the stimulus is removed. This property stems from both the material's fixed phase, which maintains its permanent shape, and its mobile switching phase. In this study, PCL and PLA polymers formed the basis of shape memory behavior,

while PVP and sodium alginate formed the hydrogel phase, supporting water retention and diffusion-controlled transport properties. The hydrogel structure is stabilized by ionic cross-linking with Ca^{2+} ions.

The surface properties of the structure were evaluated by SEM analysis, and wettability was assessed by contact angle measurements. The shape memory effect was investigated in the temperature range of 37–60°C. In the next phase of the study, it is planned to evaluate in detail the relationship between the release profile of doxorubicin and the surface structure and hydrophilicity.

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O41. Comparative Evaluation of Functional Hydrogels for Diabetic Wound Healing

Teymur GULIYEV[1],*, Serbülent TÜRK[2,3], Burak ÜNLÜ[2,3]

[1] *Sakarya University, Biomedical Engineering, Institute of Natural Sciences, Esentepe Campus, 54187, Sakarya, Turkey*

[2] *Sakarya University, Biomedical, Magnetic and Semiconductor Materials Research Center (BIMAS-RC), 54187, Sakarya, Turkey*

[3] *Sakarya University, Faculty of Science, Department of Chemistry, 54187, Sakarya, Türkiye*

* +90 (536) 669 73 12, teymurguliyev1998@gmail.com

Hydrogels have emerged as one of the most promising biomaterials for chronic wound healing due to their tunable mechanical, chemical, and biological properties. This study presents a comparative analysis of recent hydrogel systems designed for diabetic wound healing, focusing on their functional mechanisms, biocompatibility, and therapeutic outcomes.

Based on a systematic review of the selected research works, several engineering strategies were identified: (i) integration of antioxidant nanocomponents such as cerium-doped bioactive glass (CeBG) into thermosensitive methylcellulose matrices; (ii) embedding pH- or ROS-responsive carriers (e.g., ZIF-8@Cur) for controlled release of anti-inflammatory compounds; (iii) inclusion of antimicrobial and bioactive components such as quaternized chitosan (QCS) and Zn^{2+} ions; and (iv) incorporation of extracellular vesicles and reduced graphene oxide for immunomodulation and improved mechanical and photothermal performance.

Comparative assessment showed that multifunctional hydrogels combining ROS scavenging, pro-angiogenic, and antimicrobial effects achieved the most effective wound closure. The M/Q/2Ce5BG system, for instance, demonstrated strong ROS elimination, enhanced fibroblast viability, and approximately 90% wound closure within 14 days in diabetic rat models. Similarly, MCC@ZIF-8@Cur hydrogels achieved nearly complete closure (≈97%) through pH-responsive drug release and macrophage polarization toward the M2 phenotype. In contrast, systems relying on a single mechanism (e.g., solely antimicrobial or moisture-retaining matrices) were less effective in tissue regeneration.

In conclusion, multifunctional hydrogel platforms represent a synergistic approach for diabetic wound management. They effectively reduce oxidative stress, suppress inflammation, and promote angiogenesis and antibacterial protection. Future work should focus on dose optimization, safety validation of inorganic additives, and scaling up for translational and clinical applications.

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O42. Development of a patch-like hydrogel formulation for ibuprofen and its in vitro evaluation

Münteha Özsoy[1*], Mahsa Heidarnejad[2,3], Mahmut Özacar[2,4]

[1]*Kocaeli Health and Technology University, Faculty of Pharmacy, Department of Toxicology, Kocaeli, Türkiye*
[2]*Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano & Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research & Development Group (BIOENAMS R&D Group), 54050 Sakarya, Türkiye.*
[3]*Sakarya University, Institute of Natural Sciences, Department of Chemistry, 54187, Sakarya, Türkiye.*
[4] *Sakarya University, Faculty of Science, Department of Chemistry, 54050 Sakarya, Türkiye.*
[*] *Presenter's telephone, fax and e-mail address: +90 262 999 80 85 and munteha.ozsoy@kocaelisaglik.edu.tr*

Abstract

This study investigates the development of chitosan (CS)-polyethylene glycol (PEG) hydrogels for controlled ibuprofen (IBU) delivery. CS, a natural polysaccharide, was modified with PEG to improve solubility and mechanical properties. The CS-PEG hydrogel was synthesized by dissolving CS in acetic acid, adding PEG, heating, and stirring. IBU was loaded into the hydrogel, and its release was studied in PBS (pH 7.4). SEM confirmed the hydrogel's porous structure, and FTIR validated successful synthesis and drug binding. UV-Vis spectrophotometry showed controlled IBU release. The CS-PEG hydrogel system offers a promising approach to enhance IBU's stability and controlled release, potentially improving therapeutic efficacy and reducing side effects.

Introduction

Patch-like hydrogel formulations stand out for their potential to provide rapid pain-relieving effects. Chitosan is a natural polysaccharide with biodegradability, good biocompatibility, and antibacterial properties, and is used in hydrogel and film forms for wound healing. Because it is difficult to dissolve at physiological pH conditions (pH 7.4), chitosan must be modified to increase its solubility [1]. Polyethylene glycol (PEG) and polyvinyl alcohol (PVA) are common polymers used in the preparation of hydrogels. Studies using PEG to improve the solubility and mechanical properties of CS during hydrogel formation are available in the literature [2]. Ibuprofen (IBU), one of the nonsteroidal anti-inflammatory drugs (NSAIDs), remains a cornerstone in the management of chronic pain and inflammation. Current NSAIDs, including ibuprofen, have several limitations, including variability in bioavailability due to solubility restrictions and the need for frequent dosing due to their short plasma half-life. Recent advances in pH-sensitive drug delivery systems offer promise for both overcoming these limitations and for targeted therapeutic applications [3]. The study provides insights into the synthesis of CS-PEG hydrogels and their application in loading and releasing IBU, highlighting their potential for controlled drug delivery systems.

Method

In this study, taking into account the methods reported in the literature for hydrogel synthesis [4,5], CS (2% w/v) was stirred in 2% acetic acid solution for 24 h until it was completely dissolved. Then, a PEG solution prepared at the same concentration (2% w/v) was added dropwise to CS, heated at 60°C until homogeneous, and stirred at 200 rpm for overnight [6]. Then, a portion of the non-drug-loaded hydrogel was freeze-dried overnight in a lyophilizer for further analysis. Drug-loading studies were also revised based on literature reports [7,8]. 2 mL of ibuprofen iv (400 mg/4 mL) solution for injection was added to the CS-PEG hydrogel mixture, and stirring was continued at room temperature for 3 days. The drug-loaded hydrogel system was similarly dried in a lyophilizer. *In vitro* drug release studies were performed in PBS (pH 7.4) buffer. At regular time intervals, 1 mL of the released drug-enriched solvent was sampled and replaced with 1 mL of fresh PBS to maintain the test volume and restore the concentration gradient to promote drug release.The synthesized hydrogels DDSs systems were characterized using various techniques such as SEM and FTIR. The loading and releasing of IBU were evaluated using UV-Vis spectroscopy.

Results

SEM analysis of the synthesized CS-PEG and CS-PEG-IBU hydrogels confirmed that the porous structure was preserved before and after drug loading [9]. FTIR spectra confirmed the synthesis of the CS-PEG hydrogel and the successful binding of IBU to the hydrogel structure. The loading of IBU into the hydrogel and the in vitro release behavior were characterized by UV-Vis spectrophotometer, confirming the controlled release profile in PBS (pH 7.4).

Discussion

The development of a CS-PEG hydrogel formulation for IBU drug delivery applications has provided an important alternative to the literature. CS stability is enhanced by PEG, providing IBU with controlled-release properties. This release property has the potential to reduce the risk of side effects and increase therapeutic efficacy in pain management.

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O43. Development and Characterization of New Generation Hydrogel Systems based on Pluronic123-Chitosan-Sodium Alginate

Mohmad ABOBAKER[1]*, Dilek BAYRAKDAR[1], Serbülent TÜRK[2,3], Burak ÜNLÜ[2,3]

[1]*Biomedical Engineering, Institute of Natural Sciences, Sakarya University, Esentepe Campus, 54187 Sakarya, Türkiye* https://ror.org/04ttnw109

[2]*Biomedical, Magnetic and Semi Conductive Materials Research Center (BIMAS-RC), Sakarya University, Esentepe Campus, 54187 Sakarya, Türkiye* https://ror.org/04ttnw109

[3] *Sakarya University, Faculty of Science, Department of Chemistry, 54187, Sakarya, Türkiye*

**+90 535 784 6537, mohmad.abobaker1@ogr.sakarya.edu.tr*

Hydrogel-based drug delivery systems are attracting significant interest due to their properties that can maximize patient comfort, such as biocompatibility, biodegradability, and controlled release. Particularly in cancer treatment, delivering drugs to the targeted area enables the treatment of the tumorous region with minimal damage to surrounding tissues while reducing expected adverse side effects [1].

In this study, chitosan-sodium alginate hydrogel systems were prepared with the addition of Pluronic123 at different ratios to determine the most suitable formulation for the release of DOX (Doxorubicin), and characterization studies were performed. Chitosan and Sodium Alginate polymers were preferred here because they are natural, biocompatible, and biodegradable polymers capable of forming ionic cross-linked networks [2], [3]. The Pluronic123 polymer was included in the system to improve the structural stability, porosity, and drug release behavior of the hydrogel matrix [4].

Characterization studies conducted using Zeta potential, Particle Size (DLS), and FTIR analysis evaluate the effect of the Pluronic123 ratio on the surface charge, particle size, and functional groups of hydrogel systems. By evaluating the effect of the Pluronic123 ratio on the structural and surface properties of the hydrogel matrix, the aim is to lay the groundwork for developing an effective drug delivery system in future studies.

Acknowledgement

This work was supported by the Scientific Research Projects Commission of Sakarya University (Project Number: 2025-27-70-113).

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O44. Graphene-based ternary nanocomposites for Multifunctional Applications

Abhijeet Sonone,[1-2] Harsh Gaikwad,[1] Vikram Pandit[3]

[1]*Modern College, Shivajinagar, Pune, India*

[2]*Vidya Mandir Prashala and Junior College, Miraj, India*

[3]*Haribhai V. Desai College, Pune, India, vikramupandit@gmail.com*

Graphene-based ternary nanocomposites represent an advanced class of multifunctional materials that incorporate graphene with two synergistic components, such as metal oxides, conductive polymers, or carbon nanotubes, to optimize properties for diverse high-impact applications. The unique structural integration enhances electrical conductivity, mechanical strength, and surface area, leading to promising improvements in energy storage, catalysis, and environmental remediation. Recent studies demonstrate that strategic combination of graphene, transition metal oxides (e.g., TiO_2, SnO_2, Fe_2O_3), and polymers (e.g., polypyrrole, polyaniline) yields ternary systems with superior electrochemical performance, higher capacitance, and greater stability compared to binary nanocomposites. Synthesis approaches, such as hydrothermal, oxidative polymerization, and green bioinspired routes, allow controlled morphology and scalable production. This talk will discuss recent advances, structure-property relationships, and future directions for graphene-based ternary nanocomposites, emphasizing their potential as next-generation materials for energy, environment, and electronics applications.

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2nd Workshop on Challenges and Strategies in Degradation of Organic Contaminants Research

SMALL MOLECULES, BIG PROBLEMS

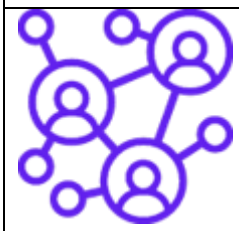
2nd Workshop on Challenges and Strategies in Degradation of Organic Contaminants Research

SMALL MOLECULES, BIG PROBLEMS

The production and constant use of various products present urgent and significant environmental challenges, causing considerable harm to living organisms. Despite efforts in water treatment, many organic contaminants have accumulated in the environment. These contaminants break down into degradation by-products under environmental conditions. Their small size, high stability, and slow decomposition make them a serious environmental concern.

The workshop aims to highlight the challenges and pitfalls in organic contamination research and explore effective methods for their removal from the environment. It will serve as a roundtable for presenting new findings and discussing them with the audience, providing a valuable opportunity to contribute to and enhance current research

The organizing committee warmly invites you to participate in our upcoming Workshop on Challenges and Strategies in the Research of Organic Contaminant Degradation, which will focus on innovative research shaping the future of materials science.

	18 November 2025
	Online via Zoom
	Students, researchers, and anyone interested in the field of materials engineering
	**Organizing committee:** André Torres-Pinto, LSRE-LCM, ALiCE, University of Porto, Portugal Daria Jardas Babić, University of Rijeka, Croatia Gil Gonçalves, University of Aveiro, Portugal Igor Bdikin, University of Aveiro, Portugal Iva Šarić Janković, University of Rijeka, Croatia Ivana Jelovica Badovinac, University of Rijeka, Croatia Ivna Kavre Piltaver, University of Rijeka, Croatia Katherine Huddersman, De Montfort University, Leicester, United Kingdom Maria Kolympadi Markovic, University of Rijeka, Croatia Mariana Rocha, IFIMUP, University of Porto, Portugal Marija Egerić, "Vinča" Institute of Nuclear Sciences, Belgrade, Serbia Marta Nunes, LAQV/REQUIMTE, University of Porto, Portugal Martina Kocijan, University of Rijeka, Croatia Matejka Podlogar, Jožef Stefan Institute, Slovenia Mattea Mačkić Jovanović, University of Rijeka, Croatia Robert Peter, University of Rijeka, Croatia Zsirkáné Fónagy Orsolya, University of Pannonia, Veszprém, Hungary

	No registration fees. Participation is free.
	Workshop Contact: ivna.kavre@phy.uniri.hr mateja.podlogar@ijs.si martina.kocijan@uniri.hr

2nd Workshop on Challenges and Strategies in Degradation of Organic Contaminants Research
SMALL MOLECULES, BIG PROBLEMS

Research, University of Rijeka, Croatia, 18 November 2025

Workshop program

9:00 - 9:15 (Portugal time)	**WELCOME ADDRESS** Dr. Martina Kocijan Dr. Matejka Podlogar Prof. Dr. Ivna Kavre Piltaver
9:15 - 9:40	***Keynote talk*** *Session Chair*: Dr. Daria Jardas Babić **Prof. Dr. Iva Šarić Janković** (W1-I1) Faculty of Physics and Centre for Micro- and Nanosciences and Technologies, University of Rijeka, Croatia *Title:* **From Principles to Applications: Atomic Layer Deposition of Photocatalytic Materials**
9:40 - 10:00	**Ivan Prološčić** (W1-O1) Faculty of Physics, University of Rijeka, and Specialty Hospital Radiochirurgia Zagreb, Sveta Nedelja, Croatia *Title:* **Light-Driven Degradation of Pollutants on ZnO-Coated γ-Fe_2O_3 Films**
10:00 - 10:20	**Dr. Maria Kolympadi Markovic** (W1-O2) Faculty of Physics and Centre for Micro- and Nanosciences and Technologies, University of Rijeka, Croatia *Title:* **Development of vapor phase organic reactions for applications in surface modification and thin film deposition**
10:20 - 10:45	***Keynote talk*** **Prof. Dr. Ivana Jelovica Badovinac** (W1-I2) Faculty of Physics and Centre for Micro- and Nanosciences and Technologies, University of Rijeka, Croatia *Title:* **Scanning electron microscopy analysis of photocatalytic materials for organic pollutant breakdown**
10:45 - 11:05	**Sandra Martín-García** (W1-O3) Laboratory of Parasitology, Faculty of Pharmacy and Aquatic One Health Research Center, University of Santiago de Compostela, Santiago de Compostela, Spain *Title:* **Enhanced Cryptosporidium inactivation using photocatalytic *g*-C_3N_4-PVDF membranes for water treatment**

11:05 - 11:25	**Katarina Hainz** (W1-O4) Department of Chemistry, Biochemistry and Environmental Protection, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia *Title:* **The efficiency of photocatalytic degradation of metformin in aqueous suspension using simulated solar irradiation**
11:25 - 11:35	Coffee break
11:35 - 12:00	***Keynote talk*** *Session Chair:* Dr. Andre Tores Pinto **Prof. Dr. Nevena Ćelić** (W1-I3) Department of Physics, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia *Title:* **Advanced Metal Oxide/PMMA Nanocomposite Foils for Sustainable Wastewater Purification**
12:00 - 12:20	**Dr. Szabolcs Bognár** (W1-O5) Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia *Title:* **Green ZnO photocatalysts for emerging pollutant removal: Powder vs. coating approaches**
12:20 - 12:40	**Klara Laura Cokan** (W1-O6) Department for Nanostructured Materials, Jožef Stefan Institute, and Jožef Stefan International Postgraduate School, Ljubljana, Slovenia *Title:* **Development of Efficient ZnO Photocatalysts for Water Remediation**
12:40 - 13:00	**Jose R. M. Barbosa** (W1-O7) LSRE–LCM, ALiCE, Faculty of Engineering, University of Porto, Porto, Portugal *Title:* **Macrostructured 3D-printed carbon materials for catalytic ozonation of oxalic acid**
13:00 - 13:30	Lunch break
13:30 - 13:55	***Keynote talk*** *Session Chair:* Dr. Mariana Rocha **Dr. Iwona Kuźniarska-Biernacka** (W1-I4) REQUIMTE/LAQV, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Porto, Portugal and Department of Physical Chemistry, Faculty of Chemistry, University of Łódź, Łódź, Poland *Title:* **From Waste to Treasure: The Use of Industrial Ashes in Wastewater Treatment**
13:55 - 14:15	**Amanda Fujita** (W1-O8) LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Porto, Portugal *Title:* **Biochar Electroactivation in Suspension for Organic Contaminant Degradation**

14:15 - 14:35	***Keynote talk*** **Dr. A. Sofia G. G. Santos** (W1-I5) LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Porto, Portugal *Title:* **Innovative Advanced Catalytic Integrated System for Organic and Inorganic Pollutants Abatement**
14:35 - 14:55	**Rúben Feiteira** (W1-O9) REQUIMTE/LAQV, Department of Chemistry and Biochemistry, Faculty of Sciences of the University of Porto, Porto, Portugal *Title:* **Highly robust hybrid carbon@metal sulfides/oxides for the photocatalytic degradation of Rhodamine B**
14:55 - 15:05	Coffee break
15:05 - 15:30	***Keynote talk*** *Session Chair:* Dr. Martina Kocijan **Dr. Arlete Apolinário** (W1-I6) REQUIMTE/LAQV, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Porto, Portugal *Title:* **Nanostructured Oxide Semiconductors for Solar Water Splitting and Green Hydrogen**
15:30 - 15:50	**Joana J. M. Dele** (W1-O10) LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Porto, Portugal *Title:* **Urea-assisted immobilisation of activated carbon for venlafaxine removal from water**
15:50 - 16:10	**Oumayma Bouhajeb** (W1-O11) Laboratory of Applied Mineral Chemistry (LCMA), Faculty of sciences of Tunis, University of Tunis El Manar, Tunis, Tunisia *Title:* **Ternary perovskite composites as efficient photocatalysts for the simultaneous removal of cationic and anionic dyes under visible irradiation**
16:10 - 16:35	***Keynote talk*** **Dr. Marija Egerić** (W1-I7) Vinča Institute of Nuclear Sciences, Beograd, Serbia *Title:* **Natural Solar Irradiation Induced Removal of Congo Red Dye Using UiO-66 MOF, Activated Carbon and Their Composites**
16:35 - 17:00	**Final Discussion and Workshop Closing Ceremony**

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W1-I1. From Principles to Applications: Atomic Layer Deposition of Photocatalytic Materials

Iva Šarić Janković[1,*], Robert Peter[1], Ivana Jelovica Badovinac[1], Ivna Kavre Piltaver[1], Aleš Omerzu[1], Gabriela Ambrožić[1], Maria Kolympadi Markovich[1], Daria Jardas Babić[1], Martina Kocijan[1]

[1]*University of Rijeka, Faculty of Physics & Centre for Micro- and Nanosciences and Technologies, Rijeka, Croatia*

[*] *+38551584638, iva.saric@uniri.hr*

Atomic layer deposition (ALD) is a vapor-phase technique for the deposition of thin films of different types of materials. It is based on sequential, self-limiting surface reactions, which enable uniquely precise and controlled growth of highly uniform, conformal films with angstrom-level thickness and composition control, even on complex, high-aspect ratio structures such as porous or rough substrates [1]. Photocatalysis has emerged as one of the most widely studied approaches for the removal of organic pollutants from water among the various available catalytic degradation methods [2,3]. Some of the fundamental challenges of photocatalysis include fast recombination of photogenerated charge carriers, slow surface reaction kinetics, limited visible-light absorption, photo-corrosion, and long-term catalyst deactivation. Careful design of photocatalysts at the atomic scale can overcome these limitations. In this context, ALD has emerged as a powerful tool for the atomically precise synthesis and optimization of photocatalytic materials. It can be applied in various photocatalyst fabrication approaches to enhance key physicochemical properties, enabling catalysts to reach their optimal efficiency and stability [2,3]. ALD provides exceptional flexibility and precision, allowing the fabrication of diverse photocatalysts, such as high-surface-area oxides, metal or bimetallic nanoparticles, core–shell structures, porous films, and heterostructures, with tunable structure, composition, and catalytic functionality [2,3].

In this talk, the fundamental concepts and instrumentation of atomic layer deposition will be presented. Approaches using ALD to design photocatalysts with enhanced activity, selectivity, and stability will be highlighted. The advantages, limitations, and future perspectives of ALD in the development of high-performance photocatalysts will also be discussed.

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W1-I2. Scanning electron microscopy analysis of photocatalytic materials for organic pollutant breakdown

Ivana Jelovica Badovinac[1,*], Ivna Kavre Piltaver[1], Iva Šarić Janković[1], Aleš Omerzu[1], Daria Jardas Babić[1], Martina Kocijan[1], Robert Peter[1]

[1]*University of Rijeka, Faculty of Physics & Centre for Micro- and Nanosciences and Technologies, Rijeka, Croatia*

[*] *ijelov@phy.uniri.hr*

Photocatalytic degradation of organic pollutants in water is a promising strategy for environmental remediation. The efficiency of photocatalytic materials is closely related to their surface morphology, porosity, particle size distribution, and other factors that directly affect light absorption, charge separation, and the generation of reactive species. This lecture highlights the intersection of electron microscopy and photocatalytic material science, focusing on how scanning electron microscopy (SEM) contributes to the development and understanding of materials used in the degradation of organic contaminants. At the beginning of the lecture, an introduction to SEM as a fundamental tool in materials characterization will be provided. SEM enables researchers to visualize surface morphology and microstructural features with remarkable resolution, playing an important role in characterizing these photocatalytic materials.

Heterogeneous photocatalysis, a process in which solid catalysts activate chemical reactions under light exposure-particularly relevant for breaking down harmful organic molecules, will also be discussed. A key component in this area is the use of thin semiconductor films, such as titanium dioxide or zinc oxide, which we produce using atomic layer deposition (ALD). ALD is a technique that enables precise control over film thickness and composition, generating uniform, conformal coatings ideal for photocatalytic applications. Practical examples will be presented, including SEM images of ALD-grown films and the correlation of SEM data with photocatalytic performance, to demonstrate how surface engineering and material design can enhance degradation efficiency of organic contaminants.

By the end of this lecture, participants will gain a deeper appreciation of SEM as a versatile and powerful tool in environmental materials research, particularly for designing and optimizing photocatalytic thin films for water treatment applications.

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W1-I3. Advanced Metal Oxide/PMMA Nanocomposite Foils for Sustainable Wastewater Purification

***Nevena Ćelić*[1]**, *Nemanja Banić[2], Ivana Jagodić[2], Roman Yatskiv[3], Jan Vaniš[3], Goran Štrbac[1], Ivna Kavre Piltaver[4], Maja Vučkovac[5], Svetlana Lukić-Petrović[1]*

[1] Department of Physics, Faculty of Sciences, University of Novi Sad, Trg D. Obradovića 4, 21000 Novi Sad,
[2] Department of Chemistry, Biochemistry and Environmental Protection, Faculty of Sciences, University of Novi Sad, Trg D. Obradovića 3, 21000 Novi Sad, Serbia
[3]Institute of Photonics and Electronics of the Czech Academy of Sciences, Chaberka 1014/57, 18251 Prague, Czech Republic
[4]University of Rijeka, Faculty of Physics and Center for Micro- and Nanosciences and Technologies, Radmile Matejčić 2, 51000 Rijeka,
Croatia
[5]Department of Applied Physics, Aalto University, P.O. Box 15100, 02150 Espoo, Finland
** + 381 21 485 2813, nevena.celic@df.uns.ac.rs*

Over the past few decades, industrial water pollution has emerged as one of the most pressing global environmental challenges. Extensive research efforts have focused on developing effective technologies for the removal of toxic pollutants from contaminated water, which threaten both aquatic ecosystems and human health. Among these approaches, heterogeneous photocatalysis has demonstrated remarkable potential for efficient water purification. Nevertheless, one of its major limitations lies in the costly and complex water recovery process following treatment. This challenge can be overcome by immobilizing photocatalytic particles onto suitable support materials.

In this work, we design stable nanocomposite foils with high photocatalytic efficiency and present a sustainable and highly effective water purification technology based on metal oxide nanoparticle - poly(methyl methacrylate) (PMMA) nanocomposites. These foils are engineered to harness the superior photocatalytic activity of metal oxide nanoparticles while maintaining mechanical integrity and reusability. To further enhance their photocatalytic performance, we investigate the incorporation of various nanoparticles - ZnO, ZnO/SnO_2, and surface-modified TiO_2 as well as the influence of surface morphology, particularly roughness and porosity. Comprehensive characterization of the nanocomposite foils is conducted using X - ray diffraction, UV - Vis spectroscopy, scanning electron microscopy (SEM), atomic force microscopy (AFM), and differential scanning calorimetry (DSC).

Acknowledgments

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W1-I4. From Waste to Treasure: The Use of Industrial Ashes in Wastewater Treatment

Iwona Kuźniarska-Biernacka[1*], Bruno Valentim [2]

[1] *REQUIMTE/LAQV, Department of Chemistry and Biochemistry, Faculty of Science, University of Porto, Rua do Campo Alegre s/n, 4169-007 Porto, Portugal; current address: University of Lodz, Faculty of Chemistry, Department of Physical Chemistry, Pomorska 163/165, 90-236 Łódź, Poland*

[2] *Instituto de Ciências da Terra, Faculdade de Ciências, Universidade do Porto, rua do Campo Alegre s/n, 4169– 007 Porto, Portugal;*

[*] *iwonaqb@gmail.com*

The coexistence of conventional and emerging pollutants (EPs) in aquatic environments poses a major threat to water quality and ecosystem health [1].

Sewage treatment plants remain inefficient in removing many organic pollutants. Consequently, wastewater reuse for irrigation contributes to their accumulation in crops due to freshwater scarcity [2]. While (photo)catalysis offers a promising route for cleaner water, developing visible-light-active catalysts with high efficiency and scalability remains a major challenge [2,3].

In this study, coal fly ash (CFA), an abundant by-product of coal combustion, was utilized as a catalyst and catalytic support for water treatment. The synthesized materials were characterized using SEM-EDS, XRD, XRF, Raman, and FTIR, confirming their composition. Photocatalytic activity was evaluated through industrial dyes degradation under simulated solar light, with additional adsorption tests conducted in the dark. The materials effectively removed persistent dyes, with iron-rich CFA composites showing the highest performance, achieving complete 4-nitrophenol removal within 5 minutes.

Acknowledgments

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W1-I5. Innovative Advanced Catalytic Integrated System for Organic and Inorganic Pollutants Abatement

A.Sofia G. G. Santos*, Carla A. Orge, M. Fernando R. Pereira, O. Salomé G. P. Soares

LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

* *Presenter's telephone, fax and e-mail address: asggs@fe.up.pt*

A newly developed technology was tested to perform the simultaneous degradation of organic and inorganic species present in water. The continuous catalytic system, consisting on the integration of catalytic ozonation and catalytic reduction processes, was applied to perform the degradation of brominated organic pollutants with the subsequent conversion of the formed BrO_3^- ion into Br^-. The integrated treatment system was successfully applied allowing the reduction of BrO_3^- concentration in water to values below the imposed advised legal limit (10 μg L^{-1}) under the application of optimized reaction conditions [1,2].

Acknowledgments

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W1-I6. Nanostructured Oxide Semiconductors for Solar Water Splitting and Green Hydrogen

Arlete Apolinário[1,2]*, Sofia Gonçalves[1,2], Sofia Caspani[1,2], Inácio Pinho[1,2] , Juliana Couto[1,2], Tânia Lopes[3,4], Adélio Mendes,[3,4] Célia T Sousa[1,5], João P. Araújo[1,2]

[1]*IFIMUP-Instituto de Física de Materiais Avançados, Nanotecnologia e Fotónica, Departamento de Física e Astronomia, Faculdade de Ciências da Universidade do Porto, Portugal*
[2] *LaPMET - Laboratório de Física para Materiais e Tecnologias Emergentes, Rua do Campo Alegre s/n, 4169-007 Porto, Portugal*
[3]*LEPABE, Departamento de Engenharia Química, Faculdade de Engenharia da Universidade do Porto, Portugal*
[4] *ALICE- Faculty of Engineering, University of Porto, Rua dr. Roberto Frias, 4200-465 Porto, Portugal*
[5]Departamento de Física Aplicada, Facultad de Ciencias, Universidad Autónoma de Madrid (UAM), Campus de Cantoblanco, C/Francisco Tomás y Valiente, 7, M 12 604-8049 Madrid, Spain
**Corresponding author e-mail address: arlete.apolinario@fc.up.pt*

Europe is actively adopting the green hydrogen strategy as part of the European Green Deal, aiming for a sustainable economy and a climate-neutral continent. Green hydrogen (H_2) production through solar water splitting in photoelectrochemical (PEC) cells represents a promising approach to solar energy harvesting and chemical fuel generation [1].

This work focuses on the development of low-cost, abundant, and chemically stable oxide semiconductor materials (e.g., TiO_2, α-Fe_2O_3, WO_3, CuO) for photoelectrodes in PEC cells. Using scalable synthesis methods—such as sol-gel, hydrothermal, electrodeposition, and electrochemical anodization we fabricated nanostructured photoelectrodes, including 1D nanowires and hexagonally ordered nanoporous/nanotubular arrays [2-6].

Electrochemical anodization of Ti, Fe, and W in fluoride-based electrolytes led to the formation of highly organized nanoporous and nanotubular structures [2,3]. We thoroughly investigated the anodization mechanisms and the influence of anodization conditions on morphological parameters such as nanotube length, pore diameter, interpore distance, and porosity.

For α-Fe_2O_3 and WO_3, nanowires and nanoplatelets were synthesized via hydrothermal methods. Optimization of parameters such as temperature, time, doping, and thickness enabled enhanced photocurrent generation [4-6].

In a complementary approach, CuO thin films were fabricated via electrodeposition followed by annealing. The effects of deposition parameters (e.g., voltage, pH, and deposition time) on film morphology and photoelectrochemical response were analyzed.

Finally, a recent advance is presented in the development of flexible photoanodes based on hematite nanoparticle layers for solar water splitting.

Acknowledgments

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W1-I7. Natural Solar Irradiation Induced Removal of Congo Red Dye Using UiO-66 MOF, Activated Carbon and Their Composites

Marija Egerić[1*], Ljiljana Matović[1,2,3], Radojka Vujasin[1], Yi-nan Wu[3,4], Djordje Petrović[1], Aleksandar Devečerski[1]

[1]*Vinča Institute of Nuclear Sciences – National Institute of the Republic of Serbia, University of Belgrade, Mike Petrovića Alasa 12-14,11351 Belgrade, Serbia*

[2]*Center of Excellence "CEXTREME LAB", Vinča Institute of Nuclear Sciences – National Institute of the Republic of Serbia, University of Belgrade, Mike Petrovića Alasa 12-14,11351 Belgrade, Serbia*

[3]*College of Environmental Science and Engineering, State Key Laboratory of Pollution Control and Resource Reuse, Tongji University, Shanghai 200092, China*

[*] *egericmarija@vin.bg.ac.rs*

This work investigates the usability of UiO-66 metal organic framework (MOF), coconut shells-derived activated carbon (AC), and their composites in the removal of Congo Red (CR) dye from aqueous solutions under natural solar irradiation. The composites were synthesized by a simple mechanical mixing of MOF and AC powders in a porcelain mortar. The degradation efficiency was examined using UV–Vis spectroscopy, while XRD, FTIR, and Raman analyses gave insights into the interaction mechanisms. All catalysts exhibited higher efficiency under 2 h of solar irradiation than in the dark (38-57% vs. 11-38%), with composites exhibiting enhanced activity due to the synergistic effect between MOF and AC, where AC acts as an electron sink, preventing charge recombination. Prolonged solar irradiation of 4 h, further increased the removal efficiency to 75-95%. FTIR spectra indicated a chemisorptive interaction between CR and the Zr–O nodes of MOF through S=O bonding. Reusability tests conducted using two different regeneration methods showed that the pure MOF retained the highest activity over multiple cycles (>70%), while the MOF/AC composites gradually lost efficiency due to surface saturation of AC. Overall, combining UiO-66 with AC offers an efficient and sustainable method for dye degradation under natural sunlight.

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W1-O1. Light-Driven Degradation of Pollutants on ZnO-Coated γ-Fe_2O_3 Films

Prološčić I.[1,2 *], Peter R.[1,3], Kralj S.[4,5,6], Šarić Janković I.[1,3], Kavre Piltaver I.[1,3]

[1]*Faculty of Physics, University of Rijeka, Radmile Matejčić 2, 51000, Rijeka, Croatia*
[2]*Specialty hospital Radiochirurgia Zagreb, Dr. Franje Tuđmana 4, 10431, Sveta Nedelja, Croatia*
[3]*Centre for Micro- and Nanosciences and technologies, Radmile Matejčić 2, 51000 Rijeka, Croatia*
[4]*Department for Material Synthesis, Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia*
[5]*Nanos SCI, Nanos Scientificae Ltd., Teslova ulica 30, 1000 Ljubljana, Slovenia*
[6]*University of Ljubljana, Faculty of Pharmacy, Department of Pharmaceutical Technology, Aškerčeva cesta 7, 1000 Ljubljana, Slovenia*
[*] *ivan.proloscic@radiochirurgia.hr*

Nowadays, a large amount of industrial waste is released into the environment, most of which ends up in water systems. Dyes from textiles and other industries, as well as detergents and pesticides, discharged through wastewater, pose a major challenge to environmental protection. Conventional methods for removing these contaminants are often expensive and inefficient.

Photocatalytic materials, especially metal oxide-based semiconductors, offer a promising alternative by enabling the degradation of pollutants such as detergents, pesticides, and dyes under UV or visible light. By initiating chemical reactions on their surface, these materials can break contaminants into less harmful substances directly in wastewater, offering a cost-effective and sustainable approach to water purification.

Microstructured γ-Fe_2O_3 films coated with ultrathin ZnO layers by atomic layer deposition (ALD) were developed as efficient photocatalytic systems for water purification. The γ-Fe_2O_3 microparticles, assembled into films, provided a microstructured template that enhanced light absorption and charge separation at the ZnO/γ-Fe_2O_3 interface. The samples were characterized using SEM, EDS, and SIMS, confirming uniform ZnO coverage and preserved morphology of the γ-Fe_2O_3 particles. Photocatalytic performance was evaluated by methylene blue degradation under UV and simulated sunlight using UV-Vis spectroscopy. After 5 hours of simulated solar irradiation, the ZnO/γ-Fe_2O_3 microstructured films degraded 82.5% of methylene blue - significantly higher than the 58.3% achieved by ZnO films on flat substrates. The enhanced activity originates from the increased active surface area and improved adsorption of methylene blue molecules, highlighting the potential of ZnO-coated γ-Fe_2O_3 microstructures for sunlight-driven wastewater treatment.

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W1-O2. Development of vapor phase organic reactions for applications in surface modification and thin film deposition

M. Kolympadi Markovic[1, *], I. Šarić Janković[1], R. Peter[1], I. Kavre Piltaver[1], I. Jelovica Badovinac[1], K. Veličan[1], M. Knez[2], G. Ambrožić[1, *]

[1]University of Rijeka, Faculty of Physics, and Centre for Micro- and Nanosciences and Technologies (NANORI), Rijeka, Croatia
[2] CIC nanoGUNE, Donostia-San Sebastian, Spain, and IKERBASQUE, Basque Foundation for Science, Bilbao, Spain

Atomic and molecular layer deposition (ALD and MLD) are vapor phase processes in which inorganic and organic thin films, respectively, can be deposited with high precision over film thickness on any substrate with active surface groups. Single process ALD/MLD combinations may lead to the formation of organic-inorganic hybrid films proving a large variety of structures and properties, that can span from nanolayers to metal-organic frameworks (MOFs) or can give access to other nanoporous films upon removal of the organic part.[1]
To expand the possibilities of MLD in modulating the lengths and chemical nature of organic constituents, we study surface reactions employing the “click” chemistry. These selective and thermodynamically-driven reactions are particularly attractive for MLD because they proceed without by-products. Our results on pulsed vapor phase surface “click” reactions on metal oxides will be presented [2,3], as well as our current focus on developing light-activated surface reactions.

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W1-O3. Enhanced *Cryptosporidium* inactivation using photocatalytic g-C_3N_4-PVDF membranes for water treatment

Sandra Martín-García[1,2,3,4], *André Torres-Pinto*[3,4], *Cláudia G. Silva*[3,4], *Joaquim L. Faria*[3,4], *Seila Couso-Pérez*[1,2], *Hipólito Gómez-Couso*[1,2], *Adrián M.T. Silva*[3,4]

[1]*Laboratory of Parasitology, Faculty of Pharmacy and Aquatic One Health Research Center (ARCUS), Universidade de Santiago de Compostela, Santiago de Compostela, Spain*
[2]*Paraquasil Group (GI-2109), Health Research Institute of Santiago de Compostela (IDIS), Santiago de Compostela, Spain*
[3]*LSRE-LCM – Laboratory of Separation and Reaction Engineering - Laboratory of Catalysis and Materials, Faculty of Engineering, University of Porto, Porto, Portugal*
[4]*ALiCE – Associate Laboratory in Chemical Engineering, Faculty of Engineering, University of Porto, Porto, Portugal*

Chemical and microbiological contaminants in water are major concerns affecting both the environment and public health. Globally, waterborne infections of gastro-enteric origin are among the leading causes of mortality and morbidity [1]. *Cryptosporidium* is a waterborne protozoan parasite that causes severe diarrhoea and presents a very resilient infective form (oocyst; ~5 µm), which is resistant to conventional water treatments, representing a significant challenge for its effective removal from water sources [2]. *Cryptosporidium* risk mitigation continues to be a critical concern for water utilities globally. For this reason, the World Health Organization (WHO) chose *Cryptosporidium parvum* as the reference pathogen in the assessment of household water treatments [3].

Polyvinylidene fluoride (PVDF) membranes are widely employed for water treatment. Their performance can be improved by incorporating photocatalytic materials, such as graphitic carbon nitride (g-C_3N_4) [4]. This metal-free photocatalyst generates reactive oxygen species that degrade organic micropollutants and inactivate microorganisms [5]. Integrating photocatalysts into membranes provides an intrinsic photocatalytic activity to the membrane while avoiding the need for recovering the photocatalysts from the treated water, which is often required when used in the powder form [6].

In the present work, a g-C_3N_4-PVDF membrane was studied for the first time against *Cryptosporidium parvum.* Distilled water spiked with $1x10^6$ *C. parvum* oocysts/mL was fed in recirculation flow mode (0.5 mL/min) to the membrane-cell photocatalytic reactor, which was irradiated by a 2 visible-LED system (average 300 W/m^2, max. emission at 405 nm), at room temperature for 4 hours. Water samples were analysed hourly to determine oocyst retention rate with an improved Neubauer counting chamber and oocyst survival using 70 kDa heat shock protein (HSP70) mRNA quantification by reverse transcription qPCR.

The membrane based on g-C_3N_4 demonstrated increasing retention rates over time, retaining 99.81% of the oocysts present in water after 4 hours of treatment. Retained oocysts in the membrane and in contact with the photocatalyst for 4 hours, showed 1.5 log decrease in their viability. In conclusion, these results demonstrate the photocatalytic effect on oocysts that are retained by the membrane, suggesting that longer exposure time could lead to greater retention and likely higher inactivation rates.

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W1-O4. The efficiency of photocatalytic degradation of metformin in aqueous suspension using simulated solar irradiation

Katarina Hainz*, Szabolcs Bognár, Daniela Šojić Merkulov

University of Novi Sad Faculty of Sciences, Department of Chemistry, Biochemistry and Environmental Protection, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia

* *Telephone: +381 21 485 2753, E-mail: katarina.hainz@dh.uns.ac.rs*

Heterogeneous photocatalysis, as part of advanced oxidation processes, represents one of the most promising methods due to its simplicity, eco-friendliness, and reliance on renewable energy sources for degrading persistent organic micropollutants resistant to conventional water treatment methods. This study aimed to evaluate the photocatalytic degradation of metformin (MET – pharmaceutical) from water, using commercial ZnO and TiO_2 photocatalysts, under various experimental conditions (catalyst loading, initial pH) and simulated solar irradiation. Photocatalytic degradation was monitored using high-performance liquid chromatography with diode array detector. The results demonstrated significant photocatalytic efficiency of ZnO and TiO_2 in the removal of MET. Considering the optimized experimental conditions, in the presence of ZnO (1.0 mg/mL, pH ~10) 77% of MET was degraded, while in the case of TiO_2 (2.0 mg/mL, pH ~10) 72% of substrate was removed, after 180 min of irradiation. Based on the obtained results, it can be concluded that both photocatalysts demonstrated high efficiency in the photocatalytic degradation of MET and can be applied for its removal from water.

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W1-O5. Green ZnO photocatalysts for emerging pollutant removal: Powder vs. coating approaches

Szabolcs Bognár[1,*], Dušica Jovanović[1], Predrag Putnik[2], Vesna Despotović[1], Nina Finčur[1], Sanja Panić[3], Branimir Bajac[4], Daniela Šojić Merkulov[1]

[1]*University of Novi Sad Faculty of Sciences, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia*
[2]*University North, Trg Dr. Žarka Dolinara 1, 48000 Koprivnica, Croatia*
[3]*University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia*
[4]*Institute BioSense, Dr Zorana Đinđića 1, 21000 Novi Sad, Serbia*

[*] *Telephone: +381 21 485 2752, E-mail: sabolc.bognar@dh.uns.ac.rs*

Advanced oxidation processes, particularly heterogeneous photocatalysis, have gained attention as promising technologies for the degradation of persistent organic micropollutants that are resistant to conventional water treatment methods. The aim of this study was to evaluate the efficiency of eco-inspired ZnO photocatalysts, prepared from green tea (GTE) – and banana peel extracts (BPE), in both powder and coating forms, for the removal of emerging pollutants (pesticide tembotrione – TEM and synthetic hormone 17α-ethinylestradiol – EE2) from water, under various experimental conditions (catalyst loading, initial pH, water matrix) using simulated solar irradiation. High-performance liquid chromatography with diode array and fluorescence detectors was employed to monitor the degradation kinetics of the target compounds. Additionally, the newly prepared materials were characterized using advanced techniques (e.g. XRD, SEM). The results demonstrated significant photocatalytic activity of the new ZnO materials, with degradation efficiencies reaching 96% for TEM (ZnO GTE) and 83% for EE2 (ZnO BPE), after 60 min of irradiation.

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W1-O6. Development of Efficient ZnO Photocatalysts for Water Remediation

Klara Laura Cokan[1,2,*], Nik Gračanin[1], Tina Radošević[1], Daria Jardas Babić[3], Matejka Podlogar[1]

[1]*Jožef Stefan Institute, Jamova Cesta 39, 1000 Ljubljana, Slovenia*
[2]*Jožef Stefan International Postgraduate School, Jamova cesta 39, 1000 Ljubljana, Slovenia*
[3]*Faculty of Physics, University of Rijeka, Ulica Radmile Matejčić 2, 51000, Rijeka, Croatia*
[*]*Klara.Laura.Cokan@ijs.si*

The global distribution of organic pollutants in water is an ongoing and increasing threat to the world's water resources. This is a strong justification for improved technologies to degrade organic pollutants in water. Photocatalytic degradation using zinc oxide (ZnO) is considered a promising and environmentally friendly method, but its wider practical application requires improvements in the stability and efficiency of photocatalysts [1].

In this study, we present a systematic examination of the preparation of ZnO nanorod arrays through a sustainable two-step approach, combining spin-coating for thin-film deposition with subsequent hydrothermal growth. The photocatalytic efficiency was evaluated by the degradation of a caffeine solution, employed as a model pollutant. The results demonstrate a strong correlation between the synthesis conditions, properties of the photocatalyst and final overall photocatalytic performance. These findings provide insights for the development of ZnO-based photocatalysts with enhanced stability and efficiency for wastewater treatment applications. Nevertheless, further research is required to improve the activity of the catalysts under visible light, assess their long-term stability during repeated use, and validate their effectiveness in real wastewater systems.

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W1-O7. Macrostructured 3D-printed carbon materials for catalytic ozonation of oxalic acid

J. R. M. Barbosa[1,*], J. Restivo[1], C. A. Orge[1], A. F.P. Ferreira[1], M. F. R. Pereira[1], A. M. Ribeiro[1], O. S. G. P. Soares[1]

[1]*LSRE–LCM, ALiCE, Departamento de Engenharia Química, Faculdade de Engenharia, Universidade do Porto, 4200-465, Porto, Portugal*

[*] jrbarbosa@fe.up.pt

Conventional water treatment processes are often ineffective in completely removing organic micropollutants (OMPs), leading to their accumulation in aquatic environments and associated risks to ecosystems and human health. Advanced oxidation technologies (AOTs) have emerged as promising alternatives, though their application can generate toxic and recalcitrant by-products [1]. Among AOTs, heterogeneous catalytic ozonation (HeCO) enhances the formation of reactive oxygen species, thereby improving OMP mineralization. Carbon materials (CMs) have shown potential as catalysts for HeCO [2]; however, most studies rely on powdered forms, which pose challenges for large-scale implementation due to handling and separation issues.

To address these limitations, this study developed 3D-printed carbon-based catalysts (3DPCCs) using Direct Ink Writing. Formulations combined multiwalled carbon nanotubes (MWCNTs) or activated carbon (AC) with sodium carboxymethyl cellulose (CMC) or sodium alginate (ALG) as binders. The catalysts were used in pellet form, as shown in **Figure 1a**, and evaluated in a semi-batch reactor for oxalic acid (OxAc), a typical recalcitrant compound, degradation via HPLC monitoring. Among the tested formulations, AC_20CMC was excluded due to mechanical instability. Using ALG as a binder resulted in reduced activity as MWCNT_20ALG showed similar performance to single ozonation, while MWCNT_20CMC achieved 96% OxAc removal after 180 min, as shown in **Figure 1b**. Reusability tests revealed that MWCNT_20CMC maintained its activity after five cycles, whereas AC_20ALG showed reduced efficiency after three (**Figure 1c**). This study demonstrates the feasibility of 3D printing for developing scalable, reusable carbon-based catalysts for HeCO, opening new pathways for the industrial implementation of advanced water treatment technologies.

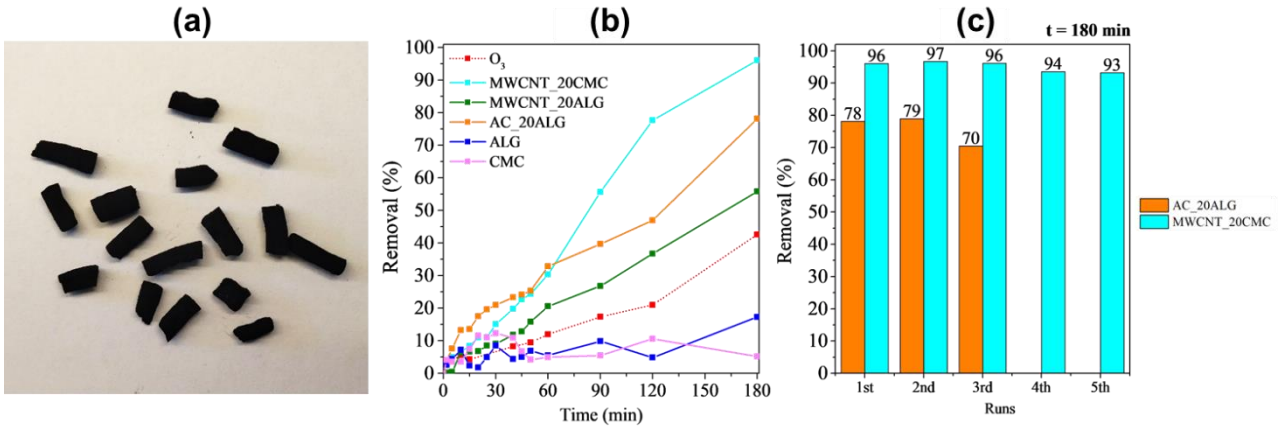

Figure 1. 3DPCCs pellets used for HeCO of OxAC (a), OxAC removal during semi-batch essays, and (c) reutilization essays results of MWCNT_20CMC and AC_20ALG.

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W1-O8. Biochar Electroactivation in Suspension for Organic Contaminant Degradation

Amanda Fujita*, André Torres-Pinto, Adrián M.T. Silva

LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

* *+351 913159579, up201900480@up.pt*

Contaminants of emerging concern (CECs) often are ineffectively eliminated by conventional water and wastewater treatments, threatening human health and ecosystems [1]. Thus, developing sustainable technologies to guarantee safe drinking water and discharge is urgent.

Electrochemical advanced oxidation processes (EAOPs) have emerged as a promising alternative as they can operate under mild conditions to produce reactive oxidants (*e.g.*, •OH) that can degrade pollutants into less harmful compounds [2]. Moreover, carbon-based catalysts were synthesized via one-pot technique and added in suspension into the EAOPs to improve their efficiency. For the synthesis of these materials, grape pomace was used as biomass for the biochar (BC), thiourea and dicyandiamide as functionalizers (BC-T and BC-D) and potassium hydroxide for activation (BC-TK and BC-DK). For the EAOPs different cathodes were assed *(i.e.,* Nickel, Stainless Steel, Titanium and Carbon Foam) and paired with boron-doped diamond (BDD) as anode to study their impact in the degradation of venlafaxine (VFX), a common CEC found in wastewater. Besides, the electrolytes were also assed by varying sodium-based salts in the process.

Different tests were conducted, first adsorption tests showed that after 2 hours BC-DK and BC-TK removed 35% and 87% of VFX, respectively, improving efficiency when comparing to non-activated ones. However, in the second test applying EAOP by pairing BDD with nickel in a solution of 6 mM of NaCl, VFX removal increased significantly, with BC-T reaching 80% and BC-DK 95% within 5 minutes, whereas electrolysis without catalysts removed less than 20% within the same period of the reaction.

The findings demonstrate the promise of EAOPs combined with carbon-based catalysts can be an efficient, sustainable treatment method that also recovers value from otherwise discarded solid wastes

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W1-O9. Highly robust hybrid carbon@metal sulfides/oxides for the photocatalytic degradation of Rhodamine B

Rúben Feiteira[1*], André M. Pereira[2], Clara R. Pereira[1], Marta S. Nunes[1], I. Kuźniarska-Biernacka[1]

[1]REQUIMTE/LAQV, Departamento de Química e Bioquímica, Faculdade de Ciências da Universidade do Porto (FCUP), 4169-007 Porto, Portugal
[2]IFIMUP, Departamento de Física e Astronomia, FCUP, 4169-007 Porto, Portugal
[*]up202006258@up.pt

The presence of persistent pollutants in consumable water is a major concern due to their potential to cause health issues in humans and animals. Advanced oxidation processes are among the most effective contaminant degradation methods, particularly solar-driven photocatalysis for wastewater treatment [1,2].
Herein, new nanohybrid photocatalysts were prepared by *in situ* growth of Bi_2S_3 and magnetic $MnFe_2O_4$ nanoparticles on oxidized multiwalled carbon nanotubes and applied for the Rhodamine B (RhB) degradation.
The structure, morphology, and composition of the nanohybrids and their individual counterparts were characterized by X-ray diffraction, scanning electron microscopy, transmission electron microscopy, X-ray photoelectron spectroscopy and Raman spectroscopy. Their adsorption and photocatalytic performance in RhB removal with or without H_2O_2 were evaluated by UV-Vis spectroscopy and ^1H NMR.
The nanohybrid with the best photocatalytic activity generated reactive oxygen species under visible light irradiation and degraded 97% of RhB in 30 min. Moreover, it remained stable and reusable for at least three cycles.

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2nd Workshop on Challenges and Strategies in Degradation of Organic Contaminants Research, University of Rijeka, Croatia, 18 November 2025

W1-O10. Urea-assisted immobilisation of activated carbon for venlafaxine removal from water

J.J. M. Dele[1, *], A. Torres-Pinto[2], A.M. Chávez[3], A.M.T. Silva[2]

[1] *LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal*

[2] *Departamento de Ingeniería Química y Química Física, Instituto Universitario del Agua, Cambio Climático y Sostenibilidad (IACYS), Universidad de Extremadura, 06006 Badajoz, Spain*

[*] *Presenter's telephone, fax and e-mail address: 22 041 3664, joanadele@fe.up.pt*

The persistent presence of organic micropollutants in drinking water poses significant risks to human health due to chronic exposure [1]. Conventional wastewater and drinking water treatment technologies often fail to effectively remove these contaminants, allowing them to circulate within aquatic ecosystems [2, 3]. This study addresses the need for efficient and recoverable adsorbent materials by developing novel activated carbon (AC)-based composites for the removal of venlafaxine (VFX), a widely detected pharmaceutical pollutant.

For this purpose, activated carbon was modified via a one-pot thermal method [4] using varying doses of urea (U), synthesising powdered composites denoted as AC/U_x (where x is the U:AC mass ratio). To overcome recovery limitations of powdered adsorbents, selected composites were immobilised onto three-dimensional alumina spheres (S) forming S-AC/U_x. Adsorption performance was evaluated in both batch and continuous flow systems using tap water spiked with VFX. In continuous flow mode, hydrogen peroxide (H_2O_2) was introduced to simulate catalytic wet peroxide oxidation (CWPO), assessing both pollutant removal and material stability over time.

Commercial AC (AC_{com}) achieved >99% VFX removal in batch mode, while among the synthesised powders, AC/U_{50} (U:AC = 50) showed the best performance, removing 67.1% of VFX within 60 minutes. The immobilisation onto S was only successful with urea-assisted thermal treatment, yielding S-AC/U_{50}. In continuous flow, S-AC/U_{50} removed 70% of VFX in 60 minutes without H_2O_2 , with its (H_2O_2) addition, CWPO activation boosted VFX removal to 99%, maintaining >97% efficiency over five days with H_2O_2 consumption ranging from 9% to 45%, confirming catalytic activity and regeneration potential.

Urea-assisted thermal synthesis enabled both enhanced adsorption and successful immobilisation of AC onto alumina supports. The structured composite S-AC/U_{50} demonstrated robust performance in continuous flow systems, with CWPO activation significantly improving removal efficiency and long-term stability. These findings highlight the potential of self-immobilised AC-based materials for scalable and regenerable water treatment applications targeting pharmaceutical micropollutants.

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W1-O11. Ternary perovskite composites as efficient photocatalysts for the simultaneous removal of cationic and anionic dyes under visible irradiation

Oumayma BOUHAJEB[1,2 *], Ramzi HAMMAMI[1], Adel MEGRICHE[1], Mahmut ÖZACAR[2,3]

[1] Laboratoire de Chimie Minérale Appliquée (LCMA) LR19ES02, Faculté des Sciences de Tunis, Université Tunis El Manar. Campus Universitaire Farhat HACHED, 2092, El Manar –Tunis, Tunisie
[2] Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano & Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research & Development Group (BIOENAMS R&D Group), 54050 Sakarya, Turkiye.
[3] Sakarya University, Faculty of Science, Department of Chemistry, 54050 Sakarya, Turkiye.
[*] Corresponding Author Tel.: +21624499567, e-mail address: oumayma.bouhajeb@etudiant-fst.utm.tn

This study reports the development of $BiFeO_3/BaTiO_3/SrTiO_3$ (BFO/BTO/STO) ternary composites as efficient visible-light-driven photocatalysts for the simultaneous degradation of cationic and anionic dyes. Composites with different molar ratios were synthesized via a sonochemical route and characterized by XRD, FTIR, SEM, EDS, PL, UV-DRS, TEM, and XPS analyses. Photocatalytic activity tests under visible light showed that the $BiFeO_3$-rich composite achieved the highest degradation efficiencies (76.7% for methylene blue and 94.6% for indigo carmine), attributed to its narrow band gap (1.75 eV) and low PL intensity. The material also demonstrated excellent stability and recyclability over five consecutive cycles. These results highlight the potential of compositionally tuned BFO/BTO/STO composites as multifunctional photocatalysts for treating wastewater contaminated with different dyes.

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4th Workshop on New Challenges of Bionanomaterials: Science, Technology, Application

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18 November, 2025

Modern state of Earth civilization show tendency with increase role of quality of people life. This is including, on the first-place, level of medicine, so, biology. In present days development of biomaterials, nano science and information technology give optimistic perspectives on this ~~way~~ direction and this allows more and more new horizons in Life sciences, Ecology, Green technologies, Education, Social organization society, etc. Thus, great opportunities open for young researchers in the realization they noble desires in understanding very difficult and very interesting fundamental laws of nature and to make practically a harmonious human future. Focusing, understanding and international exchange of knowledge are the basis for solving new questions in these areas. With this objective, we organize Workshop on Modern Problems of Bionanomaterials: Science, Technology, Application (WNCBM2025) with presentations and discussions specialists in Biomaterials, Nano science and Nano technology.

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