3rd International Conference on
ADVANCED MATERIALS
FOR BIO-RELATED APPLICATIONS
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AMBRA 2026

BOOK OF ABSTRACTS

Title

Book of abstracts

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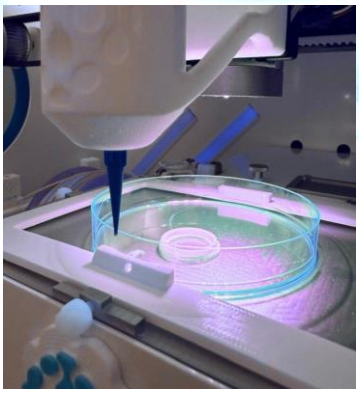
BioCloner Health is an innovative biotechnology company whose mission is to improve the quality of life and health of both humans and animals by introducing cutting-edge technologies into the medical field. Since 2016, the company has been developing its original BioCloner technology, created from scratch in Poland, which includes the BioCloner Desktop Pro 3D bioprinter along with dedicated software. This advanced machine is designed for experts in medicine and science, with applications primarily in regenerative medicine and tissue engineering. It enables the printing of three-dimensional structures using biomaterials and bioinks under sterile conditions.



The BioCloner Health team is working on creating structures that replicate human organs, synthetic menisci, and new, personalized drug therapies. The BioCloner technology allows for studying disease mechanisms and transmission, as well as monitoring cellular behavior within printed structures. All of this is possible thanks to the use of biomaterials and bioinks that support the development of cultivated cells. With this approach, BioCloner Health aims to reduce animal testing, minimizing harm to their lives and health.

BioCloner Health is also actively focused on R&D, implementing its 3D bioprinters in universities and research institutions to support scientists in their daily work and help them carry out projects. The company has already introduced its machines at the Warsaw University of Technology, the Medical University of Warsaw, the AGH University of Science and Technology, and the Cracow University of Technology.

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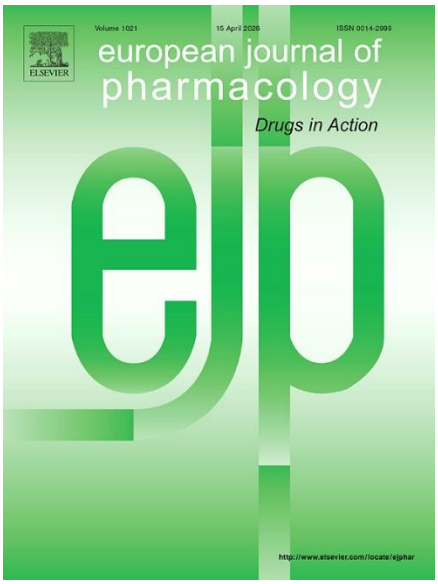

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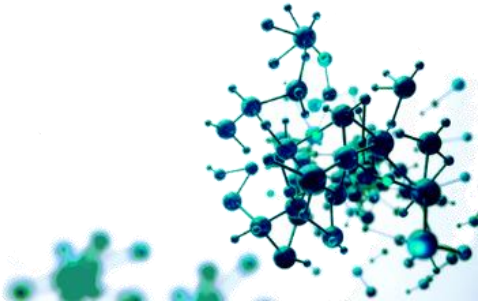


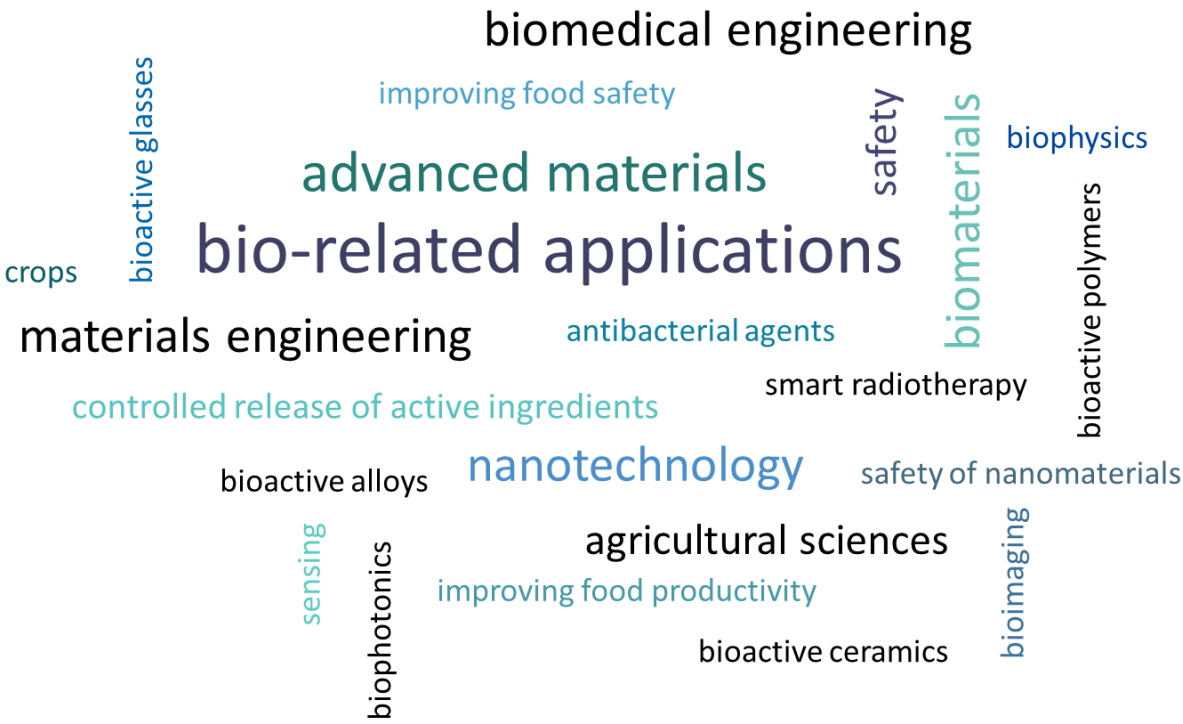
PURPOSE OF THE CONFERENCE

The aim and mission of the AMBRA conference is to present the current state of progress in R&D in the field of materials engineering as well as biomedical and agricultural sciences and to create a forum between the participants to discuss achievements and cooperation in the interdisciplinary studies on the subject of the meeting. Discussions will be conducted on the matters in the area of nanotechnology, advanced biomaterials, orthopedics, cardiac surgery, tissue engineering, facial-jaw engineering, pharmacy, biomechanics, agriculture, medical equipment, and others.

Of the main interest are issues related to biomaterials and nanomaterials for biological, medical, and agricultural applications.

CONFERENCE TOPICS

The conference topics include but are not limited to:



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Using SERS to Study Cancer Cells in Biorelevant Models

Luis M. LIZ-MARZÁN[1]

[1] CIC biomaGUNE, Donostia-San Sebastián, Spain, e-mail: llizmarzan@cicbiomagune.es
- Ikerbasque, Bilbao, Spain
- CINBIO, University of Vigo, Spain

3D printing, plasmonic nanoparticles, SERS, 3D tumor models

Nanoplasmonics involves the manipulation of light using materials with significantly smaller sizes than the radiation wavelength. This usually involves nanostructured metals, which very efficiently absorb and scatter light because of their ability to support coherent oscillations of free (conduction) electrons. Therefore, an essential pillar behind the development of nanoplasmonics is the great advance in fabrication methods, which have achieved an exquisite control over the composition and morphology of metal nanoparticles. Colloid chemistry has the advantage of simplicity and large-scale production, with the ability to direct not only nanoparticle morphology but also surface properties and subsequent processing via self-assembly. This talk will provide an overview of the fabrication of nanoplasmonic building blocks and their integration in materials and devices that can be used for real applications in sensing and diagnostics. In particular, it will focus on the application of nanostructured plasmonic substrates comprising gold nanoparticle superlattices and 3D-printed hybrid scaffolds, to the precise SERS detection of selected tumor metabolites which shape the cancer landscape.

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Funding

Financial support was provided by the European Research Council (ERC-AdG-2017 #787510 4DBIOSERS and ERC-2023-POC #101138255 3DTUMOUR) and by the Spanish MICIU/AEI/10.13039/501100011033 and ERDF/EU (Grant #PID2023-151281OB-I00).

Bioelectric Modulation of Inflammation and Cancer with Piezoelectric Nanoparticles

Michael J. NAUGHTON[1], Timothy Connolly, Kris Kempa, Karen Cordero, Adam Vanasse

[1] Boston College, Department of Physics, Chestnut Hill, MA 02467, USA, e-mail: naughton@bc.edu

piezoelectric, ultrasound, macrophage inflammation, cancer

Abstract – Macrophages are critical for the maintenance of immune system homeostasis. They differentiate into distinct functional populations, from pro- to anti-inflammatory phenotype, exhibiting remarkable biological plasticity and responding to both chemical and physical cues to achieve these phenotypes. Controlling macrophage cell phenotypes *in vivo*, with temporal and spatial control, could have significant impact on a wide range of human diseases and ailments associated with inflammation, which range from rheumatoid arthritis and Alzheimer's to cancer tumorigenesis. Piezoelectrics, materials in which pressure causes a voltage and vice versa, represent a potential platform for non-invasive and remote modulation of cells and tissues and, in particular, control of immune cell activation. We show that RAW264.7 mouse macrophage cells that have taken up $BaTiO_3$ piezoelectric nanoparticles (pzNPs) specifically adopt an M1 cellular phenotype upon ultrasound (uS) stimulation [1], and compare that result to biochemical polarization with IFN-γ+LPS, and the role FUS plays in both. We also discuss a theranostic project using pzNPs, tagged with the radionuclide ^{89}Zr for subsequent PET imaging, taken up by MDA-MB-231 cancer cells and activated (killed) with uS. The overall goal is to leverage this novel cellular assay to help improve understanding of how biological cells respond to bioelectric stimulation.

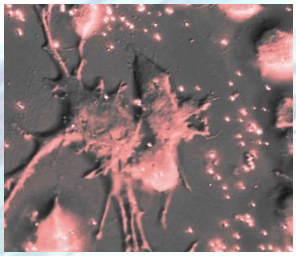

Figure 1. RAW264.7 cells adopt am M1 macrophage polarization upon ultrasound stimulation of endocytosed $BaTiO_3$ piezoelectric nanoparticles.

References

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Funding

We gratefully acknowledge funding from the Mathers Foundation for the theranostic portion of the reported research.

Catalytic Biomaterials - Nitric Oxidation Production and ROS Reduction

Yadong WANG[1], Cole LATVIS[1]

[1] School of Biomedical Engineering, Cornell University, Ithaca, USA, e-mail: yadongwang@cornell.edu

bioactivity, catalysis, metal, elastomer, biomaterials

Abstract – Our laboratory investigates soft matter engineered to modulate the interface with living tissues, with a specific focus on elastomers designed for the repair and regeneration of vital organs. Our most recent generation of bioelastomers is inspired by metallo-enzymes, specifically superoxide dismutase (SOD). By utilizing copper ions to chelate polymer chains into a highly elastic network, we have developed materials that combine mechanical robustness with excellent biocompatibility.Beyond their physical properties, these elastomers possess inherent catalytic capabilities for degrading reactive oxygen species (ROS) and generating nitric oxide (NO), thereby mimicking and enhancing the protective regulatory roles of the vascular endothelium. In the context of wound healing, the integration of anti-ROS functionality is critical; by actively scavenging excess ROS at the injury site, these materials mitigate oxidative stress, prevent prolonged inflammation, and accelerate the transition to the proliferative phase of tissue repair.These multifunctional properties are particularly transformative for vascular graft applications. By maintaining a localized flux of NO and reducing ROS-mediated damage, these grafts inhibit platelet adhesion and chronic inflammation, addressing the primary causes of graft failure such as thrombosis and intimal hyperplasia. I will discuss our efforts to translate this material into clinical settings, highlighting its potential to redefine the standards for synthetic vascular prosthetics.

Funding

This work is supported by NIH grant# 1R01EB032450

Piezoelectric Liquids and Their Potential for Sensing Applications

Gary J. BLANCHARD

Michigan State University, Department of Chemistry, East Lansing, Michigan, 48824, USA, e-mail: blanchard@chemistry.msu.edu

piezoelectric effect, ionic liquid, deep eutectic solvent

The piezoelectric effect is utilized in a wide range of applications, from personal power generation to accelerometers. Until recently, the piezoelectric effect was thought to be limited to solids, many of which were toxic or contained heavy metals, precluding their use in biosensing applications. We have recently reported that certain classes of liquids exhibit the piezoelectric effect.[1-3] This discovery opens the door to the design of conformal piezoelectric materials that can be used for applications such as impact sensing, personal power generation and acoustic monitoring. The materials that exhibit this technologically important effect are ionic liquids and deep eutectic solvents.[1,3] We will discuss the mechanism of the piezoelectric effect in these materials, and the form of the piezoelectric response. Current work is focused on understanding the interplay between ionic liquid and deep eutectic solvent constituent identity and the magnitude and speed of the piezoelectric response.

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Funding

This work was supported by the U.S. National Science Foundation (DMR 2401001).

INVITED TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

From NANOmaterials to nanoMATERIALS: Synthesis as a Pathway to Advanced Applications

Ilaria **FRATODDI**[1], Sara CERRA, Tommaso A. SALAMONE, Martina MERCURIO, Beatrice PENNACCHI, Federico MILANESE

Department of Chemistry, Sapienza University of Rome, P.le A. Moro 5, 00185, Rome Italy, e-mail: ilaria.fratoddi@uniroma1.it

functionalized nanoparticles, metal nanohybrids, nanocomposites, bioactive molecules loading, optoelectronics

The controlled synthesis of nanomaterials is a key step in developing advanced functional materials for a wide range of technological applications. In particular, the possibility to precisely tune size, morphology, core composition, surface chemistry, and surface-to-volume ratio enables the design of nanostructures with tailored properties. Hydrophilic nanostructures are being extensively studied as active surface which enables selective interactions with biomolecules, cells, and complex biological environments, particularly important for the development of platforms for drug delivery, biosensing, advanced therapeutic systems and biotechnologies [1,2]. Hydrophobic nanostructures can be engineered through fine modulation of their optical and electronic properties, enabling the fabrication of highly sensitive and selective sensors, plasmonic devices, and solid-state electronics [3, 4]. Different shapes, sizes, core structures, and surface compositions have been explored, including metallic core nanoparticles (MNPs), metal oxide nanoparticles (MO_xNPs), as well as hybrid systems and nanocomposite blends. In this talk, the role of surface functionalization in metal and metal oxide nanoparticles will be discussed, with particular emphasis on their applications in optoelectronics, biotechnology, and nanomedicine (Figure 1).

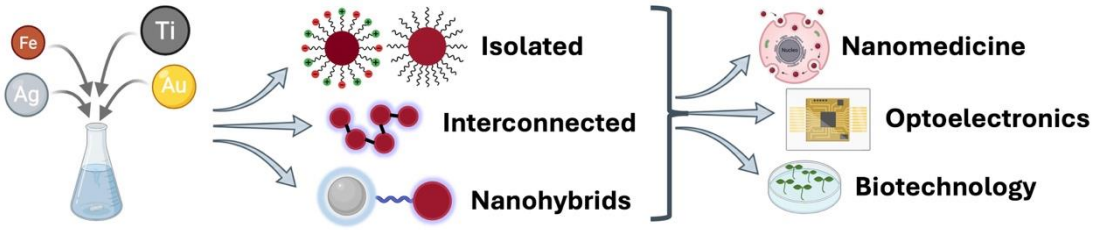

Figure 1. Functionalized nanoparticles: from synthesis to biotechnology, nanomedicine, and optoelectronic applications

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INVITED TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Conducting Polymer/Exfoliated Graphite Composites for Electrochemical Detection of Neurotransmitters

Justina GAIDUKEVIC[1,2], Gintare RIMKUTE[1], Rasa PAULIUKAITE[1,2]

[1] Faculty of Chemistry and Geosciences, Vilnius University, Naugarduko str. 24, Vilnius, Lithuania, e-mail: justina.gaidukevic@chf.vu.lt, gintare.rimkute@chgf.vu.lt
[2] Center for Physical Sciences and Technology (FTMC), Sauletekio ave. 3, Vilnius, Lithuania, e-mail: rasa.pauliukaite@ftmc.lt

exfoliated graphite, polythiocyanogen, polypyrrole, dopamine, serotonin

Electrochemical detection of neurotransmitters is essential for the diagnosis and monitoring of neurological disorders, requiring sensitive, rapid, and cost-effective analytical platforms. Carbon-based materials, particularly exfoliated graphite (EG), have attracted considerable attention due to their high surface area, good electrical conductivity, and chemical stability [1].

In this study, conducting polymer/exfoliated graphite composites were developed and investigated as electrode materials for neurotransmitter detection. EG was synthesized from graphite precursors of different particle sizes via intercalation followed by thermal exfoliation. The obtained material was further modified using conducting polymers, including polypyrrole (PPy) and polythiocyanogen ($(SCN)_n$), employing wet-chemical and mechanochemical synthesis routes.

Structural characterization using Raman spectroscopy, FTIR, and XPS confirmed the successful incorporation of heteroatoms (N, S) into the graphitic structure, leading to increased defect density and enhanced electroactive surface properties. The results revealed that both the graphite precursor grain size and the type of conducting polymer significantly influence the structural and electrochemical characteristics of the composites. Electrochemical studies demonstrated that the composite derived from medium-sized graphite exhibited the most balanced performance. PPy/EG-based sensors showed high sensitivity (up to 2180 µA mM^{-1} cm^{-2}) and a low detection limit (78 nM) for dopamine, while $EG(SCN)_n$/EG composites enabled sensitive serotonin detection with a detection limit as low as 59.5 nM and sensitivity of 1893 µA mM^{-1} cm^{-2} [1, 2]. These findings demonstrate that conducting polymer/EG composites are promising metal-free materials for electrochemical detection of biologically relevant analytes, offering potential for application in biomedical sensing technologies.

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INVITED TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Physical Methods for Studying Circulating Tumour Cells - Diagnostics, Properties and Effect of Antimetastatic Drugs

Olena GNATYUK[1], Maryna OLENCHUK[1], Danylo KOMISAR[2], Oleksii ILCHENKO[2], Denys KOLESNIK[3], Galyna SOLYANIK[3], Sergii ROMANENKO[4], Galyna DOVBESHKO[1]

[1] Institute of Physics National Academy of Sciences of Ukraine, Prospect Nauky, 46, Kyiv, Ukraine, e-mail: hrysantemka@gmail.com
[2] Technical University of Denmark, Ørsteds Plads, Building 345C, DK-2800 Kgs. Lyngby, Denmark.
[3] R.E. Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology National Academy of Sciences of Ukraine, Vasylkivska Str., 45, 03022, Kyiv, Ukraine
[4] O.O. Bogomoletz Institute of Physiology National Academy of Sciences of Ukraine, Bogomolets str., 4, 01024, Kyiv, Ukraine

circulating tumour cells (CTC), Raman mapping, CARS and SHG imaging, FTIR spectroscopy, mechanical properties of the cell membrane

Circulating tumor cells (CTC) are cells that have been able to separate from the primary tumor, survive in the bloodstream and enter other organs and tissues and form secondary tumor foci or metastases there. Such consequences often have a negative prognosis for patients. Therefore, the study of biochemical and morphological characteristics of circulating tumor cells is an important task for the development of antimetastatic therapy strategies. However, their study faces a number of problems associated with the fact that they are quite difficult to isolate from the blood of patients. Therefore, in our work, a simple and convenient model is proposed. To simulate metastasis in vitro, two cell culture models were employed: adhesive and non-adhesive (suspension) growth.

Our previous studies demonstrated that the transition to non-adhesive growth is accompanied by significant changes in biochemical properties of these cells [1]. Also in this work, several physical methods for studying CTC cells are proposed. Raman mapping, visualization using CARS and SHG, as well as studies of the mechanical properties of cell membranes do not require complex sample preparation, additional staining of cells, and can also be scaled to the needs of clinical research. Data are presented here allow us to assess morphological features, analyze the effect of antitumor drugs, and also establish criteria for determining the level of metastatic activity of cells.

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Funding

This work was financially supported by NRFU, No 2021.01/0229 “Biophysical characteristics of circulating metastatic cells as potential targets of antimetastatic therapy” and project №1.4. B/218.

Charged and Mixed-Charged Nanomaterials

Bartosz GRZYBOWSKI[1]

[1] Department of Chemistry, Ulsan National Institute of Science and Technology, IBS Center for Algorithmic and Robotized Synthesis, AMRB 103, Office 307, 50, UNIST-gil, Ulsan 44919, South Korea, e-mail: nanogrzybowski@gmail.com

nanomaterials, bio-related applications, nanoscience, nanomedicine, AI

This talk will be a walk through more than a decade of our lab's work on nanomaterials presenting charged functional groups: from early focus on synthesis and self-assembly, to applications in electronics and cancer biology.

This progression illustrates amply how nanoscience at large matures and ages - pointing to the need for this field to reinvent and rejuvenate itself.

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Melanin Nanoparticle - Infrared Light Cancer Therapy

Kris KEMPA, Brahmin THURBER-CARBONE, Michael J. NAUGHTON[1]

[1] Boston College, Department of Physics, Chestnut Hill, MA 02467, USA, e-mail: naughton@bc.edu

melanin, nanoparticle, cancer, metabolism, light

Melanin nanoparticles are known to be biologically benign to human cells for a wide range of concentrations in a high glucose culture nutrition. Here, we show cytotoxic behavior at high nanoparticle and low glucose concentrations, as well as at low nanoparticle concentration under exposure to (nonionizing) visible radiation. To study these effects in detail, we developed highly monodispersed melanin nanoparticles (both uncoated and glucose-coated). In order to study the effect of significant cellular uptake of these nanoparticles, we employed three cancer cell lines: VM-M3, A375 (derived from melanoma), and HeLa, all known to exhibit strong macrophagic character, i.e., strong nanoparticle uptake through phagocytic ingestion. Our main observations are: (i) metastatic VM-M3 cancer cells massively ingest melanin nanoparticles (mNPs); (ii) the observed ingestion is enhanced by coating mNPs with glucose; (iii) after a certain level of mNP ingestion, the metastatic cancer cells studied here are observed to die—glucose coating appears to slow that process; (iv) cells that accumulate mNPs are much more susceptible to killing by laser illumination than cells that do not accumulate mNPs; and (v) non-metastatic VM-NM1 cancer cells also studied in this work do not ingest the mNPs, and remain unaffected after receiving identical optical energy levels and doses. Results of this study could lead to the development of a therapy for control of metastatic stages of cancer.

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INVITED TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

Commercialising Advanced Materials

Denis KOLTSOV

Director of BREC Solutions (Consulting) and Chair of BSI LBI/37, e-mail: denis@brec-solutions.com, www.brec-solutions.com

More than two decades of intense research and development into nanotechnology and advanced materials leaves a significant paper-trail in publications and patents. How can all this knowledge be used for creating commercial or social value? How can this information be safely used for regulation and further investment and funding in emerging areas? I examine the questions of research leading to commercialisation with various tried business models. I also cover the most recent trends and promising developments in advanced materials where both the research and investment are being focused.

INVITED TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Engineering Vascular Grafts with Novel Bioinks: From Extrusion to Volumetric Bioprinting of Patterned hiPSC-Derived Constructs

Jagoda LITOWCZENKO-CYBULSKA[1,2]

[1] Center for Advanced Technologies, Adam Mickiewicz University in Poznań, Uniwersytetu Poznańskiego 10, 61-614 Poznań, Poland, e-mail: jagoda.litowczenko@amu.edu.pl
[2] The SHED (Safety Health Environmental Discovery Lab), Massachusetts Institute of Technology (MIT), 77 Massachusetts Avenue, Cambridge, MA, USA, e-mail: jagoda@mit.edu

biomaterials, 3D bioprinting, bioinks, stem cells, vascular grafts

Engineering perfusable tubular tissues with long-term structural and functional stability remains one of the major challenges in biofabrication. In particular, tissue-engineered vascular grafts often fail due to insufficient endothelialization, poor mechanical maturation, and limited scalability [1,2,3].

This invited lecture will present two complementary biofabrication strategies developed in the Biomaterials & Biofabrication Laboratory at Adam Mickiewicz University in Poznań.

The first part of the talk will focus on extrusion bioprinting of multilayer vascular grafts composed of distinct bioactive compartments designed to mimic native vessel organization. Using hiPSC-derived supporting cells, elastin-based hydrogels, and micro-patterned luminal interfaces, we demonstrate enhanced endothelial retention under flow, improved cellular alignment, and progressive graft maturation during perfusion culture [4].

The second part of the lecture will introduce volumetric bioprinting as a rapid manufacturing strategy for lumenized and perfusable constructs. Particular emphasis will be placed on the development of novel photoresponsive bioinks enabling fast fabrication of soft tubular geometries while maintaining structural fidelity and cellular compatibility.

Together, these approaches illustrate how biomaterial design, stem cell engineering, and advanced bioprinting technologies can be integrated to create next-generation vascular and cardiac tissue models for regenerative medicine, tissue and disease modeling, and translational bioengineering.

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INVITED TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Biomaterials in Dentistry – from Science to Clinical Innovation

Katarzyna MAŃKA-MALARA

Department of Orthodontics, Medical University of Warsaw, Poland, 61 Zwirki i Wigury Str., 02-091 Warsaw, e-mail: kmalara@wum.edu.pl

dental materials, digital dentistry, nanomaterials, sports dentistry, mouthguards

The introduction of digital treatment planning and 3D printing has led to profound changes within the field of dentistry, creating new clinical and technological challenges. The search for innovative materials is frequently associated with the need to modify entire treatment protocols, necessitating careful evaluation of treatment safety. At the same time, novel materials often address limitations that could not be overcome using conventional techniques. Any modification of material properties may influence the durability of dental appliances and, consequently, impact patient outcomes.

A notable example of recent advancements that have significantly influenced clinical practice is the development of new methods for mouthguard fabrication. Currently, most athletes use “boil-and-bite” mouthguards, which are adjusted after immersion in hot water, while custom-made appliances are typically thermoformed from ethylene-vinyl acetate (EVA). However, these solutions are characterized by limited dimensional predictability, material thinning during fabrication, and, as a result, insufficient protective capacity. This study presents a comprehensive workflow for the development of a clinically tested alternative using a hybrid acrylic material. The process includes determining optimal material composition, incorporating nanoparticles, and establishing fabrication protocols for clinically applicable mouthguards, followed by *in vitro* evaluation. The results also demonstrate the potential application of 3D printing technologies in mouthguard production, indicating future directions for the implementation of novel biomaterials in clinical practice.

The development of custom hybrid mouthguards serves as a model for discussing the process of clinically driven innovation resulting from material research, along with its associated challenges and limitations. Although the use of advanced materials offers significant benefits for both patients and clinicians, it should always be preceded by thorough and cautious in vitro assessment.

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INVITED TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

SPIONS@SiO_2-CaO-CuO bioactive glass core-shell nanoparticles: a multifunctional platform for combined diagnostic, cancer treatment and tissue reconstruction

J.-M. NEDELEC

Université Clermont Auvergne, Clermont Auvergne INP, CNRS, ICF, F-63000 France

nanoparticles, bone cancer, core shell, magnetic hyperthermia, bioactive glass

In recent decades, studies on magnetic hyperthermia, used as a primary treatment or in combination with chemotherapy or radiotherapy, have shown remarkable results for cancer treatment. In the context of bone cancer, a multifunctional material exhibiting magnetic hyperthermia, bone regeneration, and bactericidal properties would be highly promising for filling critical defects resulting from tumor ablation.

With this in mind, we developed heterostructured nanoparticles with a superparamagnetic iron oxide (γ-Fe_2O_3) core encapsulated in a copper-doped mesoporous bioactive glass shell (SiO_2-CaO). Their bioactivity (via monitoring of hydroxyapatite precipitation) and copper release were confirmed by immersing them in SBF (Simulated Body Fluid). Their safety was demonstrated by cytotoxicity tests on murine pre-osteoblastic cells (MC3T3-E1), and an antibacterial effect was observed on methicillin-resistant and methicillin-sensitive Staphylococcus aureus strains. The heating capacity of the heterostructures placed in an alternating magnetic field was obtained by AC magnetometry at various amplitudes and frequencies, and relaxometry measurements confirmed the potential use of these materials as a negative contrast agent (T2-weighted).

These results represent a first step in the development of a multifunctional, biocompatible synthetic nanomaterial combining bone regeneration and antibacterial effects, improving MRI monitoring and offering potential for cancer treatment through magnetic hyperthermia.

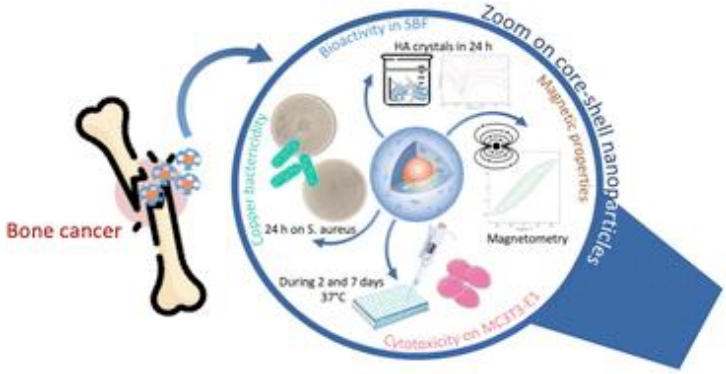

Figure 1. Bioactive glass core-shell nanoparticles: a multifunctional platform for combined diagnostic, cancer treatment and tissue reconstruction

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INVITED TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Ferrite Micro- and Nanoparticles for MRI Thermometry

Marek PRZYBYLSKI[1,2], Janusz H. HANKIEWICZ[3], Zbigniew J. CELIŃSKI[3,4]

[1] Academic Centre for Materials and Nanotechnology, AGH University of Krakow, Krakow, Poland
[2] Faculty of Physics and Applied Computer Science, AGH University of Krakow, Krakow, Poland, e-mail: marprzyb@agh.edu.pl
[3] UCCS BioFrontiers Center, University of Colorado, Colorado Springs, USA
[4] Department of Physics and Energy Science, University of Colorado, Colorado Springs, USA

ferrites, NMR, MRI, thermometry, mapping

We carried out comprehensive structural, magnetic, and toxicity studies of various ferrite micro- and nanoparticles intended for use as contrast agents in Magnetic Resonance Imaging (MRI) thermometry. Micrometer-sized particles were synthesized using a ceramic technique, whereas ultra-small polymer-coated nanoparticles were produced via a one-step thermal decomposition method [1]. Magnetic measurements performed with SQUID magnetometry were correlated with X-ray diffraction (XRD) data and compared with magnetic properties obtained from Mössbauer spectroscopy. This combined analysis enabled a detailed understanding of the magnetic structure of the investigated ferrites. Temperature-dependent magnetic measurements were then used to identify the most suitable ferrite compositions for MRI thermometry in the temperature range close to that of the human body [2].

We also evaluated the advantages and limitations of ferrite particles embedded in agar gel phantoms as MRI temperature indicators for low-magnetic-field scanners. While high-field MRI systems offer higher sensitivity and spatial resolution, low-field scanners provide more open designs that are better suited for MRI-guided interventional procedures and help reduce claustrophobic discomfort in patients. Therefore, low-field scanners possess several practical advantages for medical imaging. In this work, we compared the temperature-dependent intensity changes of MR images obtained at low field (0.2 T) with those measured at high field (3.0 T). Because T_1 relaxation times are shorter at low magnetic fields, scanners operating at 0.2 T can use shorter repetition times and achieve strong T_2* weighting. This results in pronounced temperature-dependent changes in MR image intensity even with short acquisition times. In addition to these benefits, we observed an unexpected advantage of low-field scanners: the relative change in temperature-dependent image intensity is larger at low field than at high field. Consequently, MRI thermometry performed at 0.2 T may offer two key advantages over measurements at 3.0 T: improved temperature measurement accuracy and shorter acquisition times [3].

For biomedical applications, ferrites in the form of polymer-coated nanoparticles are more suitable for clinical use. In this study, ferrite nanoparticles coated with poly(ethylene glycol) (PEG) were synthesized, yielding water-stable and biocompatible particles. When embedded in agarose gel, these nanoparticles significantly modify the relaxation times (T_1, T_2, and T_2*) of water protons, as determined by nuclear magnetic resonance measurements. Spin-echo T_2-weighted MR images of aqueous phantoms containing ferrite nanoparticles and exposed to a strong temperature gradient reveal a strong correlation between temperature and image intensity [1,4].

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INVITED TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Application of Laser Induced Emission of Graphene for Medical Applications

W. STRĘK, A. ŁUKOWIAK, P. WIEWIORSKI, R. TOMALA, M. STEFAŃSKI, Y. GERASYMCHUK, M. OLESZKO, A. MUSIALEK

Institute of Low Temperature and Structural Research, PAS, 50422 Wroclaw, Poland, e-mail: W.Strek@intibs.pl

graphene, graphene oxide, light-matter interaction, antimicrobial agent

Graphene-based materials have emerged as a transformative force in modern medicine due to their unique physical, chemical, and biological properties. This study explores the development of multifunctional carbon materials that combine structural durability with active therapeutic properties. Studied graphene and graphene oxide (GO) flakes were synthesized using electrochemical and chemical method, respectively. Characterization via X-ray diffraction, Raman spectroscopy, and transmission electron microscopy confirmed the production of expected carbon forms with multi-layer structures, typically consisting of 2–5 layers. Graphene flakes were integrated into various matrices, including Polyamide 6 (PA6) and specialized polymer coatings such as acrylic and varnish. The GO was functionalised using a metal phthalocyanine complex, which is a photosensitiser that can be used in photodynamic therapy.

Mechanical analysis demonstrated that the addition of graphene significantly enhances the performance of these host materials. Furthermore, the composites exhibited antimicrobial efficacy against a broad spectrum of pathogens, including S. aureus, P. aeruginosa, and C. albicans. This biocidal action is driven by a dual mechanism: the physical rupture of cell membranes by graphene "blades" and the induction of oxidative stress, that is enhanced in the presence of photosensitizer.

A key focus of this research is the laser-induced emission properties of graphene. Under laser or lamp excitation, these materials can trigger localized thermal effects or the production of reactive oxygen species (ROS), offering innovative pathways for photothermal therapy and light-activated sterilization. These findings suggest that graphene-polymer composites are effective for the fabrication of 3D-printed surgical tools, bioactive implants, and self-sterilizing healthcare infrastructure, paving the way for advanced, light-responsive medical technologies.

INVITED TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

Surface Phenomena Governing the Antibacterial Properties of Nano-/Microscale Zinc and Gallium-Based Oxides

Yuri M. STRZHEMECHNY[1], John H. BRANNON[1], Dustin A. JOHNSON[1], Shauna M. MCGILLIVRAY[1], Adam WATRAS[2], Vitalii V. BOIKO[2] and Rafał J. WIGLUSZ[2]

[1] Texas Christian University, 2800 South University Drive, Fort Worth, TX 76129, United States, e-mail: Y.Strzhemechny@tcu.edu
[2] Institute of Low Temperature and Structure Research, PAS, ul. Okólna 2, 50-422 Wrocław, Poland

zinc oxide, gallium oxide, gallium oxyhydroxide, surface properties, antibacterial

The global rise in antibiotic resistance has driven interest in alternative antibacterial agents, including metal oxide particles. While many metal oxides exhibit established antibacterial activity, the underlying mechanisms remain incompletely understood. Proposed pathways include reactive oxygen species generation, toxic cation release, electrostatic disruption of cell membranes, and osmotic stress. The involvement of multiple concurrent mechanisms suggests a reduced likelihood of bacterial resistance; however, the rational design of oxide-based antibacterial systems is hindered by limited understanding of how local bacterial environments modulate these interactions. We investigate interactions among oxide surfaces, bacterial membranes, and growth media using hydrothermally synthesized nano- and microparticles of undoped and Fe-doped ZnO, β-Ga_2O_3, and GaOOH. The synthesis enables controlled particle morphologies and tunable distribution of surface polarities. Antibacterial activity is assessed using *Escherichia coli* and *Staphylococcus aureus*, alongside comparative pre- and post-assay material analyses.

ORAL TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Hotspot-Engineered Core–Shell Satellite and Nanoraspberry Chip-based SERS Platforms for Ultrasensitive Biosensing of Viruses

Ojodomo J. **ACHADU**[1], Nnamdi NWAHARA[1], Enoch Y. PARK[2]

[1] School of Health and Life Sciences, & National Horizon Centre, Teesside University, Middlesbrough TS1 3BA, UK, e-mail: o.achadu@tees.ac.uk & n.nwahara1@gmail.com
[2] Research Institute of Green Science and Technology, Shizuoka University, 836 Ohya Suruga-Ku, Shizuoka 422-8529, Japan, e-mail: park.enoch@shizuoka.ac.jp

Surface-enhanced Raman Scattering (SERS); Hotspot-engineered nanostructures; core–shell nanoparticles; point-of-care viral diagnostics; norovirus and SARS-CoV-2 detection

The development of rapid, ultrasensitive, and portable diagnostics for viral pathogens remains critical for effective outbreak control and public health surveillance. Here, we present complementary hotspot-engineered surface-enhanced Raman scattering (SERS) nanoplatforms designed to overcome signal instability and limited sensitivity in complex biological matrices.
The first system employs signal-amplified Au@Ag core–shell nanoparticles decorated with satellite AuNPs and functionalised with 4-mercaptobenzoic acid (4-MBA) to generate dense electromagnetic hotspots. These nanotags demonstrated enhancement factors on the order of 10^8 and enabled norovirus-like particle detection over a range of 10 fg/mL to 100 pg/mL, with an ultralow detection limit of 0.76 fg/mL using a portable palmtop Raman spectrometer. Clinical sample analysis showed sensitivity comparable to real-time PCR, detecting as low as 7.8 RNA copies/mL [1]. The second platform integrates branched gold nanoraspberry (AuNRB)-based Au@Ag core–shell nanotags with gap-confined 4-aminothiophenol (4-ATP) reporters and a gold nanoparticle-modified fluorine-doped tin oxide (FTO) capture chip. Implemented as a sandwich immunoassay for SARS-CoV-2 S2 spike protein, the dual-enhancement system achieved detection limits of 1.07 pg/mL in PBS and 1.30 pg/mL in human serum albumin within 30 minutes [2]. Together, these studies demonstrate modular, highly sensitive SERS architectures for rapid, on-site viral diagnostics, highlighting the translational potential of hotspot-engineered nanoplasmonic biosensors for infectious disease detection.

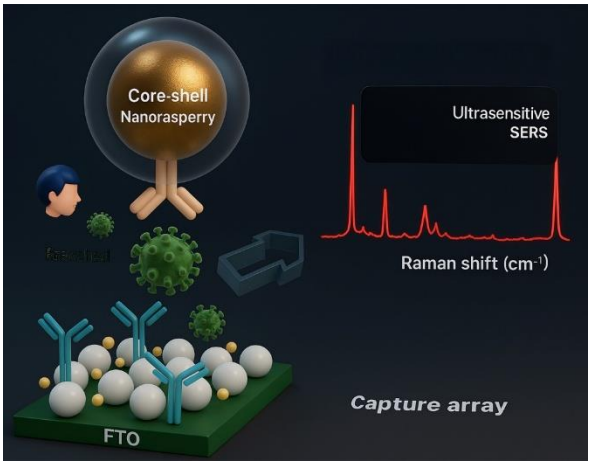

Figure 1. Graphical Representation of developed Raman spectroscopy-based nanochip for virus detection

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Royal Society – Collaboration Awards.

ORAL TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

Surface charge engineering of $ZnGa_2O_4:Cr^{3+}$ persistent luminescent nanoparticles

Vitalii BOIKO[1]*, Lena GOLUBEWA[2], Vilius ČIRGELIS[2], Yaraslau PADREZ[2], Simona STRECKAITE[2], Marzena FANDZLOCH[1], Dariusz HRENIAK[1]

[1] Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okólna 2, PL-50-422, Wrocław, Poland, e-mail: v.boiko@intibs.pl *;
[2] Center for Physical Sciences and Technology (FTMC), D217, Saulėtekio al. 3, LT-10257 Vilnius, Lithuania

Persistent luminescent nanoparticles, $ZnGa_2O_4:Cr^{3+}$, surface modification

Persistent luminescent $ZnGa_2O_4:Cr^{3+}$ (ZGO:Cr) nanoparticles are promising candidates for biomedical imaging and optical probes because of their high chemical stability, nanoscale size, and tunable optical properties [1]. In this work, ZGO:Cr nanoparticles with controlled surface charge were synthesised using two approaches: a hydrothermal method that yields near-neutral nanoparticles and a solvothermal liquid–solid–solution method that enables negatively charged surfaces via *in situ* coordination of organic species.

Zeta potential measurements showed that the surface charge for neutral is ~ −2 mV and for negative is ~ −50 mV, indicating effective surface coordination and improved colloidal stability [2]. FTIR-ATR confirmed coordinated oleate species in non-annealed samples through COO^- stretching bands at ~ 1561 and ~ 1424 cm^{-1}, consistent with bidentate binding [3]. Annealing at 300°C decomposed the organic shell and reduced hydroxyl-related bands, confirming their modification. Photoluminescence spectra of negatively charged nanoparticles showed, in addition to Cr emission, a broad band around 500 nm attributed to surface-related states, indicating that surface coordination strongly affects emission. Annealing did not significantly change neutral nanoparticles, while surface-modified ones exhibited enhanced blue–green emission and decreased overall intensity after treatment.

These results show that controlled synthesis and surface functionalisation enable precise tuning of the surface charge and optical response of ZGO:Cr nanoparticles, supporting their potential use in biomedical imaging, sensing, and bio-integrated material systems.

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Sol-gel coatings on the surface on pea seeds

Beata BORAK

Department of Mechanics, Materials and Biomedical Engineering, Wrocław University of Science and Technology, Smoluchowskiego str. 25, 50-371 Wrocław, Poland, e-mail:beata.borak@pwr.edu.pl

sol-gel coatings, pea seeds, Azofoska fertilizer

Sown seeds are exposed to a range of biotic and abiotic factors that interfere with their germination and growth. To protect them from unfavorable conditions, their surface can be covered with a thin, continuous layer containing the appropriate amount of macro- and micronutrients. This can reduce nutrient losses by placing them on the seed and also reduce weed competition. Seed coating technologies maintains seed shape and can be used on a wide range of crop seeds, including cereals, oilseeds, vegetables, ornamentals, and other seed species [1].
The aim of this work was to apply a sol-gel coating to the surface of pea seeds and investigate its effect on the germination and growth of the plant. The coatings were produced by the sol-gel method using various silicon precursors: tetraethoxysilane (TEOS), 3-aminopropyltriethoxysilane (APTES) and dimethylethoxysilane (DMES), pure and doped with the universal mineral fertilizer Azofoska, commonly used in Poland. The seeds were sown in the soil and their germination and growth were observed over time. The quality of the applied coatings and their chemical composition were examined using scanning electron microscope (SEM) and Energy Dispersive X-Ray Spectroscopy **(**EDX). The same sol that was applied to the seed surface was also applied to glass substrates to determine the contact angle and surface characteristics of the layers. After coating, the increase in seed weight ranged from 0.4 to 1.3%. Adding fertilizer to the sol does not increase the weight of the applied layer. TEOS and APTES-based coatings with Azofoska additives have a lower weight gain than the same coatings without fertilizer. Most of the seeds covered with the sol-gel layer (70-100%) germinated and showed growth in the 25-day period studied (Fig. 1).
The coated seeds stored well for 8 months and showed viability (germination and growth) after this storage period.

Figure 1. Grown peas from seeds covered with sol-gel layer

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ORAL TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

The potential of zinc alloys as materials for short-term medical implants

Katarzyna CESARZ-ANDRACZKE[1], Przemysław SNOPIŃSKI[2], Badegül TUNCAY[3], Magdalena SKONIECZNA[4,5]

[1] Faculty of Mechanical Engineering, Silesian University of Technology, 18A Konarskiego Street, 44-100 Gliwice, Poland, e-mail: katarzyna.cesarz-andraczke@polsl.pl
[2] Faculty of Mechanical Engineering, Silesian University of Technology, 18A Konarskiego Street, 44-100 Gliwice, Poland, e-mail: przemysław.snopinski@polsl.pl
[3] Department of Aeronautical Engineering, Sivas University of Science and Technology, Sivas, Turkije, Poland, e-mail: btuncay@sivas.edu.tr
[4] Department of Systems Engineering and Biology, Silesian University of Technology, Institute of Automation, 16 Akademicka Street, 44-100 Gliwice, Poland, e-mail: magdalena.skonieczna@polsl.pl
[5] Biotechnology Center, Silesian University of Technology, 8 Krzywoustego Street, 44-100 Gliwice, Poland, e-mail: magdalena.skonieczna@polsl.pl

Short-term implants, biodegradable alloys, mechanical properties, degradation process

The constantly growing demand for implants indicates the dynamic development of the implantology industry in the near future and simultaneously necessitates accelerated research and development focused on finding suitable materials for implant production, especially orthopedic ones. Currently, short-term implants (e.g., plates, bone screws) made of metallic materials (stainless steel, Co-Cr-Mo alloys) are used to treat bone fractures. These materials guarantee safe implant use until the degradation process begins. After this period, the implant must be surgically removed, as the degradation products of these implants are toxic to the patient. Long-term use of implants containing, for example, nickel releases nickel ions, causing implant corrosion. This corrosion product is metal ions that enter the body. Therefore, an incorrectly selected material for long-term use can lead to metallosis, the accumulation of metals in the liver and other organs, and consequently, serious complications and chronic diseases. Additionally, removing a non-absorbable implant requires another surgery, which is burdensome for the patient and increases treatment costs. Careful observation of implant behavior in the human body is leading to a gradual shift away from steel implants towards biocompatible alloys, which are the most friendly to living organs. Therefore, there is a need to intensify work leading to the development of a new generation of fully biocompatible, bioresorbable materials. Many teams are currently carried out of zinc alloys, which contain premises for potential biodegradable materials for short-term medical implants. Both zinc and magnesium are defined in the standard as micro- and macroelements, so the selected composition should be biocompatible and non-toxic to the patient's body. This paper presents the results of mechanical propreties, degradation's studies and cytotoxicity tests of zinc alloys. The changes in mechanical properties after several periods of immersion in Ringer's solution at 37°C were also studied. The study assessed the effect of magnesium concentration in zinc alloys on mechanical properties and corrosion resistance in Ringer's solution at 37°C.Based on these research results, the possibilities of using these materials in implantology were assessed and directions for future research were developed to improve the functional properties of zinc alloys.

ORAL TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

Bio-applications of ZnO nanoparticles – from anti-bacterial activity to cancer detection and treatment

Marek GODLEWSKI[1], Julita ROSOWSKA[1,2], Agnieszka WAL[3], Jarosław KASZEWSKI[1], Paula KIEŁBIK[4], Bartłomiej DOMINIAK[2], Anna SŁOŃSKA-ZIELONKA[2], Joanna CYMERYS-BULENDA[2], Michał Marek GODLEWSKI[2]

[1] Institute of Physics, Polish Acad. of Sci., Al. Lotników 32/46, 02-668 Warsaw, Poland, e-mail: godlew@ifpan.edu.pl
[2] Department of Physiological Sciences, Institute of Veterinary Medicine, Warsaw University of Life Sciences – SGGW, 02-776 Warsaw, Poland
[3] Department of Botany and Plant Physiology, Warsaw University of Life Sciences – SGGW, 02-776 Warsaw, Poland
[4] Department of Large Animal Diseases with Clinic, Faculty of Veterinary Medicine, Warsaw University of Life Sciences – SGGW, 02-776 Warsaw, Poland

ZnO nanoparticles; antibacterial agents, fluorescence labels; MRI contrast; cancer theragnostics

ZnO layers and nanoparticles (NPs) show anti-bacterial properties, as we confirmed testing 16 bacteria strains [1]. Once doped with rare earth metal ions we could activate their fluorescence. Importantly for further studies, this fluorescence was observed upon host-related excitation. Following this observation ZnO NPs were successfully applied for early cancer detection, either as fluorescence labels or as a new generation of MRI contrast agents [2]. For these applications it is crucial that ZnO NPs exhibit low toxicity and are biocompatible [2,3].

Our studies proved that ZnO NPs can penetrate physiological barriers including intestinal and blood-brain barrier. An effective trafficking of these markers to the areas of lung cancer was observed, whereas surrounding tissue was impermeable for nanoparticles. This means 100% selectivity of our approach. Importantly, ZnO NPs can also act as drug delivery systems. This opens chances for a direct transporting a given medicine to area of tumour. Regarding safety aspects, ZnO particles are not stable in body fluids. We thus avoid long time accumulation in the body. Chances for new applications were then demonstrated by us. If they dissociate in body fluids the ZnO NPs can also be used for micro-elements supplementation.

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ORAL TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Neurological rehabilitation progress fMRI imaging for stroke patients

Wojciech JOPEK

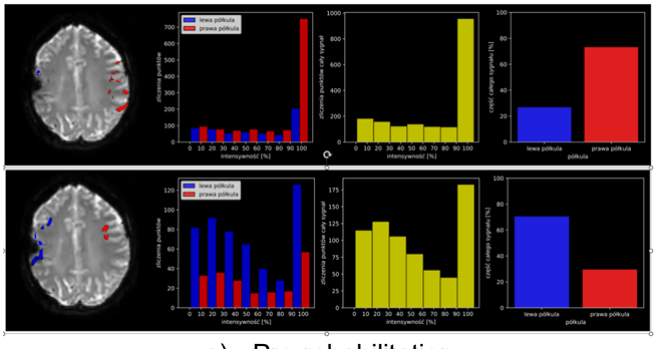
BioEngineering.pl Sp. z o.o., Radzikow 28, 58-210 Lagiewniki, Poland, e-mail: office@bioengineering.pl

stroke, rehabilitation, brain activity, neurology

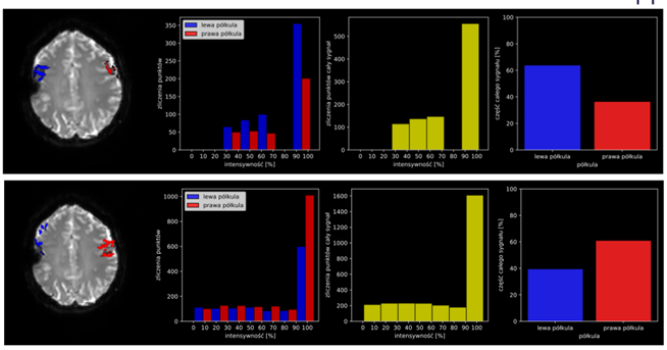
Stroke remains one of the leading causes of long-term motor disability worldwide, with upper limb dysfunction representing a major clinical challenge [1]. This paper presents a comprehensive study on the assessment of neurological rehabilitation progress using functional Magnetic Resonance Imaging (fMRI) in post-stroke patients treated with the novel NeuroRec electrostimulation-based rehabilitation system, compared to conventional kinesiotherapy.

The NeuroRec system integrates a multi-channel electromyography (EMG) acquisition module — consisting of 8 differential EMG electrodes mounted on a forearm band — with an Electrical Muscle Stimulation (EMS) unit delivering configurable current waveforms across 4 independent channels (0–100 mA, up to 200 Hz). A sensorized glove records 3D limb position, enabling full motion mapping and real-time EMG-to-EMS signal mirroring between the healthy and affected limb. Three generations of the EMS stimulator were developed and validated through EMC testing prior to clinical trials. The co-driven FES control strategy, combining surface EMG signals with joint angle data, formed the basis of the stimulation feedback loop implemented in the NeuroRec system. Brain activity monitoring relied on EEG (EPOCx device) and fMRI, with preliminary studies on healthy volunteers used to establish repeatable measurement protocols and define EEG frequency band parameters corresponding to left- and right-hand motor control.

A randomized clinical test was conducted with 30 post-stroke patients divided into two groups: Group K (conventional kinesiotherapy, 1 × 60 min/week) and Group NR (NeuroRec, 2 × 30 min/week), both carried out continuously over 12 weeks. Motor recovery was assessed at three time points using the Ashworth and Brunnstrom clinical scales [4], the 9-Hole Peg Test (9-HPT) [5], and dynamometric grip strength measurements. Brain plasticity was evaluated via fMRI in a subset of 6 patients (3 per group) before and after rehabilitation, using a standardized finger-tapping paradigm consisting of 5 alternating 30-second activity/rest blocks with a temporal resolution of 3 s (50 total measurements). fMRI data acquired in DICOM format were processed by extracting activity in the precentral gyrus and across each hemisphere, isolated using a 3D spherical segmentation approach.



a) Pre-rehabilitation



b) Post rehabilitation

Figure 1. Pre (a) and Post (b) rehabilitation using NeuroRec method stroke patient brain activity fMRI analysis example while right and left hand exercise.

Grip strength results demonstrated a 44% (left hand) and 56% (right hand) improvement in the NeuroRec group versus 31% (left) and 18% (right) in the kinesiotherapy group. In the 9-HPT, the NeuroRec group achieved a 44% (left) and 23% (right) reduction in task completion time, compared to 8% (left) and 24% (right) for kinesiotherapy. fMRI analysis confirmed cortical neuroplasticity: normalized motor cortex activity of the rehabilitated limb increased from 16% to 35% of the healthy-limb activity in NeuroRec patients. Group-averaged improvements in motor cortex activation amounted to 50.1% and 66.0% for NR patients, versus 37.0% and 49.9% for Group K patients (right and left hemispheres, respectively).

These results demonstrate that the NeuroRec system induces significantly greater and more predictable motor and neurological recovery than conventional kinesiotherapy in post-stroke upper limb rehabilitation, with fMRI confirming measurable cortical reorganization correlating with functional outcomes. The findings support the clinical value of EMG-driven EMS rehabilitation combined with objective neuroimaging biomarkers for monitoring recovery progress.

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POIR.01.01.01-00-1072/19 - Specjalistyczny system aktywizacji układów nerwowych i mięśniowych kończyn z wykorzystaniem sygnałów EMG i metod symulacji, jako innowacyjna forma diagnostyki, rehabilitacji i terapii dla osób z dysfunkcją kończyn.

ORAL TALK

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Upconverting/Magnetic core@shell Nanoparticles Fe_3O_4@Gd_2O_3:Er^{3+}, Yb^{3+}, Nd^{3+}, Mg^{2+} : from Synthesis and Characterization Methods to Applications in Bioimaging

Izabela KAMIŃSKA[1], Kamil SOBCZAK[2], Yaroslav ZHYDACHEVSKY[1], Tomasz WOJCIECHOWSKI[1,3], Roman MINIKAYEV[1], Bożena SIKORA-DOBROWOLSKA[1], Sabina LEWIŃSKA[1], Michał CHOJNACKI[1,3], Krzysztof FRONC[1,3]

[1] Institute of Physics, PAS, Warsaw 02-668, Poland, e-mail: ikaminska@ifpan.edu.pl
[2] University of Warsaw, Biological and Chemical Research Centre, Warsaw 02-089, Poland
[3] International Research Centre MagTop, Warsaw 02-668, Poland

upconversion, core/shell nanoparticles, Tyndall effect, paramagnetic

Nanoparticles (NPs), which emit light with an energy higher than that of the excitation radiation, are gaining attention as a new generation of potential probes for many important applications in biomedicine.

The aim of the research was to design, develop the fabrication technology, characterize and apply hybrid core/shell Fe_3O_4@Gd_2O_3:Er^{3+}, Yb^{3+}, Nd^{3+}, Mg^{2+} as luminescent markers in HeLa cancer cells. The NPs were synthesized using the homogeneous co-precipitation method. The NPs were characterized using XRD, TEM, SEM, EDX, standard magnetometry techniques (PPMS, Quantum Design) equipped with an AC Measurement System and vibrating sample magnetometer (VSM) options, confocal microscopy and photoluminescence measurements. In the first stage of the synthesis 13 nm Fe_3O_4 nanoparticles (core) were obtained.

The second stage, these cores were coated with $Gd(OH)CO_3$:1% Er^{3+}, 18% Yb^{3+}, 2.5% Mg^{2+}, x% Nd^{3+} NPs, and subsequently calcined in air at 700 °C for 2 h. The resulting core/shell NPs ranged in size from 220 nm to 641 nm. In these structures, the incorporation of Nd^{3+} led to luminescence quenching. The magnetic response of the core/shell samples was paramagnetic. For Fe_3O_4@Gd_2O_3:1% Er^{3+},18% Yb^{3+},2.5% Mg^{2+}, 0.5% Nd^{3+}, the magnetization at 300 K reached ~ 5.3 emu·g^{-1} at ~ 40 kOe. The nanoparticles were non-toxic up to a concentration of 1000 µg·ml^{-1} and penetrate cells via endocytosis as confirmed by confocal microscopy [1].

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ORAL TALK
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Sol-Gel Synthesis and Characterization of High-Entropy iron garnets: New Compounds for Biomedical Application

Olzhas SHALKHAR[1], Aleksej ZARKOV[1], Thomas CHUNG-KUANG YANG[2], Sarah L. STOLL[3], **Aivaras KAREIVA[1]**

[1] Institute of Chemistry, Vilnius University, 03225 Vilnius, Lithuania, e-mail: aivaras.kareiva@chgf.vu.lt
[2] Department of Chemical Engineering and Biotechnology, National Taipei University of Technology, Taipei 10608, Taiwan
[3] Department of Chemistry, Georgetown University, Washington, D.C. 20057, United States

Iron garnets, lanthanide substitution, high-entropy oxides, biomedical application

In this study, for the first time to the best our knowledge the new high-entropy iron-containing garnets of different chemical composition (from $Y_{2.4}Ln_{0.6}Fe_5O_{12}$ to $Y_{0.5}Ln_{0.5}Ln_{0.5}Ln_{0.5}Ln_{0.5}Ln_{0.5}Ln_{0.5}Fe_5O_{12}$) (Ln = Sm, Gd, Eu, Tb) were synthesized by sol-gel method and characterized. The synthesized garnets showed a cubic crystalline structure with lattice parameters ranging from 12.36 Å to 12.46 Å depending on substitution level. The X-ray diffraction patterns of representative high-entropy lanthanide-substituted yttrium iron garnets are shown in Fig. 1.

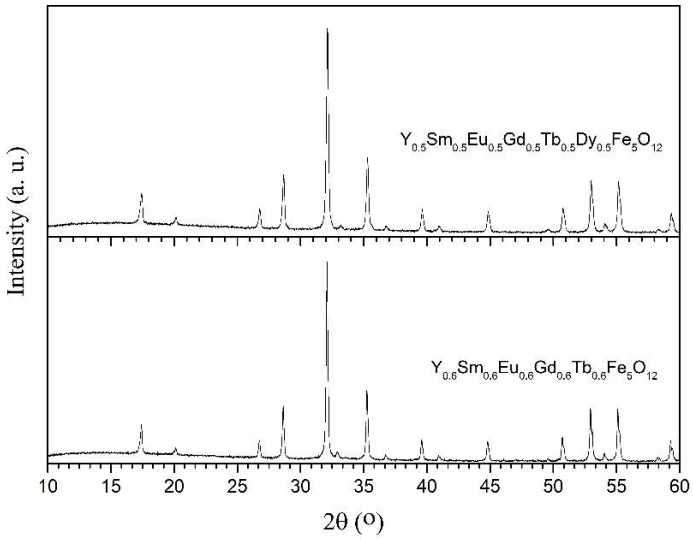

Figure 1. Powder XRD patterns of sol-gel derived garnets with different substitutional level.

The results obtained also showed the unique magnetism of high-entropy rare-earth iron garnet oxides with potential applications in biomedical imaging [1]. Moreover, their hyperthermia properties may be explored in various biomedical applications [2, 3].

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ORAL TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

XPS Insight into the Corrosion Protection Mechanism of ALD-Deposited HfO_2 Thin Films

Marcin KLEPKA[1], Aleksandra SEWERYN[1], Bartłomiej S. WITKOWSKI[1], Krzysztof KULIKOWSKI[2], Ewa URA-BINCZYK[2], Wojciech WOZNIAK[1], Anna WOLSKA[2], Hanna KONOPACKA[3,4], Dariusz M. JARZĄBEK[3,4], Marek GODLEWSKI[1]

[1] Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL-02668 Warsaw, Poland
[2] Warsaw University of Technology, Faculty of Materials Science and Engineering, Woloska 141, Warsaw, Poland
[3] Institute of Fundamental Technological Research, Polish Academy of Sciences, Pawińskiego 5B Street, Warsaw, Poland
[4] Warsaw University of Technology, Faculty of Mechatronics, św. Andrzeja Boboli 8 Street, Warsaw, Poland

XPS, implant coating, hafnium dioxide, stainless steel 316L

Protective coatings play a key role in improving the durability and biocompatibility of metallic materials used in biomedical environments. The aim of this study was to investigate the resistance to biochemical corrosion of HfO_2 thin films deposited by Atomic Layer Deposition (ALD), with particular emphasis on atomic- and molecular-level characterization using X-ray Photoelectron Spectroscopy (XPS). HfO_2 coatings were deposited on S316L stainless steel substrates and their corrosion behaviour was evaluated under simulated physiological conditions. The films were prepared using ALD at different temperatures: low temperature (90 °C), resulting in amorphous coatings, and medium and high temperatures (180 °C and 240 °C), followed by rapid thermal processing (RTP) at 500 °C to obtain monoclinic HfO_2 films. The corrosion barrier performance of the coatings was assessed using surface-sensitive electrochemical techniques. Potentiodynamic polarization (PP) and electrochemical impedance spectroscopy (IS) were applied to evaluate corrosion resistance, while XPS analysis was used to determine the chemical stability and surface composition of the films at the molecular level. The results demonstrated that HfO_2 coatings with thicknesses below 100 nm significantly improve the corrosion resistance of stainless steel by effectively limiting the diffusion of corrosive ions in aggressive biological environments. These findings highlight the potential of ALD-grown HfO_2 thin films as protective barriers for biomedical applications.

ORAL TALK
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Flaxseed Biopolymers as Sustainable Systems for Encapsulation and Delivery of Functional Compounds

Gabriela KOWALSKA, Karolina MIŚKIEWICZ, Gabriela RZEPKOWSKA, Justyna ROSICKA-KACZMAREK

Lodz University of Technology, Faculty of Biotechnology and Food Sciences, Institute of Food Technology and Analysis, ul. Stefanowskiego 2/22, 90-537 Lodz, Poland; e-mail: gabriela.kowalska@p.lodz.pl

flaxseed biopolymers, microencapsulation, spray drying, phenolic compounds, controlled release

Biopolymers derived from plant sources are increasingly explored as sustainable, biodegradable materials for encapsulation systems. Flaxseed-derived biopolymers, rich in neutral and acidic polysaccharides such as rhamnose, glucose, galactose, and xylose, represent promising matrices due to their functional properties and ability to interact with bioactive compounds. The present study aimed to evaluate flaxseed biopolymers as encapsulation carriers for honeydew honey, focusing on their potential to enhance stability, antioxidant activity, and controlled release of functional compounds.

Microencapsulation was carried out using spray drying at an inlet temperature of 110°C, resulting in stable and free-flowing powders. Scanning electron microscopy revealed the formation of spherical, homogeneous microcapsules with diameters ranging from approximately 1.8 to 6 µm, indicating good structural integrity and suitability for industrial applications.

The antioxidant activity of the obtained microcapsules was evaluated using Fremy's salt, DPPH, and TEMPO assays. A significant increase in antioxidant capacity was observed after encapsulation, reaching up to 101%, 89%, and 92% improvement, respectively, compared to native honey. This enhancement suggests a synergistic interaction between honey bioactive compounds and the flaxseed biopolymer matrix, which itself exhibits inherent antioxidant potential. Simulated *in vitro* gastrointestinal digestion demonstrated a substantial increase in the release of phenolic compounds from microcapsules. In the small intestinal phase, the release of bioactive compounds increased by up to 921% compared to non-encapsulated honey, while in the colonic phase the increase exceeded 5000%. These results confirm that encapsulation effectively protects sensitive compounds and enables their targeted delivery to specific sections of the gastrointestinal tract. Additionally, the effect of encapsulated systems on gut microbiota activity was evaluated through short-chain fatty acid (SCFA) production. Microcapsules significantly enhanced SCFA synthesis, increasing acetic, propionic, and butyric acid production by 32%, 50%, and 42%, respectively.

Overall, flaxseed-derived biopolymers demonstrate strong potential as sustainable encapsulation materials, enhancing antioxidant properties, bioavailability, and controlled release of bioactive compounds. Their application may be particularly valuable in the design of functional foods, nutraceuticals, and advanced delivery systems in pharmaceutical and biomedical fields.

ORAL TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

(Chemical-) Transdifferentiation as a Safe Source of Cells for Tissue-Engineering

Marek J. ŁOS

Biotechnology Center, Silesian University of Technology, Gliwice, Poland, e-mail: bioappl@yahoo.com

transdifferentiation, reprogramming, tissue engineering, regenerative medicine, additive manufacturing

The progress in transplantology is hampered by the shortage of donor tissues and organs. The emerging technologies of tissue engineering and artificial organ development offer a promise but still, in the majority of cases lack sufficient advancement allowing for clinical implementations. While the advances in material engineering offer a variety of biocompatible materials (to a various degree), most tissue engineering approaches are still hampered by the lack of sufficiently-safe cell sources for artificial tissue and organ development. While reprogramming (iPS-generation) with subsequent differentiation initially offered promise, several factors like (i) long time-line for cell differentiation procedures, (ii) safety issues associated both with the use of lentivirus based technologies in most cases and by inherent danger of contamination with non-differentiated embryonic stem cells (teratomagenesis), hamper its broader application in the clinic. Transdifferentiation technologies, on the other hand appear to be much safer, faster and they are inherently devoid of the risk of teratomagenesis because of lack of embryonic stem cells in the procedure. Hence, transdifferentiation-derived cells are increasingly seen as a suitable therapeutic alternative. The transdifferentiation process converts one differentiated somatic cell into another cell-type by using transcription factors (TFs), small molecules, or small, single-stranded, non-coding RNA molecules (miRNA). The transdifferentiation techniques rely on simple, fast, and versatile protocols. They do not carry a risk of tumorigenicity and genotoxicity if conducted with the use of “small molecules”. However, there are still challenges and limitations that need to be addressed to enhance their clinical translational usefulness in the future. The presentation will introduce the transdifferentiation as a comparison to reprogramming-based procedures of obtaining cells for tissue-engineering. Furthermore, limitations, challenges, and future perspectives will also be discussed.

Funding:

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ORAL TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Boosting the Photoactivity of Titania in Carbon Dioxide Reduction

Joanna KAPICA-KOZAR[1], Ewelina KUSIAK-NEJMAN[*], Katarzyna ĆMIELEWSKA[1], Agnieszka WANAG[1], Waldemar BEDNARSKI[2], Marcin GANO[3], Konrad SOBCZUK[1], Piotr STACIWA[1], Daniel SIBERA[4], Ewa EKIERT[1], Iwona PEŁECH[1], **Urszula NARKIEWICZ[1]**, Antoni W. MORAWSKI[1]

[1] Department of Inorganic Chemical Technology and Environment Engineering, Faculty of Chemical Technology and Engineering, West Pomeranian University of Technology in Szczecin, Pułaskiego 10, 70-322 Szczecin, Poland
[2] Institute of Molecular Physics of the Polish Academy of Sciences, M. Smoluchowskiego 17, 60-179 Poznań, Poland
[3] Department of Organic Chemical Technology and Polymer Materials, Faculty of Chemical Technology and Engineering, West Pomeranian University of Technology in Szczecin, Pułaskiego 10, 70-322 Szczecin, Poland
[4] Department of General Civil Engineering, Faculty of Civil and Environmental Engineering, West Pomeranian University of Technology in Szczecin, Piastów Ave. 50a, 70-311 Szczecin, Poland

ruthenium; titania; ruthenium-TiO_2 photocatalyst; photocatalytic CO_2 reduction; hydrogen evolution

TiO_2 is a well-known photocatalyst, a premier one for reducing carbon dioxide with hydrogen from water into valuable chemicals. Despite many strengths, the titania photocatalyst has one weakness – a too large energy gap. To decrease it, many modifications have been applied up to now, mainly using metals and their compounds. Ruthenium is a promising candidate for TiO_2 modification, owing to its capability for hydrogen evolution from water decomposition and CO_2 reduction. It was proven that the $Ru_{1-x}Ti_xO_2$ solid solution transition layer in Ru/TiO_2 ensures the synergistic effect of Ru co-catalyst on TiO_2, significantly improving quantum conversion efficiency [1]. In our studies ruthenium red heated at 400 ^oC in argon was applied to obtain chlorine-free titania based photocatalysts for CO_2 reduction to valuable chemicals with higher photoactivity then the commercial P25 TiO_2. The results showed a considerable influence of Ru modification on the optical characteristics of TiO_2 samples (the E_g significantly decreased with the Ru content increase). The modification with Ru resulted in the creation of oxygen defects and Ti^{3+} sites, crucial for photoactivity in CO_2 reduction. Also, the relative free electron concentrations in the oxygen vacancies in TiO_2 samples were influenced by ruthenium. All modified samples exhibited high selectivity to hydrogen and TiO_2+0.25%Ru sample was the most effective in CO and CH_4 production.

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ORAL TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

The Power of Collagen: Engineering the Next Generation of Biomaterials

Filip PORZUCEK[1], Monika MANKOWSKA-WOZNIAK[1], Adam MIELOCH[1], Tomasz SZYMANSKI[1], Piotr CYWONIUK[1], Marta TUSZYNSKA[1], Weronika GIEBEL[1], **Jakub D. RYBKA**[1]

[1] NanoBioMedical Centre, Adam Mickiewicz University, Poznań, Poland, e-mail: jrybka@amu.edu.pl

meniscus regeneration, 3D bioprinting, collagen, biomaterials

Collagen-based biomaterials are increasingly recognized for their versatility in regenerative medicine and nutraceuticals. This work presents an integrative approach to collagenous biomaterials by exploring (i) marine-derived spongin as a sustainable collagen-like biopolymer, (ii) decellularized extracellular matrix (dECM) from porcine meniscus for bioink development, and (iii) cellular blueprints via single-cell transcriptomics to inform biomaterial design. Comprehensive structural analyses using proteomics, solid-state NMR, and Raman spectroscopy confirmed that spongin shares key features with mammalian collagen, predominantly types I and III. Notably, HPLC-MS revealed halogenated di- and tri-tyrosine crosslinks, offering insights into its intrinsic stability and crosslinking mechanisms. Concurrently, we developed a scalable protocol for producing collagen-rich meniscus dECM bioinks, integrating homogenization, hydrolysis, supercritical CO_2 extraction, and lyophilization. This method preserves native bioactivity, enhances printability, and supports cell viability despite residual DNA levels exceeding typical thresholds—challenging conventional decellularization standards. Complementing the biomaterial development, a single-cell transcriptome atlas of the porcine meniscus delineates key cell populations, including five chondrocyte subtypes with distinct roles in tissue remodeling, matrix synthesis, and microenvironment modulation. The high cellular congruence between porcine and human menisci underscores the translational potential of these biomaterials. Together, this study advances collagen-inspired materials for bioprinting, regenerative medicine, and functional nutraceuticals.

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Biography

Prof. dr hab. inż. Jakub Dalibor Rybka, MBA is a specialist in biotechnology, biomedical engineering, and bionanomaterials, affiliated with Adam Mickiewicz University in Poznań (AMU). He currently serves as a full professor and the director of the NanoBioMedical Centre at AMU. He is one of the first titular professors in the field of biotechnology in Poland. His academic path includes a PhD in modular antibody engineering obtained at the University of Natural Resources and Life Sciences (BOKU) in Vienna and a habilitation at the Faculty of Biology, AMU, focusing on the

application of nanomaterials in biotechnology. Prof. Rybka is the head and founder of the Laboratory of Applied Biotechnology at AMU, and his research team focuses on 3D bioprinting, nanomaterials, and tissue engineering. Additionally, he serves as the Chief Operating Officer and co-founder of SpinBionic, the first biotechnology spin-off company of Adam Mickiewicz University. He has led significant research grants, contributing to advancements in COVID-19 immunodiagnostics, regenerative medicine, and nanobiotechnology. Jakub Rybka has supervised three PhD theses (in the fields of chemical sciences, biological sciences, and materials engineering), six master's theses, and six bachelor's theses. Prof. Rybka has been honored with, among others, the Silver Seal of the City of Poznań (2023) and the Minister of Science Award for significant achievements in implementation (2024). He is also a multiple recipient of the Rector's Award at AMU. Additionally, Jakub Rybka is known for his efforts in science popularization.

ORAL TALK
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Development of High-Purity Atelocollagen-Based Biomaterials from Porcine Tendons for Biomedical Applications

Przemysław ALOT[1], Judyta KACZYŃSKA[1], **Kinga RUSINEK**[1]

[1] Implon Laboratories Sp. z o.o., al. Jana Pawła II 27, 00-867 Warsaw, Poland, e-mail: przemyslaw.alot@implon.com

Atelocollagen, Collagen purification, Biomaterials, Collagen-based matrices, Regenerative medicine

Collagen-based biomaterials play a key role in regenerative medicine due to their biocompatibility and structural properties. This study presents the development of a controlled, multi-stage process for the isolation and processing of atelocollagen derived from porcine Achilles tendons for applications in implantology and tissue regeneration.

The process integrates optimized disinfection, mechanical purification, acid-enzymatic digestion, and controlled precipitation, enabling the production of highly purified collagen matrices. Analytical characterization confirmed the predominance of collagen with non-collagenous proteins below 0.1%. The process achieved a reproducible yield of approximately 50% at laboratory scale, with controlled physicochemical parameters, including dynamic viscosity (6–7 Pa•s) and endotoxin levels below 250 EU/g.

The material was processed into defined biomaterial formats, including dense membranes and cylindrical scaffolds, exhibiting high mechanical strength (up to 600 N). Functional evaluation confirmed sterility and cytocompatibility. The study also includes the design of a GMP-compliant pilot-scale purification system, supporting future scalability.

Funding

This work was supported by the Smart Growth Operational Programme (POIR), project no. POIR.01.01.01-00-0717/19-00.

Hafnium dioxide thin films obtained by Atomic Layer Deposition induced the growth of nanocrystalline carbonated hydroxyapatite.

Aleksandra SEWERYN[1], Marcin T. KLEPKA[1], Anna KALETA[1], Bartomiej S. WITKOWSKI[1], Dorota JANASZKO[1], Boguslaw KUROWSKA[1], Wojciech KNAPP[2,3], Dmytro BUT[2,3], Wojciech WOZNIAK[1], Marek GODLEWSKI[1]

[1] Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL-02668 Warsaw, Poland
[2] CENTERA, CEZAMAT, Warsaw University of Technology, ul. Poleczki 19, 02-822 Warsaw, Poland
[3] CENTERA labs, Institute of High Pressure Physics PAS, ul. Sokołowska 29/37, 01-142 Warsaw, Poland

ALD, HfO_2, carbonated hydroxyapatite, nanocrystals

Thin films deposited by Atomic Layer Deposition (ALD) are increasingly investigated as multifunctional implant coatings due to their excellent conformality and controllable physicochemical properties. In this study, nanocrystalline hafnium dioxide (HfO_2) thin films were evaluated as potential initiators of biomimetic bone mineralization (BM). The films were immersed in simulated body fluid (SBF) to induce calcium phosphate formation, and the resulting structures were characterized using scanning electron microscopy (SEM), X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and Raman spectroscopy.

Structural characterization confirmed the formation of uniform monoclinic HfO_2 coatings containing both stoichiometric and oxygen-deficient fractions. The presence of lattice defects enhanced surface chemical reactivity and promoted nucleation processes leading to the formation of carbonate-substituted hydroxyapatite (C-HAp). Raman spectroscopy and transmission electron microscopy (TEM) analyses revealed the nanocrystalline structure of C-HAp with B-type carbonate substitution within the hydroxyapatite (HAp) lattice. The resulting mineral phase exhibited physicochemical characteristics closely resembling natural bone mineral, including nanocrystalline morphology and mixed carbonate substitution.

These results demonstrate that ALD-grown HfO_2 coatings can function as bioactive surfaces capable of initiating bone-like mineral formation while maintaining structural integrity.

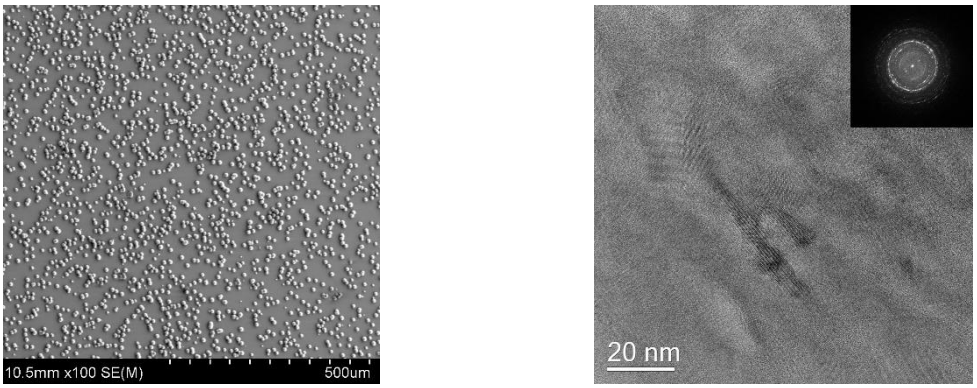

Figure1: C-HAP structures seeded on the HfO_2 surface: SEM image(links), TEM image (right)

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ORAL TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Characteristics of orthopaedic implants damage and mechanisms of its initiation

Grzegorz SZCZĘSNY[1], Adrian ŁUKASZEWICZ[2], Zbigniew L KOWALEWSKI[3], Mateusz KOPEC[3]

[1] Department of Orthopaedic Surgery and Traumatology, Medical University, Warsaw, Poland
[2] Institute of Materials Science, Military University of Technology, Warsaw, Poland
[3] Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland

orthopaedic implants, implant's destruction, intramedullary nail, bone plate, surface analysis

Implant fractures complicate orthopaedic procedures requiring secondary surgeries [1]. However, it is not exactly known when the damage initiation starts and which factors predispose them to the highest degree [2]. Thus, the aim of the study was to characterize changes observed in orthopaedic implants after their removal from the bone [3]. Particular efforts were made to determine, which of them occur during the process of its production, installation, usage and removal. Such identification enabled to specify the role of lesions emerging during each period and their role in the implant's deformation or fracture. The paper was focused on implants dedicated to the stabilization of the femur fractures since the bone transfers the highest loads. External surface and geometric features of eight representative implants were observed under standard and stereoscopic cameras, as well as under light and scanning electron microscopes. Macroscopic analysis of the investigated implants exhibited a number of defects in the form of scratches, abrasions, deformations and chipping. The wear degree of each implant was different and strictly depended on how it was implanted in the patient's body, as well as on how the patient exploited it through his mobility. Four different sources of implant integrity changes were identified: manufacturing-related changes, implant application-related changes, daily life-related changes and implant removal-related changes [4-5].

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ORAL TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

Design and Preparation of a Bioresorbable 3D-printed Mandibular Bone Implant for a Missing Tooth Germ

Dorota MIERZWA[1], **Adam WATRAS[2]**, Małgorzata MUZALEWSKA[3], Marek WYLEŻOŁ[3], Mateusz KUREK[4], Katarzyna WIGLUSZ[5] Ariadna PIELOK[2], Maciej DOBRZYŃSKI[6], Rafał J. WIGLUSZ[2]

[1] Department of Dental Surgery, Faculty of Dentistry, Wroclaw Medical University, Wroclaw, Poland
[2] Division of Biomedical Physicochemistry, Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wroclaw, Poland
[3] Department of Fundamentals of Machinery Design, Faculty of Mechanical Engineering, Silesian University of Technology, Gliwice, Poland
[4] Department of Pharmaceutical Technology and Biopharmaceutics, Faculty of Pharmacy, Jagiellonian University Medical College, Krakow, Poland
[5] Department of Basic Chemical Sciences, Faculty of Pharmacy, Wroclaw Medical University, Wroclaw, Poland
[6] Department of Pediatric Dentistry and Preclinical Dentistry, Faculty of Dentistry, Wroclaw Medical University, Wroclaw, Poland

nanohydroxyapatite, bone implant, 3D-printing

Our previous studies demonstrated the synthesis method as well as the physicochemical and mechanical properties of the nHAp@PLDLLA (nanohydroxyapatite@poly(L-lactide-*co*-D, L-lactide) material [1]. In addition, we also presented the finished implant and its properties 6 months after implantation. The results presented here describe the preparation method and the physicochemical test results of the nHAp@PLLA (nanohydroxyapatite@poly(L-lactide) material, which will be used to 3D-print a mandibular bone implant for a patient with a missing tooth germ.

Nanosized hydroxyapatite was obtained by the precipitation method and subjected to XRD (X-ray Powder Diffraction), SEM (Scanning Electron Microscopy), and EDS mapping (energy dispersive spectroscopy), FT-IR (Fourier-transformed infrared spectroscopy), and Raman spectroscopy analyses. Subsequently, a PLLA filament with a 10 wt.% nHAp admixture was prepared, and test prints were performed, which were also subjected to physicochemical property analyses. Moreover, the virtual model of the implant, an input to the 3D printing process, was created using voxel-based modeling. The presentation will discuss the individual stages of material preparation and the results of the studies.

Figure 1. 3D-printed mandibular bone implant for a missing tooth germ.

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ORAL TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

Synthesis and Optimization of $BiVO_4$ Photocatalysts with FeOOH Polymorphs for Water Purification and Clean Energy Production

Noor ELLAHIE[1], Lily HARUTYANYAN[1], Ekaterina SKOLOTNEVA[3], Magdalena SKOMPSKA, **Justyna WIDERA-KALINOWSKA**[1]

[1] Adelphi University, Department of Chemistry, 1 South Ave., Garden City, NY 11530, USA
[2] University of Warsaw, Faculty of Chemistry, 1 Pasteur Str., 02-093 Warsaw, Poland
[3] University of Genoa, Department of Civil, Chemical and Environmental Engineering (DICCA), Genova, Italy

photocatalysis, bismuth vanadate ($BiVO_4$), FeOOH polymorphs, water purification, hydrogen evolution

Photocatalysis is a promising green chemistry approach for simultaneously purifying water of pharmaceutical and organic pollutants [1,2] while generating clean hydrogen fuel [3]. Bismuth vanadate ($BiVO_4$) is a widely used photocatalyst owing to its narrow bandgap, which lowers the energy threshold for generating reactive electron-hole pairs [4,3]. However, its utility is limited by slow charge-transfer kinetics and rapid electron-hole recombination [4]. This work investigates two complementary strategies for enhancing $BiVO_4$ performance: (1) modification with metallo-organic coordination polymers [5], dopants, and nanoparticles; and (2) the synthesis and integration of iron oxyhydroxide (FeOOH) polymorphs into $BiVO_4$ hybrid systems.
Synthesized $BiVO_4$ was deposited on FTO electrodes in the form of film and characterized using cyclic voltammetry (CV), chopped-light chronoamperometry, and UV-Vis diffuse reflectance spectroscopy (DRS) to determine bandgap and photocurrent density [4]. For the modification strategy, varied synthetic conditions were tested including deposition of Fe-$C_3N_3S_3$ and Co-$C_3N_3S_3$ coordination polymers [5], Mo doping, and combining with Au nanoparticles. Transmission electron microscopy (TEM) revealed that the Fe-containing procedure yielded a mixture of Fe-$C_3N_3S_3$ and FeOOH rather than pure polymer, motivating deeper investigation of FeOOH as a co-catalyst. For the FeOOH polymorph study, all four polymorphs (α, β, γ, and δ) were synthesized via hydrothermal, wet chemical, and SILAR methods, with purity confirmed by Raman spectroscopy and FTIR.

Photocatalytic performance of prepared semiconducting hybrids was evaluated by tracking UV-Vis absorbance of sulfamethoxazole (SMX) [1,2] and other organic pollutants as a function of irradiation time [3]. Pseudo-first-order rate constants were calculated from C/C_0 vs. time plots to compare degradation efficiencies. $BiVO_4$ modified with FeOOH showed enhanced pollutant degradation over bare $BiVO_4$ [4]. Among the polymorph/$BiVO_4$ hybrid systems, $BiVO_4$/δ-FeOOH deposited via SILAR achieved the highest rate constant and degradation efficiency, while the α polymorph showed the least activity. In the dopant and nanoparticle modification study, low Mo-dopant concentrations yielded the greatest photocurrent, attributed to a balance between minimizing crystalline distortion and suppressing charge recombination [4]. These complementary findings establish FeOOH—particularly the δ polymorph—and low-concentration Mo doping as effective strategies for optimizing $BiVO_4$ photocatalysts [4,3]. Future work will focus on refining hybrid architectures, characterizing band positions, and optimizing layer thickness and deposition order to further improve photocatalytic efficiency for both water purification and hydrogen evolution.

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ORAL TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

Multifunctional Nanomaterials at the Biointerface: Polysaccharide-Functionalized UCNPs for Targeted Theranostic Applications

Karolina ZAJDEL[1], Volodymyr LOBAZ[2], Martin ONDRA[3,4], Rafal KONEFAŁ[2,5], Oliver MORAVEC[2], Ognen POP-GEORGIEVSKI[2], Jiří PÁNEK[2], Damian KALITA[1], Bożena SIKORA-DOBROWOLSKA[6], Lukáš LENART[3], Marián HAJDÚCH[3,4], Martin HRUBÝ[2], Marek PRUSZYŃSKI[1,7]

[1] NOMATEN Centre of Excellence, National Centre for Nuclear Research, A. Sołtana 7, 05-400 Świerk/Otwock, Poland, e-mail: Karolina.Zajdel@ncbj.gov.pl.
[2] Institute of Macromolecular Chemistry of the Czech Academy of Sciences, Heyrovského n. 1888/2, 162 06 Prague 6, Czech Republic.
[3] Laboratory of Experimental Medicine, Institute of Molecular and Translational Medicine, Faculty of Medicine and Dentistry, Palacky University and University Hospital, Olomouc, Czech Republic
[4] Institute of Molecular and Translational Medicine, Czech Advanced Technology and Research Institute, Palacky University Olomouc, Czech Republic
[5] NanoBioMedical Centre, Adam Mickiewicz University, Wszechnicy Piastowskiej 3, 61-614 Poznań, Poland
[6] Institute of Physics Polish Academy of Sciences, Aleja Lotników 32/46, 02-668 Warsaw, Poland
[7] Institute of Nuclear Chemistry and Technology, Dorodna 16, 03-195 Warsaw, Poland

upconverting nanoparticles, nano–bio interactions, theranostics, surface functionalization, macrophage targeting

New multifunctional nanomaterials operating at the nano–bio interface represent a rapidly advancing class of nanoplatforms integrating diagnostic and therapeutic functionalities within a single system. Among these, upconversion nanoparticles (UCNPs) are particularly attractive due to their unique optical properties, enabling the conversion of near-infrared (NIR) excitation into higher-energy visible or ultraviolet emission through anti-Stokes processes.

UCNPs exhibit several favourable properties that make them highly attractive for biomedical applications. NIR excitation significantly reduces background autofluorescence in biological samples while enabling deep tissue penetration with minimal photodamage. They also demonstrate exceptional photo- and chemical stability, with strong resistance to photobleaching. Moreover, their high functionalizability, afforded by tailorable surface chemistry, enables precise modulation of bio–nano interactions and facilitates targeted delivery and functional integration in theranostic applications across diverse biomedical fields.

In this work, we present the design and surface engineering of inorganic core β-$NaYF_4$:Yb^{3+},Er^{3+} and core-shell β-$NaYF_4$:Yb^{3+},Er^{3+}@$NaYF^4$ UCNPs. The nanoparticles were functionalized with hydroxybisphosphonate-modified polysaccharides, including mannan and inulin, to enhance colloidal stability and biocompatibility. This surface engineering strategy provided strong anchoring to the UCNPs and enhanced steric and electrostatic stabilization in biologically relevant media, effectively preventing aggregation and preserving upconversion luminescence. Mannan-functionalized UCNPs also enabled selective interaction with mannose receptor-expressing macrophages J774A.1 (Figure 1), promoting efficient cellular uptake as confirmed by confocal microscopy and receptor inhibition assays. *In vitro* studies demonstrated high biocompatibility across a broad concentration range (0.5–10 μg mL^{-1}), with no detectable cytotoxicity or oxidative stress [1].

This study emphasizes the importance of bio-interface engineering in the development of next-generation nanomaterials. Their combination of optical stability, receptor-specific cellular uptake, and minimal cytotoxicity supports further advancement toward *in vivo* biomedical imaging and targeted therapeutic applications.

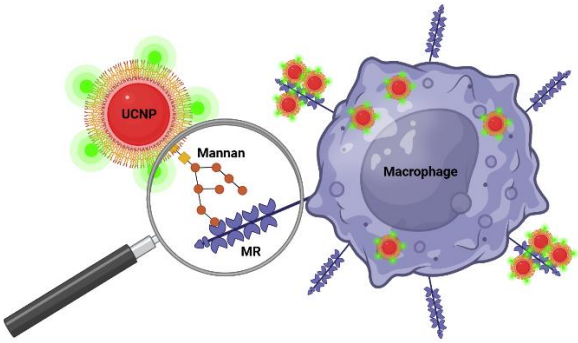

Figure 1. A Mannan-functionalized UCNP surface strategy improves stability and facilitates selective macrophage targeting for bioimaging and theranostic applications.

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SHORT TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Engineering Host–Guest Interactions to Control Encapsulation Pathways in Polymeric Nanocarriers for Hormone-Dependent Breast Cancer

Andrzej BALIŚ[1], Michał ŁUCKI[1], Agata BARZOWSKA-GOGOLA[1], Mateusz TATARUCH[2], Dawid LUPA[3], Barbara PUCELIK[1]

[1] Łukasiewicz Research Network – Krakow Institute of Technology, Zakopiańska 73, 30-418 Krakow, Poland,e-mail: andrzej.balis@kit.lukasiewicz.gov.pl
[2] Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Niezapominajek 8, 30-239, Krakow, Poland, e-mail: mateusz.tataruch@ikifp.edu.pl
[3] Jagiellonian University, Faculty of Physics, Astronomy and Applied Computer Science, Łojasiewicza 11, 30-348 Krakow, Poland, e-mail: dawid.lupa@uj.edu.pl

drug delivery systems, polymer-based nanoparticles, ADC, guest-host complexes

Highly potent topoisomerase-targeting cytotoxic agents, active at nanomolar concentrations, represent promising candidates for advanced breast cancer therapies, i.e. antibody-drug conjugates (ADCs); however, their full potential relies on the development of delivery systems that enhance therapeutic efficacy and selectivity. Within this framework, combining such agents with modulators of hormone signalling offers a compelling strategy with potential synergistic effects.

In this work, the synthesis parameters of polymer-based nanoparticles were optimized for two preparation methods: nanoprecipitation (solid-core particles) and solvent evaporation in a W/O/W system (particles with aqueous cores). The obtained nanocarriers were comprehensively characterized using DLS (particle size and zeta potential), AFM, TGA, and FT-IR spectroscopy. To enable efficient encapsulation of hydrophobic therapeutic agents from aqueous environments, selected solubilization strategies were employed to enhance their compatibility with the carrier matrix. The solubilization kinetics of the drugs were investigated by UV–Vis spectroscopy, and the critical concentration required to maintain stable, non-precipitating complexes was determined.

Furthermore, modifications of the polymer matrix were introduced to improve hydrophilicity and modulate internal structure. Encapsulation efficiency was quantified by HPLC for used drugs in both W/O/W and solid nanosystems, considering three loading strategies: drug pre-complexed with a complexing agent, drug introduced via the organic phase, and drug encapsulated without the use of a complexing agent.

Together with biological data, these findings provide insight into the key factors governing the efficient incorporation of hydrophobic agents into polymer-based nanocarriers, highlighting their versatility for advanced targeted therapies in hormone-dependent breast cancer.

Funding

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SHORT TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

Enhanced Eu^{3+} ions Luminescence through Meloxicam Sensitization in Silicate-Substituted Hydroxyapatite (Si-HAp)-based Nanocarrier

Natalia CHARCZUK[1], Katarzyna WIGLUSZ[2], Edyta PISKORSKA-HOMMEL[1], Rafal J. WIGLUSZ[1]

[1] Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okolna 2, 50-422, Wroclaw, Poland, e-mail: n.charczuk@intibs.pl, e.piskorska@intibs.pl, r.wiglusz@intibs.pl
[2] Department of Basic Chemical Sciences, Faculty of Pharmacy, Wroclaw Medical University, Borowska 211 A, 50-556 Wroclaw, Poland, e-mail: katarzyna.wiglusz@umw.edu.pl

nanosized hydroxyapatite-type materials, enhanced luminescence, drug delivery, theranostic platform

Hydroxyapatite (HAp)-based materials are widely used in bone regeneration due to their structural similarity to natural bone mineral and their bioactivity and biocompatibility. However, in tissue engineering, structural support alone is no longer sufficient. The current challenge is to develop multifunctional systems that combine regenerative and diagnostic capabilities. Owing to its ability to undergo ionic substitution, the HAp lattice provides a versatile platform for introducing functional ions, including luminescent and paramagnetic centres. Furthermore, the HAp surface can be functionalized with therapeutic agents, such as nonsteroidal anti-inflammatory drugs (NSAIDs), enabling controlled local delivery to inflamed bone tissue. These modifications allow HAp-based materials to directly address the needs of modern tissue engineering.

In this work, a co-doped with Eu^{3+} and Gd^{3+} ions, silicate-substituted hydroxyapatite-type material (Si-HAp-EG) was synthesized *via* co-precipitation and employed as a carrier for meloxicam (MLX), a nonsteroidal anti-inflammatory drug. The silicate-substituted HAp-based framework provides a bioactive scaffold, while the incorporation of Eu^{3+} and Gd^{3+} ions imparts diagnostic functionalities. Comprehensive characterization – including XRPD, FT-IR, Raman spectroscopy, TGA, DSC, DRS, luminescence measurements, and *in vitro* release studies – was performed to correlate structural features with functional performance. Phase-pure Si-HAp-EG nanocrystals were successfully obtained, exhibiting effective drug loading. Spectroscopic analyses indicate that interactions between MLX and the Si-HAp-EG matrix extend beyond simple physical adsorption. Importantly, the resulting Si-HAp-EG@MLX carrier displays a distinctive luminescence profile with enhanced Eu^{3+} ion emission, highlighting its potential for luminescence-based monitoring. Furthermore, MLX release is prolonged and well-controlled.

Overall, the developed Si-HAp-EG@MLX system represents a multifunctional platform that combines bone-regenerative properties, controlled anti-inflammatory drug delivery, and luminescent traceability, supporting the concept of BRAT (Bone Regeneration and Theranostics) materials for advanced bone tissue engineering.

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Effect of the Shape of ZrO_2 and Y_2O_3 Nanoparticles on the Redox Status, Transcriptomic and Histopathology of Chicken Embryos

Bartłomiej DOMINIAK[1], Agnieszka WAL[2], Julita ROSOWSKA[1], Alicja MAJEWSKA[1], Jarosław KASZEWSKI[3], Bartłomiej S. WITKOWSKI[3], Marek GODLEWSKI[3], Michał M. GODLEWSKI[1]

[1] Department of Physiological Sciences, Warsaw University of Life Sciences—SGGW, Nowoursynowska 159, 02-776 Warsaw, Poland, e-mail: bartlomiej_dominiak@sggw.edu.pl, julita_rosowska@sggw.edu.pl, alicja_majewska@sggw.edu.pl, michal_godlewski@sggw.edu.pl
[2] Department of Botany and Plant Physiology, Warsaw University of Life Sciences—SGGW, 02-776 Warsaw, Poland, e-mail: agnieszka_wal@sggw.edu.pl
[3] Institute of Physics Polish Academy of Sciences, Al. Lotników 32/46, 02-668 Warsaw, Poland, e-mail: kaszewski@ifpan.edu.pl, bwitkow@ifpan.edu.pl, godlew@ifpan.edu.pl

ZrO_2 nanoparticles; Y_2O_3 nanoparticles; embryotoxicity; oxidative stress; chicken embryo

Zirconium oxide (ZrO_2) nanoparticles (NPs) are a material with high hardness and chemical stability, and are insoluble in water. Thanks to their high mechanical strength, ZrO_2 NPs are used in durable ceramic dental components [1]. Yttrium oxide (Y_2O_3) is of interest due to its physical properties, such as high electrical conductivity, high mechanical strength and high melting point. In addition, this material exhibits good chemical stability. Y_2O_3 NPs are insoluble, however, from a biological application perspective, they exhibit antibacterial activity. There is no data on embryotoxicity of both insoluble NPs (ZrO_2 and Y_2O_3) [2].

The aim of this study was to verify the effect of ZrO_2 and Y_2O_3 NPs on the embryo development. In the present study, the effect of the dose and type NPs was evaluated on a chicken embryo model. The NPs were administered in the form of a suspension to the air chamber of the egg on the first day of incubation in doses of (10 and 100 µg/ml). The possible impact of NPs on the redox status of embryos was determined by superoxide dismutase activity, level of lipid peroxidation and content of carbonylated proteins. To determine whether the tested NPs affect programmed cell death in developing embryos, immunohistochemical staining was performed. Concluding, a histopathological evaluation and analysis of the transcriptomic profile (microarrays) was performed.

For both ZrO_2 and Y_2O_3 NPs, a significant upward trend for all examined oxidative stress markers was observed in the subsequent days of the experiment, suggesting cumulative effects of used nanoparticles. Comparing the results of immunohistochemical staining, significant changes in the content of proteins associated with proapoptotic potential was observed following exposure to both ZrO_2 and Y_2O_3 NPs.

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SHORT TALK

3rd International Conference on Advanced Materials for Bio-Related Applications

Small Structural Changes – Large Luminescent Consequences: Room-Temperature Phosphorescence of Regioisomeric Indoles

Agnieszka M. JABLONSKA, Bong LEE, Jeanne M. FAVRET, Sergei V. DZYUBA, Ignacy GRYCZYNSKI, Zygmunt GRYCZYNSKI

Texas Christian University, 2800 South University Drive, Fort Worth, TX 76129, United States, e-mail: a.m.jablonska@tcu.edu

room-temperature phosphorescence, indole-based derivatives, poly(vinyl alcohol), ultralong phosphorescence

Room-temperature phosphorescence (RTP) of a series of regioisomeric indole amides embedded in poly(vinyl alcohol) (PVA) films was investigated. The spectral characteristics and lifetimes of RTP were found to depend strongly on the position of the substituent on the indole scaffold. In particular, selected regioisomers exhibit ultralong RTP lifetimes, resulting in persistent visible emission (Figure 1)[1]. Computational studies indicated that the RTP depended on the number of the triplet states that were energetically close to the S_1 state. Importantly, these compounds can be directly excited to the triplet state (i.e., conventionally assumed to be a forbidden transition $S_0 \rightarrow T_1$) using visible light, which enables excitation with commercially available laser diodes. Such excitation is effective even for optically dense samples and leads to pronounced RTP anisotropy. The combination of long emission lifetimes and high anisotropy makes these systems suitable for studies of (bio)macromolecular dynamics on micro- to millisecond time scales.

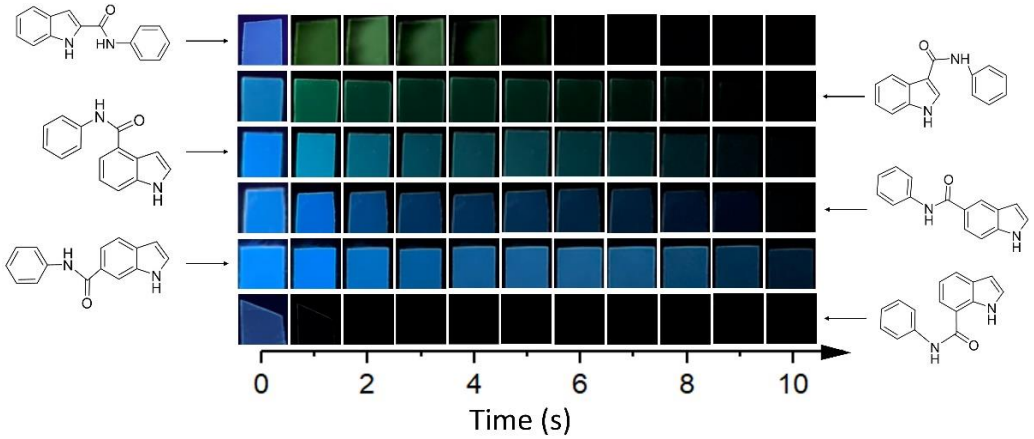

Figure 1. Phosphorescence of indole derivatives embedded in PVA films after UV excitation. The first column (t=0s) shows the photographs recorded with the UV illuminator on, followed by images acquired at approximately 1 s intervals after switching off the excitation.

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SHORT TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Nano Support- Application of Chitosan Nanoparticles and Chitosan Powder for Alleviating Water Stress in *Lepidium sativum*

Zuzanna **KASSNER**

I Liceum Ogólnokształcące im. Marii Skłodowskiej Curie w Pile, ul. Wincentego Pola 11, 64-920, Piła, Polska, e-mail: zuzannakassner.1@gmail.com

drought stress, chitosan nanoparticles, plant biostimulants, *Lepidium sativum*, sustainable agriculture

Drought is a global issue that has a significant negative impact on edible crops grown in affected areas. This study aimed to develop a liquid fertilizer based on chitosan nanoparticles to mitigate the adverse effects of soil water deficiency on the growth and development of *Lepidium sativum* seedlings. Additionally, the study sought to compare its efficacy with a bulk chitosan fertilizer. Plants were irrigated with solutions of chitosan nanoparticles at varying concentrations (0.1 g/L, 0.2 g/L, 0.4 g/L) and a macro chitosan solution (0.2 g/L) and grown in a controlled greenhouse environment for 20 days. The seedlings were subjected to different levels of soil water availability, exposing some to physiological stress.

Seedlings exposed to drought and irrigated with 0.2 g/L and 0.4 g/L chitosan nanoparticle solutions exhibited significantly higher growth, leaf count, seedling survival, aboveground length, dry mass, and wet mass than water-irrigated controls. Strongest improvements were observed in the group treated with 0.4 g/L chitosan nanoparticles. Some positive effects (e.g., improvements in wet and dry mass, aboveground length) were also noted in groups irrigated with the macro chitosan solution (0.2 g/L). Moreover, some differences in developmental parameters (aboveground length, wet and dry mass, growth, and average number of healthy leaves per seedling) were also recorded among non-stressed groups irrigated with different solutions, with a notable difference observed between the 0.4 g/L nanoparticle treatment and water. The results highlight the significant positive impact of chitosan nanoparticles on the developmental parameters of *L. sativum* seedlings and their ability to mitigate physiological stress caused by soil water deficit. Given that chitosan is a recycling- derived, biodegradable material, proposed fertilizer based on its nanoparticles can be an environmentally friendly alternative for synthetic fertilizers (e.g. nitrogen- based) and can find application in protecting crops in the most drought- affected regions of the world.

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SHORT TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Structural, Mechanical, and Absorptive Properties of Furcellaran Aerogels for Advanced Wound Care

Agnieszka KŁAPCIA[1], K. BERENT[1], Krystian SOKOŁOWSKI[1], Anna PAJDAK[2], S.J. BUWALDA[3], D. LACHOWICZ[1]

[1] AGH University of Krakow, Academic Centre for Materials and Nanotechnology, al. A. Mickiewicza 30, 30-059 Krakow, Poland, aklapcia@agh.edu.pl

[2] Strata Mechanics Research Institute, Polish Academy of Sciences, Poland

[3] Mines Paris, PSL University, Center for Materials Forming (CEMEF), France

furcelleran, cyclodextrin, curcumin, aerogel, wound dressing

Furcellaran (FUR) was processed into porous aerogels functionalized with β-cyclodextrin polymer (BCDp) as a structural modifier and curcumin (CUR) carrier, creating a potential wound dressing that absorbs exudate, gels in situ, and enables controlled anti-cancer drug release to support tissue regeneration and limit cancer cell dissemination. FT-IR analysis confirmed the successful incorporation of BCDp and CUR within the polymer matrix. SEM observations revealed significant differences in microstructure, indicating that adding BCDp leads to a more compact network with smaller pores, while CUR induces structural reorganization and increased porosity. Absorption and swelling in PBS were assessed via equilibrium swelling, kinetics, and diffusion models. Modified systems showed higher absorption than pure FUR, with BCDp enhanced initial uptake, while CUR increased overall swelling via higher porosity and slower diffusion-controlled kinetics. Mechanical testing showed that structural modifications balance stiffness and flexibility, with hydration reducing modulus but enhancing elasticity, important for biomedical applications. Overall, the synergistic incorporation of BCDp and CUR enables precise modulation of both sorption and mechanical properties, underscoring the potential of furcellaran-based composite aerogels as versatile biomaterials for wound healing and drug delivery applications.

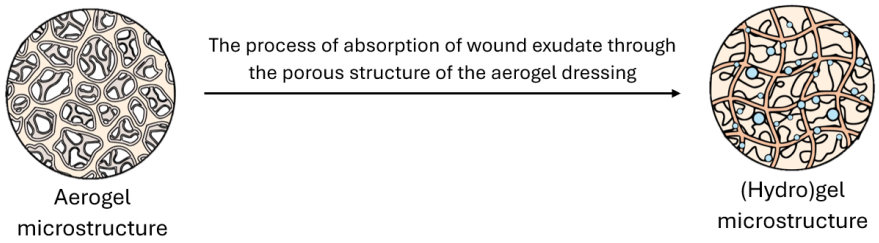

Figure 1. Structural changes in the aerogel dressing during exudate absorption.

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Novel Neuroleptic–Gold Nanoparticle Conjugates - Electrokinetic Properties, Protein Interactions and Neuronal Responses

Oliwia KOWALSKA[1], Anna ALWANI[2], Małgorzata FIEGIEL[3], Anna BARABASZ[4], Piotr CHMIELARZ[2], Magdalena OĆWIEJA[1]

[1] Jerzy Haber Institute of Catalysis and Surface Chemistry, PAS, Niezapominajek 8, 30-239 Cracow, Poland, e-mail: oliwia.kowalska@ikifp.edu.pl, magdalena.ocwieja@ikifp.edu.pl
[2] Department of Brain Biochemistry, Maj Institute of Pharmacology, PAS, Smetna 12, 31-343 Cracow, Poland, e-mail: alwani@if-pan.krakow.pl, chmiel@if-pan.krakow.pl
[3] Department of Physical Biochemistry, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University, Gronostajowa 7, 30-387, Cracow, Poland, e-mail: m.figiel@uj.edu.pl
[4] Department of Biochemistry and Biophysics, University of the National Education Commission, Podchorążych 2, 30-084 Cracow, Poland, e-mail: anna.barbasz@uken.krakow.pl

gold nanoparticles, electrokinetics, neuroleptics, drug-nanoparticle conjugates

The progressive aging of societies is accompanied by a growing prevalence of neurodegenerative diseases, whose pathogenesis is associated with disturbances in protein homeostasis and the formation of toxic aggregates. Phenothiazine neuroleptics (PTZ), such as chlorpromazine (CPZ) and fluphenazine (FPZ), are widely used in the treatment of psychiatric disorders, but their application is limited by adverse side effects and insufficient tissue selectivity. One strategy to modify the biological profile of these compounds is their immobilization on nanocarriers such as gold nanoparticles (AuNPs). In this study, phenothiazine–AuNP (PTZ–AuNP) conjugates were obtained by electrostatically driven immobilization of the drugs onto negatively charged AuNPs with an average diameter of 15 ± 3 nm. Positively charged cysteamine-stabilized AuNPs (CHSB–AuNPs) with an average diameter of 11 ± 3 nm were used as a reference system to disentangle the effect of surface charge from that of surface chemistry. This approach enabled comparison of systems with the same positive charge (CHSB–AuNPs and PTZ–AuNP conjugates) as well as their relation to negatively charged citrate-stabilized AuNPs (TC–AuNPs). Electrokinetic characterization demonstrated that the properties of the conjugates depend on drug loading, pH, and ionic strength, with the isoelectric point located in the pH range of 7.5–8.5. Biological studies performed on the human neuroblastoma (SH-SY5Y) cell line and primary mouse neuronal cultures revealed a pronounced, dose-dependent reduction in cell viability following 24 h exposure to PTZ–AuNP conjugates at drug concentrations ranging from 0.1 to 50 μM and AuNP concentrations of 1–50 mg/L, exceeding the effects observed for free drugs and AuNPs alone. The cytotoxic response was strongly correlated with the surface properties of the systems, including the sign and magnitude of the electrokinetic potential. The results of streaming potential measurements demonstrated that AuNPs and both types of PTZ–AuNP conjugates engage in measurable interactions with a model protein, lysozyme, and the character of these interactions is dependent on environmental pH. Changes in electrokinetic response indicate that control of electrostatic parameters plays a key role in designing nanostructured systems capable of modulating protein–surface interactions relevant to fibrillization processes implicated in neurodegenerative diseases.

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SHORT TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Mesoporous Silica Nanoparticles-Based Formulations for Enhanced Oral Delivery of Peptide Drugs: A Case Study on Insulin

Claudia IRIARTE-MESA[1,2], Estelle JUERE,[1] Andrea BILECK[3,4], Thomas KREMSMAYR[5], Michael L. GOODSON[6,7], Allison EHRLICH[6], Adnan HODZIC[8], Martin KUNERT[8], Christopher GERNER[3,4], Hanspeter KAHLIG[9], Doris MARKO[10], Markus MUTTENTHALER[5,11], David BERRY[8,12], Giorgia DEL FAVERO[10,13], Freddy KLEITZ[1]

[1] Department of Functional Materials and Catalysis, Faculty of Chemistry, University of Vienna, 1090 Vienna, Austria, e-mail: giorgia.del.favero@univie.ac.at; freddy.kleitz@univie.ac.at
[2] Vienna Doctoral School in Chemistry (DoSChem), University of Vienna, 1090 Vienna, Austria
[3] Department of Analytical Chemistry, Faculty of Chemistry, University of Vienna, 1090 Vienna, Austria
[4] Joint Metabolome Facility, University and Medical University of Vienna, 1090 Vienna, Austria
[5] Institute of Biological Chemistry, Faculty of Chemistry, University of Vienna, 1090 Vienna, Austria
[6] Department of Environmental Toxicology, College of Agriculture and Environmental Science, University of California, 95616 Davis, CA, USA
[7] Department of Anatomy, Physiology and Cell Biology, School of Veterinary Medicine, University of California, 95616 Davis, CA, USA
[8] Center for Microbiology and Environmental Systems Science, Department of Microbiology and Ecosystem Science, Division of Microbial Ecology, University of Vienna, 1030 Vienna, Austria
[9] Department of Organic Chemistry, Faculty of Chemistry, University of Vienna, 1090 Vienna, Austria
[10] Department of Food Chemistry and Toxicology, Faculty of Chemistry, University of Vienna, 1090 Vienna, Austria
[11] Institute for Molecular Bioscience, The University of Queensland, 4072 Brisbane, Queensland, Australia
[12] Joint Microbiome Facility of the Medical University of Vienna and the University of Vienna, 1090 Vienna, Austria
[13] Core Facility Multimodal Imaging, Faculty of Chemistry, University of Vienna, 1090 Vienna, Austria

mesoporous silica nanoparticles, oral peptide drug delivery, gastrointestinal degradation, insulin-responsive signaling, insulin transport

Despite decades of intensive research, oral insulin delivery has yet to be realized in clinical practice due to the challenge of overcoming gastrointestinal barriers. The use of dendritic mesoporous silica nanoparticles (DMSNs) in combination with a protein-based excipient, succinylated β-lactoglobulin (sBL), has enabled the preparation of pH-responsive tablets that prevent premature gastric release and degradation of encapsulated insulin [1]. Nevertheless, important challenges persist—such as controlling insulin release rates, enhancing intestinal permeability, and improving mucoadhesion—that must be addressed to enable reliable translation of these systems to therapeutic applications [2]. To this aim, the influence of the surface chemistry of DMSNs on loading efficiency and insulin release performance was examined [3]. For this purpose, DMSNs (130 nm; pore size: 7.0 nm) were functionalized with polyethylene glycol (PEG, 2 kDa) and a phosphonate-silane, trihydroxysilylpropyl methylphosphonate (THMP) through post-grafting strategies [4,5]. The functionalized DMSNs (PEG-MSN and PO_3-MSN) exhibited enhanced colloidal stability in aqueous and saline media (PBS) over a wide pH range, improving the solubility of loaded insulin upon peptide confinement within the silica mesopores. Tablet formulations were prepared by mixing sBL with pure and functionalized DMSNs containing insulin (20% w/w), and release tests were performed in simulated body fluids. Compared with DMSN-free formulations, encapsulated insulin showed markedly enhanced protection against proteolysis, with premature release under gastric conditions reduced to <10% and sustained controlled release over 24 h at pH 7.4. In particular, PO_3-MSN enabled the transient reorganization of tight junction proteins, thereby promoting the paracellular transport of insulin-loaded DMSNs and overcoming a major biological barrier to oral absorption. Insulin delivered through these formulations retained bioactivity, as demonstrated by activation of insulin-responsive signaling pathways in vitro and reduction of blood glucose levels

in hyperglycemic mice [3]. These findings highlight DMSNs as promising carriers for oral peptide delivery, supporting the development of effective, patient-friendly therapies with enhanced efficacy and compliance.

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Magnetic Core-Shell Nanoparticles for Anticancer Therapy

Paulina PIETRZYK-THEL[1], Magdalena OSIAL[1], Magdalena OĆWIEJA[2], Krystian MOKRZYŃSKI[3], Michael GIERSIG[1]

[1] Institute of Fundamental Technological Research, Polish Academy of Sciences, Pawińskiego 5B 02-106 Warsaw, e-mail: ppietrz@ippt.pan.pl
[2] Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Niezapominajek 8, 30-239, Cracow, Poland
[3] Jagiellonian University, Faculty of Biochemistry, Biophysics, and Biotechnology, Gronostajowa 7, 30-387 Cracow, Poland

SPIONs, functional nanocomposite, drug delivery, magnetic hyperthermia

Cutaneous melanoma is a cancer that originates from melanocytes, the pigment-producing cells, and although it is classified as a malignant tumour, early detection significantly increases the chances of effective treatment. In Poland, melanoma accounts for approximately 2% of all diagnosed malignant cancers, and the number of cases is steadily increasing by an average of about 3% per year [1]. Hence, it creates a growing demand for increasingly advanced therapies, one of which is the use of nanotechnology to develop platforms for simultaneous imaging, for example, using nuclear magnetic resonance imaging, and treatment through local drug release and temperature elevation directly within tumour tissues.
Here, we demonstrate a stable suspension containing superparamagnetic iron oxide nanoparticles (SPIONs) coated with thin layer of hydroxyapatite and functionalized with polydopamine mimicking natural melanin, and sugar. The platform was prepared by the co-precipitation method, and the coating by organic components was around 7% by mass. Those core-shell nanoparticles were studied in terms of the colloidal stability - Zeta potential, hydrodynamic diameter, as well as biological activity for 3 different cell lines – melanoma A375, HeCaT, and strongly pigmented MNT-1. Moreover, the platform was evaluated for its heat-generation capability under different organ-mimicking conditions for magnetic hyperthermia applications. At a suspension concentration of around 10 mg/mL and an applied alternating magnetic field of 35 G, the specific absorption rate (SAR) values, normalized to the magnetic core mass, were in the range from ~67 to 82 W/g in the media mimicking natural tissues. Obtained results are similar to those present in the literature [2].

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SHORT TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

From Waste to Value: Bioactive Peptides Isolated from Spent Coffee Grounds

Gabriela RZEPKOWSKA, Gabriela KOWALSKA, Joanna ORACZ

Lodz University of Technology, Faculty of Biotechnology and Food Sciences, Institute of Food Technology and Analysis, ul. Stefanowskiego 2/22, 90-537 Lodz, Poland; e-mail: 257950@edu.p.lodz.pl

SCG, plant-based protein, bioactive peptides, alkaline extraction, UAE

Spent coffee grounds (SCG) are an abundant byproduct of the global beverage industry, increasingly drawing attention within the circular economy framework. Rich in valuable components such as lignin, hemicellulose, lipids, and proteins, SCG offer a significant opportunity for reintegration into the food sector. Specifically, they can serve as a sustainable, plant-based protein source or be utilized to extract bioactive peptides for functional food. This study aimed to characterize the protein and peptide fractions extracted from SCG, evaluating their chemical composition, molecular structure, and resulting biological potential.

To obtain these fractions, proteins were first isolated from defatted SCG using alkaline extraction and isoelectric precipitation. This process was supported by ultrasound- and enzyme-assisted treatments designed to disrupt the dense lignocellulosic matrix and enhance protein release. The resulting protein isolates were subsequently subjected to enzymatic hydrolysis using pepsin, followed by membrane ultrafiltration to isolate the targeted peptide fractions.

High-Performance Liquid Chromatography (HPLC) and Size-Exclusion Chromatography (SEC) were used for analyzing structural and chemical profiles of peptides, comparing their initial native states with the profiles obtained post-hydrolysis. The evaluation revealed distinct chemical dynamics while caffeine content remained a remarkably stable chemical baseline averaging roughly 1990 mg/100g in 96% of the samples, the chlorogenic acid profiles exhibited profound variance. Specifically, while 62.5% of all samples-maintained trace acid levels below 250 mg/100g, ultrasound-assisted hydrolyzed samples triggered a notable shift, elevating acid concentrations beyond 1000 mg/100g. Furthermore, SEC analysis demonstrated that this chemical liberation was accompanied by significant structural depolymerization. While native protein isolates were initially dominated by high-molecular-weight fractions (>10 kDa, 65–75%), enzymatic hydrolysis efficiently broke these down, increasing the proportion of low-molecular-weight peptides (<10 kDa) to 60–80%. Specifically, fragments below 5 kDa accounted for up to 30–40% of the total peptide fraction in the hydrolyzed samples.

FT-IR analysis confirmed that ultrasound- and enzyme-assisted hydrolysis preserved the peptide backbone, evidenced by intact amide I and II bands. Furthermore, EPR measurements using the TEMPO radical showed the process significantly enhanced overall antioxidant capacity (increasing from 0.5–0.9 to 17–21 mmol TE/100 g) and accelerated initial radical scavenging rates by 1.5- to 2.5-fold (rising from 30–45% min^{-1} to 47–80% min^{-1}).

Ultimately, this research underscores the immense potential of upcycling spent coffee grounds into functional, highly bioavailable ingredients for the nutraceutical and food industries.

SHORT TALK
3rd International Conference on Advanced Materials for Bio-Related Applications

Effect of the Shape of Biodegradable ZnO Nanoparticles on the Redox Status, Genomics and Histopathology of Chicken Embryos

Agnieszka WAL[1], Bartłomiej DOMINIAK[2], Julita ROSOWSKA[2], Alicja MAJEWSKA[2], Mikołaj A. GRALAK[2], Jarosław KASZEWSKI[3], Bartłomiej S. WITKOWSKI[3], Marek GODLEWSKI[3], Michał M. GODLEWSKI[2]

[1] Department of Botany and Plant Physiology, Warsaw University of Life Sciences-SGGW, 02-776 Warsaw, Poland, e-mail: agnieszka_wal@sggw.edu.pl
[2] Department of Physiological Sciences, Warsaw University of Life Sciences-SGGW, Nowoursynowska 159 Str., 02-776 Warsaw, Poland, e-mail: bartlomiej_dominiak@sggw.edu.pl, J.R.julita_rosowska@sggw.edu.pl, alicja_majewska@sggw.edu.pl, mikolaj_gralak@sggw.edu.pl, michal_godlewski@sggw.edu.pl

[3] Institute of Physics, Polish Academy of Sciences, Al. Lotników 32/46, 02-668 Warsaw, Poland, e-mail: J.K. kaszewski@ifpan.edu.pl, B.S.W. bwitkow@ifpan.edu.pl, M.G. godlew@ifpan.edu.pl

ZnO nanoparticles; shape of the nanoparticles; embryotoxicity; oxidative stress; chicken embryo

Over the last years, an immense increase in the popularity of nanomaterials was observed, with number of products containing them skyrocketing. So far, nanoparticles (NPs) have found applications as food additives, in food packaging and in the cosmetics industry. Some of the most popular NPs that are used in everyday products are ZnO NPs [1]. These NPs are characterised by hydrophilicity and solubility in biological media, which makes them considered safe. Previous studies have shown that these NPs can cross biological barriers such as the blood-brain barrier and, importantly, the placental barrier, which may have an impact on embryo development [2].

The aim of this study was to verify the effect of ZnO NPs on the embryo development. In the present study, the effect of the dose and shape of ZnO NPs (oval vs. long) was evaluated on a chicken embryo model. The NPs were administered in the form of a suspension to the air chamber of the egg on the first day of incubation in doses of (10 and 100 µg/ml). The possible impact of NPs on the redox status of embryos was determined by superoxide dismutase activity, level of lipid peroxidation and content of carbonylated proteins. Furthermore, a transcriptomic analysis was performed using microarrays. To determine whether the tested NPs affect programmed cell death in developing embryos, immunohistochemical staining was performed for Bax, Bcl-2, and active form of caspase-3 (CPP32). Concluding, a histopathological analysis was done.

Both NPs forms induced changes in the oxidoreductive potential, however long ZnO NPs had a lesser and more delayed impact on evaluated parameters. Both NPs form affected expression of a significant number of identified genes during early embryo development (1487 for oval and 548 for long). Surprisingly, oval ZnO NPs reduced the proapoptotic potential in chicken embryos. In contrast, long ZnO NPs did not cause changes in the occurrence and localisation of Bax, Bcl-2 nor CPP32. Results of histopathological analysis showed no impact of studied NPs on the development of embryonic tissues, regardless of their shape and dose.

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Optical Properties of War-Derived Carbon-Containing Smoke Nanoparticles with Heavy Metals

Vitalii BOIKO[1,2], Olena GNATYUK[2*], Oleksii BEZKROVNYI[1], Galyna DOVBESHKO[1,2] Tatiana BORISOVA[3]

[1] Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okólna 2, Wrocław, 50-422, Poland, v.boiko@intibs.pl
[2] Institute of Physics, National Academy of Sciences of Ukraine, 46 Nauky Ave, Kyiv, 03680, Ukraine;
[3] Palladin Institute of Biochemistry, National Academy of Sciences of Ukraine, 9 Leontovycha str, Kyiv, 01054, Ukraine

iron, airborne particulate matter, carbon-based nanoparticles, photoluminescence

War-related combustion processes generate airborne particulate matter containing carbon nanostructures and toxic heavy metals, posing risks to environmental and biological systems. Understanding the optical and luminescent properties of such particles is essential for their identification, monitoring, and potential use as intrinsic optical probes. In this work, carbon-containing nanoparticles derived from the combustion of organic biomass (poplar wood) and synthetic polymeric materials (protective mask) were investigated, with particular attention to their interactions with Fe^{2+} and Fe^{3+} ions.

UV–Vis absorption spectra revealed characteristic bands at approximately 230 and 270 nm, attributed to π–π* transitions in aromatic carbon structures and n–π* transitions associated with oxygen-containing surface groups [2]. The addition of iron salts altered the absorption intensity, including an increase in the visible region near 500 nm and changes in the relative intensities of UV bands, confirming interactions between iron ions and the surface functional groups of carbon nanoparticles. Photoluminescence measurements showed a stable emission band excited at 270 nm, indicating luminescence originating from carbon cores with functionalized surfaces, consistent with carbon dot–like nanostructures. Broader emissions in the blue spectral region were attributed to intermediate combustion products and agglomerates. These results demonstrate that combustion-derived carbon nanoparticles exhibit intrinsic luminescent properties and sensitivity to heavy-metal ions, highlighting their relevance as environmental indicators and model nanomaterials for optical sensing in biological and ecological systems affected by war-delivered pollution.

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Can We Use the DNA Molecule as a Platform for Energy Sources Batteries?

Galyna DOVBESHKO[1], Olena GNATYUK1, Wieslaw STREK[2], Olena VOITSIHOVSKA[1], Przemyslaw WIEWIORSKI[2]

[1] Institute of Physics National Academy of Sciences of Ukraine, Prospect Nauky, 46, Kyiv 03028, Ukraine, e-mail: matinelli@gmail.com
[2] Institute of low temperature and structure research, Polish Academy of Sciences, Okólna, 2, Wrocław 50-422, Poland

DNA with metal ions, single-walled carbon nanotubes, partially opened multi-walled carbon nanotubes

It is known that the main problem is looking for new sources for energy. Here we want to discuss is DNA molecules could be used for solving that problem.

Given the great need for new highly efficient power sources, the task of searching new materials and complexes that could be used as electrolytes or as electrodes remains relevant. The main problem of existing accumulators and batteries is their high cost and toxicity of materials. Therefore, the use of DNA complexes with nanotubes and metal ions has the prospect of application in environmentally friendly accumulators and batteries. One of the main advantages of innovative DNA-based materials is their low cost, biocompatibility, biodegradability and environmental friendliness. Another significant advantage is the ability to store in dry form, which takes up less volume and has a significantly lower mass, and if necessary, restore it simply by adding the appropriate amount of liquid.

In this work we present a study of the molecular mechanisms of the formation complexes different molecular weights DNA with metal ions (Na, Li, K), with single-walled and partially opened multi-walled carbon nanotubes, and also determines the mechanisms of electric charge transfer in such complexes.

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POSTER
3rd International Conference on Advanced Materials for Bio-Related Applications

Liquid Crystalline Ordering of Graphene Oxide Fibers with Enhanced Mechanical Properties

S. GYOZALYAN[1], M. ZHEZHU[1], G. BAGHDASARYAN[1], H. GHARAGULYAN[1, 2]

[1] Liquid Crystalline Nanosystems Research Group, A.B. Nalbandyan Institute of Chemical Physics NAS RA, Yerevan 0014, Armenia, gyozalyansaralcn@gmail.com
[2] Institute of Physics, Yerevan State University, Yerevan 0025, Armenia

graphene oxide fiber, liquid crystalline graphene oxide, sodium alginate, mechanical properties

Graphene oxide (GO) fibers have attracted considerable attention as promising candidates for lightweight, high-strength materials owing to their tunable structure and favorable mechanical properties [1, 2]. However, the performance of GO fibers is strongly influenced by the degree of ordering of GO flakes during the assembly process. In this study, we show that GO fibers spun from liquid crystalline (LC) GO dispersions exhibit improved mechanical properties compared with fibers produced from non-LC GO dispersions (Fig. 1). The enhanced tensile strength is mainly attributed to the larger GO flake size and the highly ordered alignment achieved within the LC phase. The fibers derived from the LC dispersion exhibited a Young's modulus of 12.3 GPa, a tensile strength of 146.8 MPa, and an elongation at break of 2.5%. These results highlight the key role of flake size and LC ordering in improving the mechanical performance of GO-based fibers and provide a simple route toward the scalable fabrication of strong yet flexible carbon-based materials.

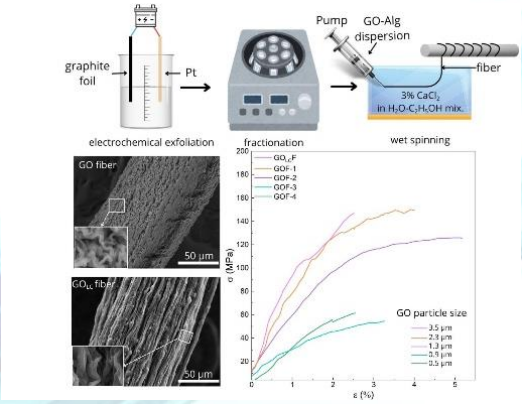

Figure 1. Schematic illustration of the GO fiber fabrication process, SEM images of GO and GOLC fibers, and their mechanical properties as a function of flake size.

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POSTER
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Modification of the Surface of Titanium Alloy Samples Produced Using DMLS Technology for Orthopedic Applications

Gabriela WIELGUS[1], Wojciech KAJZER[2], Julia LISOŃ-KUBICA[1], Tomasz BOROWSKI[3], Bogusława ADAMCZYK-CIEŚLAK[3], Aleksandra ŻURAWSKA[1*], **Anita KAJZER[1]**

[1] Department of Biomaterials and Medical Devices Engineering, Faculty of Biomedical Engineering, Silesian University of Technology, Roosevelta 40 Street, 41-800 Zabrze, Poland, email: gabriela.wielgus@polsl.pl, julia.lison-kubica@polsl.pl, az306892@student.polsl.pl, anita.kajzer@polsl.pl
[2] Department of Biomechanics, Faculty of Biomedical Engineering, Silesian University of Technology, Roosevelta 40 Street, 41-800 Zabrze, Poland, email: wojciech.kajzer@polsl.pl
[3] Warsaw University of Technology, Faculty of Materials Science and Engineering, Warsaw, email: tomasz.borowski@pw.edu.pl, boguslawa.cieslak@pw.edu.pl

additive technologies, personalized orthopedic implants, nitrogen layers

The aim of the study was to evaluate the properties of Ti64 ELI alloy samples produced using DMLS (Direct Metal Laser Sintering) technology and subjected to surface layer modification. To improve the material's performance, a glow discharge nitriding process was applied, resulting in the formation of a diffusion layer of titanium nitride (TiN). This process was preceded by heat treatment of the samples at various temperatures, which enabled an analysis of the influence of the material's microstructural state on the physicochemical and mechanical properties of the layer.

The obtained test results allowed for a comprehensive assessment of the influence of heat treatment and the nitriding process on the characteristics of the surface layer, indicating their key role in shaping the material's functional properties. The presence of a diffusive nitrogen layer leads to a significant increase in hardness and improved resistance to abrasive wear in all analyzed material variants.

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Functional Nanoparticles for Energy Applications

Emilia KARPIEL[1], Aleeza KHURRAM[1], Magdalena OSIAL[2], Njemuwa NWAJI[2], Paulina PIETRZYK-THEL[2], Justyna WIDERA-KALINOWSKA[1]

[1] Adelphi University, Department of Chemistry, 1 South Ave, Garden City, NY, 11530, USA
[2] Institute of Fundamental Technological Research, Polish Academy of Sciences, 5B Pawinskiego, Warsaw, 02-106, Poland

energy storage, MOFs, oxygen evolution reactions, nanomaterials

The global crisis of skyrocketing fossil fuel prices is being caused by the depletion of fossil fuels while there is a rise in demand for them. Unlike renewable energy, fossil fuels are limited in their resources and cannot be reused. By using renewable energy, the global crisis of climate change and limited resources can be reduced. The use of nanoparticles as a catalyst can be a leading solution for this crucial issue. Metal Organic Frameworks (MOFs) are nanoparticles consisting of a lattice structure of metal ions connected by organic linkers. These particles are very porous in structure and have a tunable surface area that allows for modifications to enhance its properties. The MOFs were synthesized on nickel foam to create an electrode used for further investigation. Zinc based MOFs were synthesized by mixing cetyltrimethylammonium bromide (CTAB) in a solution of zinc acetate ($Zn(OAc)_2 \times 2H_2O$) and 2-methylimidazole (2-MiM) in deionized water. In a similar process cobalt(III) nitrate ($Co(NO_2)_3 \times 6H_2O$) was used instead of zinc acetate and CTAB to create Co based MOFs. Once these metal MOFs form they can be manipulated using ammonium thiomolybdate to create a more porous and larger MOF structure. To explore the electrocatalytic properties of MOFs, nickel foam is used as the working electrode in a three electrode system along with Pt wire as the counter electrode and Ag|AgCl|KCl as the reference electrode in 1 M KOH. The MOFs were characterized by linear sweep voltammetry (LSV) and it was found that the sulfurized MOFs show lower redox potential compared to the unsulfurized one. This was further confirmed by the smaller Tafel slope observed for a sulfurized catalyst as well. A lower redox potential for a catalyst suggests a quicker and better performance of the catalyst. A lower potential achieved for the sulfurized MOFs could be due to their larger electrochemical surface area, which was observed and determined by the scanning electron microscopy (SEM). These sulfurized MOFs can be applied to Oxygen Evolution Reactions (OER) and possibly create viable results for renewable energy applications.

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Functional Polyvinyl Chloride for Environmental Application

Aleeza KHURRAM[1], Emilia KARPIEL[1], Magdalena OSIAL[2], Dr Njemuwa NWAJI[2], Paulina PIETRZYK-THEL[2], Sławomir WILCZEWSKI[3], Justyna WIDERA-KALINOWSKA[1]

[1] Adelphi University, Department of Chemistry, 1 South Ave, Garden City, NY, 11530, USA
[2] Institute of Fundamental Technological Research, Polish Academy of Sciences, 5B Pawinskiego Str., Warsaw, 02-106, Poland
[3] Faculty of Chemical Technology and Engineering, Bydgoszcz University of Technology, 3 Seminaryjna Street, 85-326 Bydgoszcz, Poland

nanomaterials, Polyvinyl Chloride membraines, circular economy, electrospun materials, adsorption study

Polyvinyl Chloride (PVC) membranes functionalized with nanofillers serve to be a versatile approach for wastewater treatment with enhanced adsorption of organic dyes. In this project, soft (PVC-P) and rigid (PVC-R) membranes were synthesized via electrospinning with varying percentages (0.1-1%) of fillers graphene oxide (GO), graphene (GN), nano-hydroxyapatite (HAp), and nano-bentonite (nB). Determination of point zero charge (pHpzc revealed isoelectric points within the pH 5-7 range, which helped to focus adsorption experiments to be at acidic and basic conditions. Adsorption studies were conducted with UV-Vis spectroscopy and had demonstrated that filler type did influence dye removal process. Modified membranes with GO and GN fillers had been shown to have the highest removal efficiencies for cationic dyes such as crystal violet and methyl violet, exceeding 95% removal within 24 hours at pH 8. This can be attributed to electrostatic interactions and increased surface reactivity between the dye and the catalytic material. In comparison, HAp and nB showed more moderate performance with dye-specific affinities. Kinetic modeling had revealed that the dye adsorption process followed pseudo-first and pseudo-second order models depending on filler type, with faster kinetics observed at basic pH. Fourier-transform infrared spectroscopy (FT-IR) confirmed dye-membrane interactions through shifts in characteristic functional group vibrations, while thermogravimetric analysis (TGA) revealed slight reductions in thermal stability after the dye experimentation. Overall, PVC-P membranes with GO and GN fillers demonstrated the best adsorption behavior, highlighting their potential as low-cost, efficient materials for the targeted removal of organic pollutants from wastewater.

Effect of pH and Storage Media on Short-Term Fluoride Release from a Metal-Modified Glass Ionomer Cement (Riva Silver): An *in vitro* Study

Sylwia KLIMAS[1], Rafal J. WIGLUSZ[2], Anna NIKODEM[3], Maciej DOBRZYŃSKI[1]

[1] Department of Pediatric Dentistry and Preclinical Dentistry, Wroclaw Medical University, Krakowska 26, 50-425 Wroclaw, Poland, e-mail: sylwia.klimas@student.umw.edu.pl, maciej.dobrzynski@umw.edu.pl
[2] Polish Academy of Sciences, Institute of Low Temperature and Structure Research, Okolna 2, 50-422 Wroclaw, Poland, e-mail: r.wiglusz@intibs.pl
[3] Department of Mechanics, Materials and Biomedical Engineering, Wroclaw University of Science and Technology, Ignacego Lukasiewicza 7/9, 50-371 Wroclaw, Poland, e-mail: anna.nikodem@pwr.edu.pl

fluoride release, glass ionomer cement, silver-reinforced cement, metal-modified glass ionomer

The aim of this study was to evaluate short-term (7-day) fluoride ion release from a metal-modified glass ionomer cement, Riva Silver. Riva Silver is a silver-reinforced glass ionomer cement combining fluoride-releasing properties with improved mechanical strength and antibacterial potential [1]. Fluoride ion release (µg/mm²) was measured in artificial saliva at different pH levels (4.5, 5.5, 6.0, 7.0, and 7.5) and additionally in other media, including tap water, distilled water, demineralized water, and 0.9% saline solution. Five samples were prepared for each solution using a custom Teflon mold. Fluoride ion concentration was determined using an ORION 9609 ion-selective electrode at specific time intervals (1, 3, 24, 48, 72, 96, and 168 hours). The cumulative values, as well as fluoride ion release at individual time points, were compared. The highest fluoride ion release from the metal-modified glass ionomer cement, Riva Silver, was observed in distilled water after 24 hours (8.12 µg/mm²). In most media, the peak fluoride release occurred at 24 hours; however, in demineralized water and 0.9% saline solution, the highest values were recorded after 168 hours. Furthermore, among the artificial saliva solutions representing the oral environment, the highest fluoride release was observed at pH 4.5 (4.84 µg/mm²). Across all tested media, the greatest cumulative fluoride release was obtained in 0.9% saline solution (35.62 µg/mm²). These findings suggest that the fluoride release profile of the examined material may support enamel remineralization and help prevent tooth decay, particularly under acidic conditions in the oral cavity.

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Homocysteine and Homocysteine Thiolactone Contribute to Alzheimer's Disease *via* TAU Modifications in N2A-APPswe Cells

Aleksandra KOTECKA[1,2], Sara GNIADEK[1,2], Oliwia KŁÓDCZYŃSKA[1,2], Kinga MATYSIAK[1,2], Miłosz PACIOREK[2], Maja WOJASIEWICZ[2], Gabriela ZEIDLER[2], Łukasz WITUCKI, Joanna PERŁA-KAJÁN[1]

[1] Department of Biochemistry and Biotechnology, Poznań University of Life Sciences, Poznań, Poland, e-mail: joanna.kajan@up.poznan.pl
[2] Operon Scientific Club, Poznań University of Life Sciences, Poznań, Poland

homocysteine metabolites, Alzheimer's disease, TAU

Elevated levels of homocysteine (Hcy) and/or homocysteine thiolactone (HTL), are linked to neurodegenerative diseases, including Alzheimer's disease (AD). Hyperphosphorylation or elevated acetylation of TAU protein are hallmarks of AD. However, the mechanistic roles of Hcy and HTL in the development and progression of AD are not fully understood. We tested a hypothesis that Hcy and HTL promote TAU accumulation *via* hyperphosphorylation and acetylation of TAU in mouse neuroblastoma N2A-APPswe cells. Neuroblastoma N2A-APPswe cells (N2A-APPswe) harboring a human transgene with mutation in the amyloid precursor protein (APP) gene were grown on the complete DMEM/F12 medium. Cells were treated with 20-200 μM Hcy or HTL. Phosphorylation and acetylation of TAU, as well as selected enzymes involved in TAU modification, were quantified by Immunofluorescence and Western blotting. Immunofluorescent analysis showed that Hcy and HTL upregulate phosphorylated TAU at threonine 205 and serine 396, and acetylated TAU at lysine 174, relative to untreated cells. However levels of total TAU were not affected in cells after Hcy and HTL treatment compared to control cells. At the same time Western blots showed upregulation of CDK5, GSK3β, and GSK3α after Hcy and HTL treatments compared to untreated cells. Treatment with Hcy or HTL affects TAU modifications which in turn promote TAU aggregation in mouse neuroblastoma N2A-APPswe cells. The hyperphosphorylated TAU at Ser396 and at Thr205 results from elevated levels of TAU kinases CDK5, GSK3β, and GSK3α, which are upregulated by Hcy and HTL treatments.

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Efficient Copper-Based Photocathodes Utilizing MOF-Derived Metal Oxide co-Catalysts for PEC H_2 Production

Ashley KRETH[1], Linh TRINH[2], Renata SOLARSKA[2], Krzysztof BIENKOWSKI[2], Justyna WIDERA-KALINOWSKA[1]

[1] Adelphi University, Department of Chemistry, 1 South Ave, Garden City, NY, 11530, USA
[2] University of Warsaw, Center for New Technologies (CeNT), 2c Banacha Str., 02-097 Warsaw, Poland

hydrogen production, MOFs, nanomaterials, copper oxide, energy conversion

Copper oxide (CuO) has been shown to be used as a desirable photocathode due to its earth abundance, low cost, and strong absorption in the visible region. However, its efficiency is limited by photooxidation, short carrier diffusion lengths, and high electron-hole recombination rates. To address these challenges, the integration of metal oxide co-catalysts derived from iron hydroxide, Prussian Blue, nickel hydroxide, and nickel Hofmann-type metal-organic frameworks (MOFs) were explored with photoelectrochemical (PEC) water splitting. These materials were utilized as heterojunction layers on CuO films to improve charge separation, enhance interfacial charge transport, and increase long-term stability.

Utilizing the doctor-blade technique, films were fabricated on fluoride tin oxide (FTO) glass substrates, followed by thermal evaporation and thermal annealing. The various deposition orders were characterized by several techniques, using UV-Vis spectroscopy, Tauc analysis, linear sweep voltammetry (LSV), chronoamperometry (I-t), and electrochemical impedance spectroscopy (EIS). The modified photocathodes indicated enhanced light absorption and photocurrent density compared to bare CuO films. Specifically, Fe_2O_3 (4/2/1) and NiOMOF (4/1/1) deposition orders achieved the highest photocurrent responses and earlier onset potentials. Chronoamperometry showed significant improvements in their stability, with Fe_2O_3 retaining 28.8% and NiOMOF retaining 32.1% of photocurrent after 3500 seconds under illumination, compared to rapid decay observed in unmodified CuO films. EIS data revealed reduced charge transfer resistance and more efficient interfacial charge transport in heterojunction systems.

These results highlight the potential of MOF-derived and iron-based metal oxides as effective co-catalysts for CuO photocathodes. By enhancing photocurrent density, stability, and charge transfer, these systems improve PEC performance for solar-driven hydrogen (H_2) production.

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Study on the Antimicrobial Efficacy and Cytotoxic Potential of Compomer Materials Incorporated with Silver Nanoparticles and Copper Oxide

Adam LUBOJAŃSKI[1], Katarzyna SZYSZKA[2], Bartosz MIELAN[3], Magdalena PAJĄCZKOWSKA[5], Joanna NOWICKA[5], Magdalena ZIĄBKA[6], Adam WATRAS[2], Rafal J. WIGLUSZ [2,], Maciej DOBRZYŃSKI[1]

[1] Department of Pediatric Dentistry and Preclinical Dentistry, Wroclaw Medical University, Krakowska 26, 50-425 Wroclaw, Poland
[2] Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okolna 2, 50-422 Wroclaw, Poland
[3] Pre-Clinical Research Centre, Wroclaw Medical University, Marcinkowskiego 1, 50-368 Wroclaw, Poland
[5] Department of Microbiology, Faculty of Medicine, Wroclaw Medical University, Tytusa Chałubińskiego 4, 50-368 Wroclaw, Poland
[6] Department of Ceramics and Refractories, Faculty of Materials Science and Ceramics, AGH University of Krakow, Mickiewicza 30, 30-059 Krakow, Poland

compomers, silver, copper oxide, metal-modified compomers, antimicrobial

Dental caries is a widespread issue, especially in children. Compomer materials offer a combination of aesthetic appearance and mechanical strength, as well as antibacterial properties due to their fluoride content. Incorporating silver (Ag^0) and copper oxide (CuO) particles may further improve their antimicrobial performance, potentially lowering the risk of complications such as recurrent caries and pulp inflammation [1]. This study aimed to evaluate the antibacterial activity and cytotoxicity of compomer materials enriched with 0.125 wt.%, 0.25 wt.%, and 0.5 wt.% of Ag^0 and CuO particles. The analysis was carried out under both static and dynamic conditions using a CDC bioreactor. Reference microbial strains were preserved at −80°C in TSB medium with 15% glycerol and cultured before testing under appropriate growth conditions. Strains including *S. mutans*, *C. albicans*, *L. rhamnosus*, and *S. epidermidis* were grown on suitable media under aerobic, anaerobic, or elevated CO_2 conditions. Standardized microbial suspensions (0.5 McFarland) were prepared and incubated with the tested biomaterials. After incubation, biofilms were removed using saponin, serially diluted, and cultured on selective media to determine colony-forming units (CFU/mL and CFU/cm²). Each experiment was performed in six replicates, using both static and flow biofilm models. Cytotoxicity was assessed according to ISO 10993 guidelines using L929 fibroblasts and BALB/3T3 cell lines, which were exposed to extracts or discs containing Ag^0 and CuO for 24 hours. Both Ag^0 and CuO showed a statistically significant, dose-dependent antimicrobial effect against *S. mutans* and *S. epidermidis*. The highest cytotoxicity was observed for Ag^0 at concentrations of 0.25 wt.% and 0.5 wt.% in both tested cell lines. The incorporation of CuO and Ag^0 particles enhances the antibacterial properties of compomer materials, particularly against *S. mutans* and *S. epidermidis*.

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Cellular Response and Mineral Formation Induced by a Calcium Phosphate Composite Setting Paste

Agnieszka JELONEK, **Marcin MARTYNIAK**

Biovico Sp. z o. o., Hutnicza 15 B, 81-061 Gdynia, Poland, e-mail: marcin.martyniak@biovico.com

calcium phosphate bone cement, composite setting paste, mineralization, osteogenic gene expression

The biological performance of calcium phosphate bone cements (CPCs) was improved by incorporating components influencing mineral phase formation and cellular response. An innovative Composite Setting Paste (CSP) containing octacalcium phosphate (OCP), lecithin-modified hydroxyapatite (L-HAp) [1], and a methacrylate derivative of 4-aminosalicylic acid (PHMA) was developed. The presence of OCP and L-HAp may promote bone regeneration and accelerate new bone formation [2, 3], while PHMA may interact with Ca^{2+} ions and facilitate apatite nucleation [4, 5]. The proposed composition was evaluated with respect to its influence on osteogenic gene expression and mineralization.

The phase composition of the material after incubation in PBS was analyzed using powder X-ray diffraction (XRD). The influence of 10% cement extracts on osteogenic gene expression was evaluated in MG-63 cells after 10 days of exposure using quantitative PCR. The expression of osteonectin, osteocalcin, osterix, RUNX2, BMP4 and BMP7 genes was analyzed and normalized to reference genes. Mineralization potential was assessed in Saos-2 cells using Alizarin Red S staining to detect calcium deposits and evaluate the progression of the mineralization process.

XRD analysis confirmed progressive phase transformation toward hydroxyapatite under physiological conditions (37 °C, PBS). Observed dissolution–reprecipitation-driven maturation pathway resembled a biomineralisation-like process, in which transient precursor phases transform into bone-like apatite In MG-63 cells cultured with CSP extracts, the expression of osteogenic markers was maintained at levels comparable to the control, indicating no inhibitory effect on osteogenic activity. A trend toward higher expression of osteonectin, RUNX2 and BMP4 was observed for the PHMA-containing cement in comparison to CSP without PHMA. Mineralization assays demonstrated enhanced calcium deposition in cultures exposed to CSP extracts compared with the control conditions and reference CPC. The increased intensity of mineralization may indicate an enhanced osteogenic potential of the CSPs, which under in vivo conditions could translate into accelerated material remodeling and faster, more efficient replacement by newly formed bone tissue.

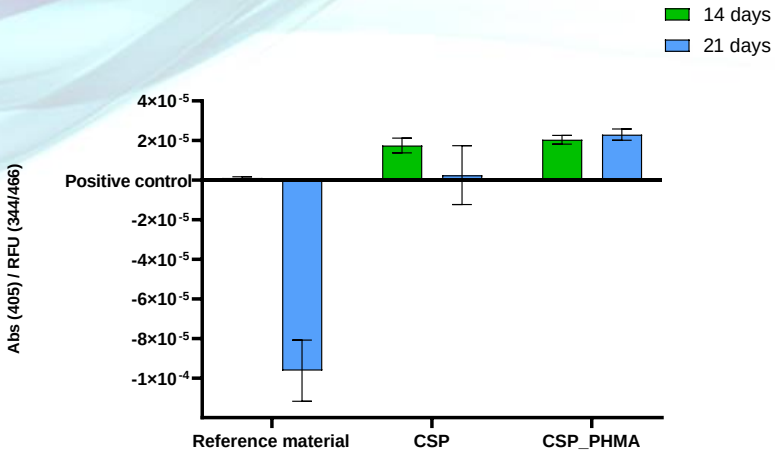

Figure 1. Effect of 10% CP cement extracts on the mineralization of Saos-2 cells after 14 and 21 days of incubation. Results presented as absorbance normalized to DNA quantity.

The obtained results indicate that the proposed Composite Setting Paste supports osteogenic cellular activity and promotes mineral deposition in vitro. The presence of PHMA was associated with a tendency toward increased expression of selected osteogenic markers compared with the composition without PHMA. These findings suggest that the developed CSP may enhance the biological performance of calcium phosphate bone cements and potentially support faster bone regeneration.
The described solution is part of patent application PL P.448989.

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Deficiency of Bleomycin Hydrolase Affects Amyloid-β Precursor Protein Processing and Induces ER stress, UPR and Apoptosis in Mouse Neuroblastoma N2a-APPswe Cells

Łukasz MENCEL, Mayuri BHOSALE, Łukasz Witucki, Joanna Perła-Kaján

Department of Biochemistry and Biotechnology, Poznań University of Life Sciences, Wojska Polskiego 28, 60-637, Poznań, Poland, e-mail: lukasz.mencel@up.poznan.pl, mayuri.bhosale@up.poznan.pl, lukasz.witucki@up.poznan.pl, joanna.kajan@up.poznan.pl

homocysteine thiolactone, bleomycin hydrolase, APP, ER stress, UPR, apoptosis, Alzheimer's disease

Elevated plasma total homocysteine (tHcy) and related toxic metabolites such as Hcy thiolactone (HTL) and *N*-homocysteinylated (*N*-Hcy)-protein are associated with Alzheimer's disease (AD). Deficiency of bleomycin hydrolase (BLMH), an enzyme with HTLase activity, is an emerging risk factor of AD. AD is characterized by the accumulation of amyloid-β (Aβ) plaques, endoplasmic reticulum (ER) stress, unfolded protein response (UPR), and apoptosis. It has been hypothesised that BLMH *via* detoxifying HTL could prevent the accumulation of toxic protein aggregates and protect against AD development. Elucidate mechanisms by which *Blmh* deficiency accelerates development of AD in mouse neuroblastoma N2a-APPSwe cells focusing on: (1) amyloid precursor protein (APP) processing pathways; (2) ER stress, unfolded protein response (UPR), and apoptosis.

Mouse neuroblastoma N2a-APPswe cells harbouring a human APP transgene with the K670N and M671L Swedish mutations were grown on the complete DMEM/F12 medium. The expression of *Blmh* gene was silenced using a *Blmh*-specific siRNA. Scrambled siRNA was used as a negative control. siRNAs prepared in mix with Lipofectamine and Opti-MEM medium, were added to cells for 48 h incubation. Proteins involved in APP metabolism pathway, ER stress, UPR and apoptosis were quantified by Western blotting and the corresponding mRNAs by RT-qPCR. We also studied the impact of *Blmh* gene silencing on Aβ fibril formation in N2a-APPswe cells by confocal immunofluorescence microscopy.

Silencing of *Blmh* gene resulted in upregulation of APP, Nicastrin, PEN2 and downregulation of BACE1 protein. Silencing significantly upregulated the expression of *APP* and *Psenen* mRNAs. The *Blmh* gene silencing in N2a-APPswe cells resulted in upregulation of ER chaperone GRP78, UPR-responsive ATF3, and CHOP. In addition, pro-apoptotic protein BAX and CASPASE-3 were upregulated, while the anti-apoptotic protein BCL-2 was downregulated. Quantification of the *GRP78*, *ATF3*, *CHOP*, *BAX* and *BCL-2* mRNA levels by RT-qPCR indicated similar changes to those observed at the protein levels, which suggests transcriptional regulation of gene expression. Immunofluorescense analysis showed significantly increased average size and signal intensity of Aβ fibrils in *Blmh*-silenced cells compared to siRNAscr.

Our findings suggest that *Blmh* deficiency may promote the development of AD by dysregulating APP processing, contributing to ER stress, UPR activation, promoting CHOP-driven mitochondrial apoptosis and increased Aβ fibril formation in N2a-APPswe cells.

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From Fabrication Errors to Tissue Engineering Scaffolds: Leveraging MEW Hierarchical Coiled Architectures

Maryla MOCZULSKA-HELJAK, Dorota KOŁBUK-KONIECZNY, Paweł SAJKIEWICZ

Institute of Fundamental Technological Research, Polish Academy of Sciences, Adolfa Pawińskiego 5B, 02-106 Warszawa, Poland, e-mail: m.heljak@ippt.pan.pl

MEW, tissue Engineering, coiled fibers; hierarchical architectures

Addressing the treatment of critical tissue defects remains a significant challenge in medicine and bioengineering. Tissue engineering (TE) scaffolds, which feature porous architectures conducive to cell growth, offer a promising solution. Recent advancements in additive manufacturing techniques have revolutionized scaffold fabrication, enabling precise control over complex porous structures and anisotropic architectures. One such technique is *melt electro writing* (MEW), which allows for the printing of highly resolved porous structures of controllable architecture.

The phenomenon of *melt electro-written entangled fibers* was examined for the first time in 2011 [1]. Initially, this type of structure was considered a printing error. It was found that characteristic coils are formed due to the buckling of melt jet deposits (Figure 1).

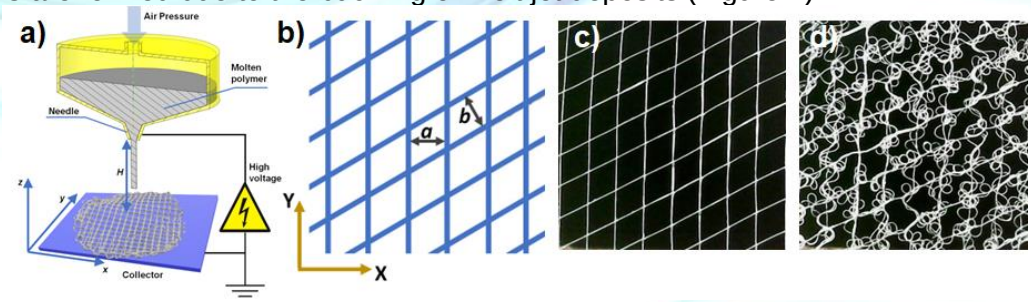

Figure 1. Scaffold fabrication using MEW technique: a) schematic view; H – tip-collector distance; b) selected inter-fiber distances of the primary pattern; c) primary architecture; d) coiled architecture based on the primary pattern [2]

Later, it was demonstrated that MEW structures composed of coiled fibers could serve as hierarchical TE scaffolds. The concept of applying hierarchical porosity in TE is justified by the idea that small pores and surface features can facilitate cell attachment, while larger pores allow for the ingrowth of regenerated tissue.

The ultimate goal of the study was to explore the possibility of fabricating multi-level hierarchically ordered TE scaffolds with entangled fibers through a synergistic combination of MEW and porogen leaching, using polyethylene glycol PEG as a porogen. The research aimed to elucidate the relationships between fabrication parameters and the morphological, mechanical, and functional properties of these scaffolds.

Finally, it was revealed that 3D PCL fibrous scaffold with a coiled morphology, created through a synergistic combination of MEW and porogen leaching using PEG as a porogen, could be an efficient method to produce hierarchical architectures characterized by multi-level hierarchical porosity.

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SPION@Polydopamine Nanocarriers Modified with Plant Extract for Magnetic Hyperthermia

Ngan Giang HA, Magdalena OSIAL, Michael GIERSIG

Institute of Fundamental Technological Research, Polish Academy of Sciences, Pawińskiego 5B, 02-106 Warsaw, e-mail: gha@ippt.pan.pl, mosial@ippt.pan.pl, mgiersig@ippt.pan.pl

magnetic hyperthermia, polydopamine, SPIONs, core-shell nanostructure, plant extract

Superparamagnetic iron oxide nanoparticles (SPIONs) are highly promising agents for magnetic hyperthermia. However, to enhance their functionality SPIONs are widely combined with other materials to deliver multifunctional materials working not only as heat generator but also cargo for biologically active compounds. Here, we demonstrate a multifunctional nanoplatform combining localized thermal therapy with natural phytotherapy, based on core-shell SPION@Polydopamine (PDA) nanoparticles functionalized with a bioactive plant extract from *Calendula officinalis L.*.
The synthesis is designed through a two-step green approach. First, a uniform PDA coating is formed on stabilized SPIONs via the oxidative self-polymerization to form core-shell structure. This robust organic shell is engineered to provide colloidal stability and act not only as a photoactive heat generator but also as the cargo for bioactive compounds. Subsequently, phytochemicals from the natural extract are immobilized onto the PDA matrix through physical adsorption.
Initial physicochemical characterization confirm the successful integration of the particular components of the core-shell structure. Fourier-transform infrared (FT-IR) spectroscopy reveals distinct vibrational shifts indicative of PDA and phytochemical interactions alongside the core Fe-O lattice bonds. The hybrid nanostructures demonstrate favorable colloidal dispersion in aqueous media without artificial surfactants. Furthermore, preliminary evaluations under an alternating magnetic field (AMF) suggest that the PDA coating preserves the inherent magnetic properties of the core, which is anticipated to enable rapid temperature elevation to the therapeutic hyperthermia window in the range of 42 °C – 45 °C. Current studies are underway to systematically quantify the extract loading efficiency and specific absorption rate (SAR) values. This proposed methodology offers a highly biocompatible and versatile platform for advancing synergistic targeted therapies.

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POSTER
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Advancing Rare Earth Recovery: Adsorption of La^{3+} Ions Using Hydroxyapatite

Phuong Thu NGUYEN [1], Hai Thi DO[2], Thu Phuong LE[1], Nam Hong NGUYEN[1], Thanh Thi DINH MAI[1]

[1] University of Science and Technology of Hanoi, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet, Nghia Do, Hanoi;
[2] University of Mining and Geology, 18 Pho Vien, Duc Thang, Dong Ngac, Hanoi

hydroxyapatite, adsorption, rare earth element, apatite ore

Rare earth elements (REEs) have unique properties that make them essential in many modern technologies, from electronics to medical devices. Because of their growing use, finding efficient ways to recover REEs is increasingly important—not only for resource sustainability but also for protecting human health, as improper disposal can lead to environmental contamination and potential health risks.

In this study, we explored how well hydroxyapatite (a material obtained by modifying apatite ore) can adsorb La^{3+} ions, a type of rare earth element. The best conditions for adsorption were found to be an adsorbent dose of 0.1 g per 10 mL (10 g/L), an initial pH of 5.2, room temperature, and a contact time of 30 minutes. The adsorption behavior fits the Freundlich isotherm model, while the maximum adsorption capacity calculated using the Langmuir model is 7.2 mg/g. The process follows a pseudo-second-order kinetic model and is both spontaneous and endothermic. Importantly, the hydroxyapatite maintains its structure even after adsorption.

Overall, these results show that modified hydroxyapatite is an effective and environmentally friendly material for capturing La^{3+} ions. This is especially relevant for students and researchers interested in sustainable technologies, as it highlights a practical approach to reducing environmental pollution and minimizing potential health impacts associated with rare earth element waste.

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POSTER
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A Magnetic-Field-Assisted FFF 3D Printing from Ferromagnetic TPU-Based Composites

Emil PAJĄK

Faculty of Physics, University of Warsaw, Pasteura 5, 02-093 Warsaw, Poland, e-mail: el.pajak@student.uw.edu.pl

3D printing; TPU; ferromagnetic infill; magnetic-field-assisted extrusion

The main goal of this study was to 3D print flexible objects with designed magnetisation. Such structures are capable of shifting geometry when an external magnetic field is applied and returning to their initial shape after the field is removed, showcasing possible applications in soft robotics, as they do not require electrical energy to function properly but instead rely on appropriate changes of the magnetic field. Due to the commercial unavailability of 3D printing filaments that are both elastic and ferromagnetic, a method for manufacturing TPU-based composite filaments that remain flexible even after the mass fraction of the ferromagnetic infill exceeds 70 wt% was developed within this study. To enable this, a uniform distribution and good wetting of the ferromagnetic microparticles had to be achieved, which was later confirmed by scanning electron microscopy. Multiple composite materials were studied, mainly formed by suspending varying mass fractions of hard and soft ferromagnetic infill microparticles in a polymer matrix. To optimise the morphology of used microparticles, ultrasonic atomisation was performed, followed by the microstructure analysis. Subsequently, the magnetic properties of created composites were determined by vibrating-sample magnetometry and the influence of mass fraction of the hard ferromagnetic material on the remanent magnetisation was measured. Furthermore, the nozzle of a 3D printer was modified to enable magnetic-field-assisted filament extrusion. To validate the developed materials, proof-of-concept structures were 3D-printed that behaved as anticipated under the influence of a magnetic field, which demonstrates their possible applications in soft robotics.

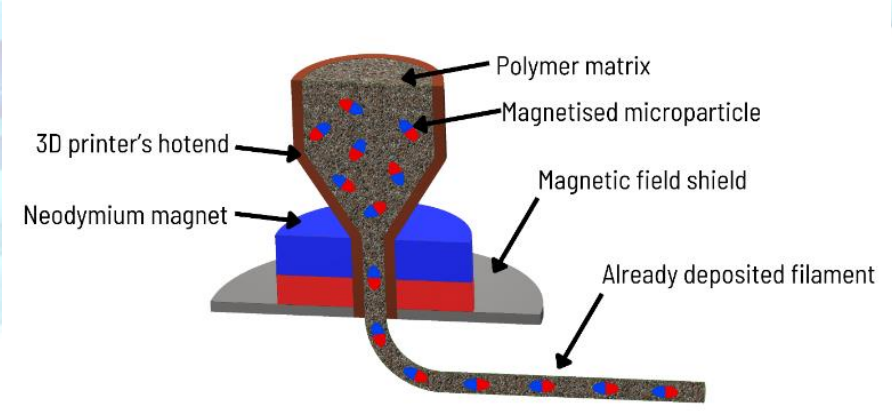

Figure 1. Illustration of the proposed magnetic-field-assisted FFF 3D printing method enabling the reorientation of magnetised infill microparticles after the polymer matrix is heated and plasticised.

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POSTER
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Neuroprotective Effects of a Cyclic Peptide in a Cellular Model of Parkinson's Disease

Sylwia GRABOWICZ[1], Marcin FIDURA[2], **Renata PERLIKOWSKA**[2]

[1] Department of Pharmaceutical Microbiology and Microbiological Diagnostic, Medical University of Lodz, Lodz, Poland, e-mail: sylwia.grabowicz@umed.lodz.pl
[2] Department of Nucleic Acid Biochemistry , Medical University of Lodz , Lodz, Poland, e-mail: marcin.fidura@student.umed.lodz.pl, renata.perlikowska@umed.lodz.pl

neuroprotection, neuronal survival, 6-hydroxydopamine, neurodegeneration

Peptides have emerged as promising neuroprotective agents due to their ability to modulate key molecular pathways involved in neuronal survival and function [1]. The cyclic peptide Tyr-c(D-Lys-Phe-Phe-Asp)NH_2, previously characterized by high affinity for μ-opioid receptors and potent antinociceptive activity following both intracerebroventricular and peripheral administration [2], prompted us to investigate its potential neuroprotective properties. The peptide was evaluated in an in vitro Parkinson's disease (PD) model using differentiated SH-SY5Y neuroblastoma cells exposed to 6-hydroxydopamine (6-OHDA). The study focused on the peptide's ability to attenuate neuronal damage and improve cell viability.

The peptide exhibited no cytotoxicity toward differentiated SH-SY5Y cells. Additionally, human umbilical vein endothelial cells (HUVECs) were used as a model of healthy human tissue, and no cytotoxic effects were observed in this cell line, confirming a favorable safety profile. Importantly, a neuroprotective effect was observed in differentiated SH-SY5Y cells subjected to 6-OHDA-induced injury. The peptide significantly reduced cytotoxicity and apoptosis, decreased intracellular reactive oxygen species (ROS) levels, and improved mitochondrial function.

These findings indicate that Tyr-c(D-Lys-Phe-Phe-Asp)NH_2 exerts a cell-type-specific neuroprotective effect in a cellular model of PD, supporting further investigation of opioid-based peptides as potential therapeutic candidates for neurodegenerative disorders.

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Design of Sodium Alginate Hydrogels Loaded with Amorphous and Low-Crystalline Nanosized Calcium Phosphates Using 3D Printing

Magdalena B. ŁABOWSKA[1], **Nataliia D. PINCHUK[2,3]**, Paulina SOBIERAJSKA[2], Ariadna PIELOK[2,4], Katarzyna WIGLUSZ[5], Oleksii BEZKROVNYI[2], Rafal J. WIGLUSZ[2]

[1] Department of Mechanics, Materials and Biomedical Engineering, Faculty of Mechanical Engineering, Wroclaw University of Science and Technology, Smoluchowskiego 25, 50-372 Wroclaw, Poland
[2] Institute of Low Temperature and Structure Research Polish Academy of Sciences, Okólna 2, 50-422, Wrocław, Poland, e-mail: n.pinchuk@intibs.pl, r.wiglusz@intibs.pl
[3] Frantsevich Institute for Problems of Materials Science of the NAS of Ukraine, Pritsaka, 3, Kyiv, 03142, Ukraine, e-mail: npinchuk@ukr.net
[4] Laboratory of Preclinical Research and Cell Transplantation “In VetBio”, Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, Wroclaw University of Environmental and Life Sciences, Chełmońskiego 38, 51-630, Wroclaw, Poland
[5] Department of Basic Chemical Sciences, Faculty of Pharmacy, Wroclaw Medical University, Borowska 211 A, 50-566 Wroclaw, Poland

hydroxyapatite, calcium phosphates, sodium alginate, hydrogel, 3D printing

Hydrogels based on natural polymers exhibit significant potential in biomedical applications due to their excellent biocompatibility. These applications include regenerative medicine, e.g., bone defect filling and wound healing, and drug delivery systems. Sodium alginate is a widely available natural biopolymer that serves as a versatile matrix for hydrogel composites incorporating bioactive additives. Among these additives, calcium phosphates (CaPs) are of particular interest owing to their biocompatibility and bioactivity. Hydroxyapatite is one of the most extensively studied CaPs, and its properties can be tailored by controlling its degree of crystallinity.

The aim of this study was to synthesize amorphous and low-crystalline CaP nanosized powders and utilize them to fabricate sodium alginate hydrogel composites via an extrusion-based additive manufacturing technique. Additionally, preliminary *in vitro* screening was conducted to investigate the cytotoxicity of the prepared CaPs and their effect on the morphology of MG-63 cells. The resulting composite structures were stabilized through subsequent external cross-linking using calcium ions. The prepared materials were characterised using a range of physicochemical methods, with particular emphasis on the mechanical properties and *in vitro* bioactivity of the as-fabricated hydrogels.

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Development of High-Purity Atelocollagen-Based Biomaterials from Porcine Tendons for Biomedical Applications

Przemysław ALOT[1], Judyta KACZYŃSKA[1], **Kinga RUSINEK**[1]

[1] Implon Laboratories Sp. z o.o., al. Jana Pawła II 27, 00-867 Warsaw, Poland, e-mail: przemyslaw.alot@implon.com

atelocollagen, collagen purification, biomaterials, collagen-based matrices, regenerative medicine

Collagen-based biomaterials play a key role in regenerative medicine due to their biocompatibility and structural properties. This study presents the development of a controlled, multi-stage process for the isolation and processing of atelocollagen derived from porcine Achilles tendons for applications in implantology and tissue regeneration.

The process integrates optimized disinfection, mechanical purification, acid-enzymatic digestion, and controlled precipitation, enabling the production of highly purified collagen matrices. Analytical characterization confirmed the predominance of collagen with non-collagenous proteins below 0.1%. The process achieved a reproducible yield of approximately 50% at laboratory scale, with controlled physicochemical parameters, including dynamic viscosity (6–7 Pa•s) and endotoxin levels below 250 EU/g.

The material was processed into defined biomaterial formats, including dense membranes and cylindrical scaffolds, exhibiting high mechanical strength (up to 600 N). Functional evaluation confirmed sterility and cytocompatibility. The study also includes the design of a GMP-compliant pilot-scale purification system, supporting future scalability.

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Influence of Amorphicity on the Structure, Morphology, Thermal Stability and *In Vitro* Biological Response of Calcium Phosphates

Paulina SOBIERAJSKA[1,*], Nataliia D. PINCHUK[1,2], Ariadna PIELOK[1,3], Katarzyna WIGLUSZ[4], Vasyl KINZHYBALO[1], Oleksii BEZKROVNYI [1] and Rafal J. WIGLUSZ[1]

[1] Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okólna 2, 50-422, Wrocław, Poland, p.sobierajska@intibs.pl
[2] Frantsevich Institute for Problems of Materials Science of the NAS of Ukraine, Pritsaka, 3, Kyiv, 03142, Ukraine
[3] Laboratory of Preclinical Research and Cell Transplantation "In VetBio",
Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, Wroclaw University of Environmental and Life Sciences, Chełmońskiego 38, 51-630, Wroclaw, Poland
[4] Department of Basic Chemical Sciences, Faculty of Pharmacy, Wroclaw Medical University, Borowska 211 A, 50-566 Wroclaw, Poland

amorphous, calcium phosphates, tricalcium phosphate, thermal behaviour, MG-63 cells

Calcium phosphates occur in both amorphous and crystalline forms. Amorphous calcium phosphates (ACPs) can convert into more stable crystalline phases, such as hydroxyapatite ($(Ca_{10}(PO_4)_6(OH)_2$) or tricalcium phosphate (α or β-$Ca_3(PO_4)_2$) during bone formation and remodelling [1].

In this study, ACP nanosized powder was synthesized by rapid precipitation and then dried by liquid nitrogen with freeze-drying (ACP-L) or oven-dried at 60°C (CP-D). Structural and morphological changes for these materials were studied by XRPD and HRTEM after thermal treatment over a wide temperature range (100–900°C) or in situ. Thermal behaviour was analysed using TGA and DSC techniques.

ACP-L and CP-D exhibited pronounced differences in degree of crystallinity, morphology an thermal behaviour. In vitro screening studies revealed distinct cytotoxicity profiles of the studied materials and cell-material interactions, as well as the morphology of MG-63 cells, and PCR analysis provided preliminary information on changes in gene expression.

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Abductin: Production Optimization of a Promising Biomaterial

Alicja SZYCHULSKA[1], Jakub D. Rybka[2], Piotr Cywoniuk[2]

[1]Scientific Association of Biotechnology Students “Operon”, Poznań University of Life Sciences, Wojska Polskiego 28, 60-637 Poznań, Poland, e-mail: 79663@student.up.poznan.pl
[2]NanoBioMedical Centre Adam Mickiewicz University, Wszechnicy Piastowskiej 3, 61-614 Poznań, Poland

abductin, biomaterials, elastomers, recombinant proteins

Protein based biomaterials are receiving recognition due to their biocompatibility and advantages over conventional materials, such as tuning their properties for the desired applications. Abductin is an elastomer found in hinge ligaments of bivalves and functions as a coil-spring that enables shell opening. What differentiates Abductin from other known elastomers such as Resilin and Elastin is its higher tensile and compressive moduli, which may provide superior mechanical performance and broaden its potential range of application.[1]
Despite its promising properties Abductin production remains poorly characterized, with only one reported low-yield production. This study focuses on optimizing culture conditions to enhance recombinant abductin-based protein production in *Escherichia coli*.

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Optimization of Atmospheric Low-Temperature Plasma Parameters for Tailoring the Physicochemical Properties of Ti6Al4V Alloy in Modern Orthopedic Implantology

Julia KOLASA, **Anna TARATUTA**, Julia LISOŃ-KUBICA, Marcin BASIAGA

Department of Biomaterials and Medical Device Engineering, Faculty of Biomedical Engineering, Silesian University of Technology, Roosevelta 40, 41-800 Zabrze, Poland, e-mail: anna.taratuta@polsl.pl, julia.kolasa@polsl.pl, julia.lison-kubica@polsl.pl, marcin.basiaga@polsl.pl

Ti6Al4V, piezoelectric direct discharge, osseointegration, surface modification, orthopaedic implants

This study focuses on the optimization of atmospheric low-temperature plasma (ALTP) parameters generated via Piezoelectric Direct Discharge (PDD) technology to modify the surface of the Ti6Al4V alloy. Despite its superior mechanical properties, this alloy exhibits biological inertness, which can significantly delay the osseointegration process. In this research, a Piezobrush® device was employed to treat titanium samples, evaluating the effects of varying treatment duration and power levels. The results demonstrate that PDD technology effectively eliminates organic contaminants and introduces polar functional groups to the surface. This leads to a rapid increase in surface free energy (SFE) and a transition to a super-hydrophilic state. Such enhanced hydrophilicity promotes protein adsorption and the adhesion of osteoblastic cells [1]. The utilization of a compact PDD source represents a highly efficient and cost-effective method for "point-of-use" implant activation. The findings suggest that precise tuning of PDD plasma parameters enables a significant acceleration of the biological integration of Ti6Al4V implants. This approach offers promising new avenues for personalized orthopedic surgery and regenerative medicine by providing
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Optimization of Electrospun Progesterone-Loaded Fibres for Local Endometriosis Therapy

Olga URBANEK[1], Łukasz LUŚTYK[1, 2], Paulina PIETRZYK-THEL[1]

[1] Institute of Fundamental Technological Research, Polish Academy of Sciences, Pawińskiego 5b, 02-106 Warsaw, Poland, e-mail: ourbanek@ippt.pan.pl
[2] Faculty of Materials Science and Engineering, Warsaw University of Technology, Wołoska 137, 02-507 Warsaw, Poland

fibres, electrospinning, drug delivery, endometriosis, fibres post-processing

Endometriosis is a chronic pathological condition characterized by persistent inflammation and defined by the ectopic growth of tissue that is morphologically and functionally similar to the endometrium.[1] Although endometriosis affects a substantial proportion of women of reproductive age and poses a significant burden on physical, psychological, and social well-being, treatment options remain limited to symptomatic management rather than causal intervention.[1] Hormonal agents, including progestin-based therapies and combined estrogen–progestin regimens commonly utilized for contraceptive purposes, are routinely prescribed. However, these agents are administered systemically, predominantly orally, which necessitates higher doses and is frequently associated with systemic adverse reactions[1]. Despite growing interest in novel therapeutic approaches, research focused on localized drug delivery systems for endometriosis remains scarce and is largely confined to preclinical investigations[2].

The research aims to develop, optimize, and characterize a material system based on electrospun fibers that will serve as a carrier for selected active substances to limit the development of endometrial foci. The presented results concern the optimization of the composition and method of preparation and processing of fibers intended to serve as the drug carrier. For this purpose, poly(lacide-co-glicolide) (PLGA) with two different monomer ratios (50/50 and 75/25) was used separately to form fibres containing a selected amount of progesterone (P4) – 1%, 2,5%, and 5 % w/w. The fibres' morphology was imaged by scanning electron microscopy (SEM). The encapsulation efficiency % (EE%), drug loading (DL), and drug release of the progesterone encapsulated in fibers were analysed. Additionally, differential scanning calorimetry (DSC) and infrared spectroscopy (FTIR) were used to determine the fibres' supramolecular structure. The *in vitro* studies led to verification of system biocompatibility. The obtained results will allow us to select materials for further research.

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Preparation and *in vitro* Characterization of Encapsulated Miconazole Patches

Katarzyna WIGLUSZ[1], Rafal J. WIGLUSZ[2]

[1] Wroclaw Medical University, Faculty of Pharmacy, Department of Basic Chemical Sciences, Borowska 211A, 50566 Wroclaw, Poland, e-mail: katarzyna.wiglusz@umw.edu.pl
[2] Polish Academy of Sciences, Institute of Low Temperature and Structure Research, Okolna 2, 55422 Wroclaw, Poland, e-mail: r.wiglusz@intibs.pl

encapsulated miconazole, stability study, *in vitro* release test, inhibition of CYP51

The invasive fungal infections, with more than 6.5 million cases reported annually by the WHO [1], pose a serious threat to public health. Miconazole nitrate (1-(2,4-Dichloro-β-[(2,4-dichlorobenzyl)oxy]phenethyl)imidazole) is one of the azole antifungal drugs used to treat fungal skin infections. Locally applied, acting cutaneous products can be achieved with miconazole patches. For this purpose, the miconazole-hydroxyapatite material was encapsulated with biodegradable agents, including an aminopolysaccharide biopolymer as deacetylated chitin (chitosan), a synthetic copolymer Pluronic F-127, and a natural carbohydrate polymer Starch from corn. The relatively high surface area of hydroxyapatite, around 57 m^2/g [2], helps stabilize the nanosized composite.

The new idea of introducing miconazole nitrate into the encapsulation system as a patch was verified through physicochemical studies and an *in vitro* release test. The morphology of the novel miconazole nitrate materials was recorded using scanning electron microscopy (SEM). An *in vitro* release study was conducted at 32 °C in phosphate-buffered saline (PBS) (pH 7.4), because the normal temperature of human skin is 32–34 °C. The stability of miconazole-plaster was constant throughout storage (6 months); the designated shelf life was based on its physical and chemical properties and on activity against the isoenzyme CYP51. The azole antifungal agent inhibits the ergosterol biosynthesis pathway by inhibiting the cytochrome P450, and this effect was confirmed in this study. Ergosterol is the most abundant sterol in fungal cell membranes.

The highest encapsulation efficiency (35%), good stability (-35 mV of zeta potential), and high homogeneity (about 0.3 of polydispersity index) indicate that the direction of preliminary studies on miconazole patches may have application potential.

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Impact of Silver Nanowires on Fluorescently Labelled Nucleotides

Wiktoria ZACHEJA[1], Teodor OLEJKO[2], Jacek JEMIELITY[2], Sebastian MAĆKOWSKI[3], Joanna NIEDZIÓŁKA-JONSSON[1]

[1] Institute of Physical Chemistry, Polish Academy of Science, Warsaw, Poland, e-mail: wzacheja@ichf.edu.pl
[2] Centre of New Technologies, University of Warsaw, Warsaw, Poland
[3] Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University in Toruń, Toruń, Poland

silver nanowires, labelled nucleotides, fluorescence

Nucleotides are essential components of mRNA and play key roles in transcription and in controlling mRNA stability and translation efficiency. Previous studies have shown that both nucleotide sequences and nucleotide chemical modifications can strongly affect gene expression and mRNA transcript stability. For instance, the type and methylation state of the first nucleotide within the 5′ cap structure of eukaryotic mRNA have been reported to influence protein production in living cells [1]. These observations underscore the significant role of nucleotide modifications in regulating RNA-related biological processes.

In addition to their biological importance, nucleotides can serve as tools for investigating enzymatic mechanisms in living systems. Fluorescently labelled nucleotides, in particular, allow optical detection and monitoring of structural or biochemical changes in RNA molecules. In this project, Cy5-labeled nucleotides were conjugated to silver nanowires. Due to their plasmonic properties, silver nanowires can enhance local electromagnetic fields, potentially increasing fluorescence from Cy5-labeled nucleotides [2].

Our results demonstrate that effective conjugation of fluorescently labelled nucleotides to nanowires requires precise control of parameters, including incubation time and nucleotide concentration. Molecules containing thiol modifications formed stable conjugates with the nanowires, while nucleotides without thiol groups did not generate detectable fluorescence signal on the nanowire surface. These results point toward the possibility of developing sensoric substrates based on nucleotide probes immobilized on nanowires for monitoring enzymatic reactions kinetics in real time.

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Sol–gel derived Ce-doped SiO_2–CaO bioactive glass: interfacial reactivity, luminescence and oxidative response

Antonino ZARCONE[1,2], Anna ŁUKOWIAK[1], Franck MADY[2]

[1] Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wroclaw, Poland, ul. Okólna 2, 50-422 Wrocław, e-mail: A.Zarcone@intibs.pl, A.Lukowiak@intibs.pl
[2] Université Côte d'Azur, Institut de Physique de Nice, CNRS UMR 7010 17 rue Julien Lauprêtre 06200 Nice, France, Franck.Mady@univ-cotedazur.fr

bioactive glass, cerium doping, sol-gel synthesis, luminescence

The incorporation of rare earth elements into bioactive glasses represents a promising strategy to expand their functionality beyond conventional mineralization processes. In this work, SiO_2–CaO bioactive glass doped with 0.5 mol% cerium is synthesized via a sol–gel route and investigated to determine glass structure, ion release, oxidative response, and luminescent properties. Structural features are assessed by X-ray diffraction, while electron microscopy is used to evaluate morphology, elemental distribution, and surface evolution. The interfacial reactivity of the material is examined through immersion in simulated body fluid, focusing on calcium phosphate nucleation as an indicator of ion exchange processes and mineralization at the material–solution interface. Although these latter tests are not directly predictive of in vivo bioactivity, they provide insight into surface reactivity under controlled conditions. Ion release behaviour is analysed by inductively coupled plasma optical emission spectroscopy to monitor the release of Ca, Si, Ce ions and their interaction with the surrounding environment. Photoluminescence spectroscopy is employed as a sensitive probe of the local environment of cerium ions, enabling the investigation of changes in their emission behaviour associated with surface modification upon immersion. Radioluminescence measurements are additionally performed on the as-prepared material to evaluate the luminescence response under ionizing excitation, providing complementary information on structural defects and emission properties of the glass. In addition, the oxidative response of the material is evaluated under H_2O_2-induced conditions to assess its interaction with reactive oxygen species, considering the role of reversible Ce^{3+}/Ce^{4+} redox cycling. This aspect is particularly relevant in biological environments where oxidative stress plays a key role. Overall, this study aims to provide a comprehensive understanding of how cerium incorporation influence both physicochemical properties and functional responses of SiO_2–CaO bioactive glasses, supporting their development as multifunctional biomaterials.

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Real-Time Monitoring in Neural Tissue Regeneration: Fist Observations from the PIEZOMAT Project

Angelika ZASZCZYŃSKA A., Dorota KOŁBUK-KONIECZNY D, Arkadiusz GRADYS ,Paweł Łukasz SAJKIEWICZ

Institute of Fundamental Technological Research, Laboratory of Polymers and Biomaterials, Polish Academy of Sciences, Pawinskiego 5B, 02-106 Warsaw, Poland, e-mail: azasz@ippt.pan.pl

smart materials; piezoelectricity; neural tissue engineering; electrospinning

Modern scaffolds designed for neural tissue engineering usually fulfill only one of two essential functions: either they provide a structural matrix that encourages axonal outgrowth, or they act as passive platforms for external measurement techniques. Currently, no material unites these capabilities within a single, biocompatible system. PiezoMat aims to address this gap by engineering a multilayer, nanoparticle-enhanced piezoelectric scaffold that accelerates functional nerve repair while converting mechanical cues arising from cellular activity into a measurable electrical signal [1,2].

The project's primary goal is to develop a bio-inspired scaffold that can track key biological events that accompany the regeneration of injured peripheral or central nerves in real time and without the need for invasive electrodes or fluorescent labels. In short, PiezoMat promises to shift the paradigm from passive, one-off implants to active, self-reporting scaffolds - an advance that aligns with the broader trend towards personalized, feedback-controlled regenerative therapies, and which addresses a clearly articulated need in the field of neural tissue engineering [3].

Two grades of PVDF with low and high molecular weight were investigated along with various electrospinning parameters, such as the rotational speed of the collector, applied voltage, and solution flow rate. A multi-technique approach of microscopy and spectroscopy allows for determining the effect of molecular weight and processing parameters on the content of the electroactive phases. It is evident from the data in Fig. 1 that the effect of the collector's rotational speed on the content of electroactive phases is strong [4]. Such a strong increase in the content of electroactive phases with collector rotational speeds is related to an increase in stretching forces, leading to effective molecular orientation in the nanofibers. The influence of molecular weight on the content of electroactive phases is evident only at the lowest rotational speed. Importantly, the identified electroactive phases are expected to play a crucial role in enabling real-time monitoring of regeneration processes, as their piezoelectric response directly reflects dynamic cellular activity within the scaffold. This capability will be further explored in subsequent stages of the project, where the material will be integrated with nanoparticles to continuously track cell behavior. Such an approach will allow for correlating scaffold properties with biological performance over time, ultimately contributing to the development of adaptive, feedback-driven regenerative therapies.

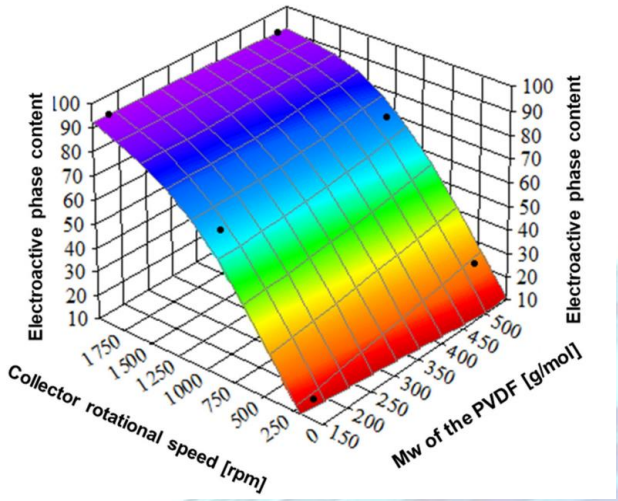

Figure 1. The relation between collector rotational speed, polymer molecular weight, and the electroactive phases content (α+γ).

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Effect of the Parameters of GELMA Synthesis on Rheology

Angelika ZASZCZYŃSKA A., Gustaw GŁUSKI, Maryla MOCZULSKA-HEJLAK, Sahra TABAKOGLU, Dorota KOŁBUK-KONIECZNY

Institute of Fundamental Technological Research, Laboratory of Polymers and Biomaterials, Polish Academy of Sciences, Pawinskiego 5B, 02-106 Warsaw, Poland, e-mail: azasz@ippt.pan.pl

tissue engineering, 3D printing, gelatin methacryloyl

Gelatin methacryloyl (GelMA) is a commonly applied biomaterial in tissue engineering, valued for its adjustable physicochemical characteristics and high biocompatibility. Nevertheless, its effectiveness in additive manufacturing is largely influenced by the conditions of synthesis and purification, which affect its rheological properties and printability.

The objective of this work was to examine how different synthesis parameters of GelMA impact its rheological behavior and applicability in three-dimensional (3D) printing. GelMA samples were prepared using three distinct synthesis approaches and subsequently purified using two different methods to assess how processing variables shape material performance. Structural characterization of the obtained polymers was carried out using nuclear magnetic resonance (NMR) spectroscopy, while viscosity measurements were used to evaluate rheological properties. Printability was assessed through extrusion stability and the ability to maintain the intended shape after printing. Additionally, cytotoxicity analyses were performed to confirm material safety.

The findings reveal that both the synthesis method and purification strategy play a crucial role in determining the rheological characteristics of GelMA, which in turn directly affect its printability. Differences in viscosity and flow behavior were shown to influence extrusion efficiency and the structural stability of printed constructs. These results underline the importance of precise control over synthesis conditions and minimizing degradation during the synthesis stage to improve GelMA-based bioinks for additive manufacturing applications.

This study emphasizes the link between processing conditions and functional properties, offering practical insights for the development of bio-based inks in tissue engineering.

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PREPARATY LINE-ETOH

Produkty zwolnione z akcyzy, które z powodzeniem zastępują etanol odczynnikowy w większości procesów chemicznych, w histopatologii i biologii komórkowej.

PRODUKTY BIOBÓJCZE

Nazwa	Skład	Zastosowanie	Kanister 4 kg	Kanister 8 kg
Line-Antybakteria 96	Etanol 96% z dodatkiem propan-2-olu i propan-1-olu	Preparat dezynfekujący do higienicznej dezynfekcji rąk metodą wcierania. Preparat do bakterio- i grzybobójczej dezynfekcji powierzchni nieporowatych w obszarze spożywczym, przemysłowym, domowym i instytucjonalnym. Zabija 99,9% bakterii, grzybów i wirusa COVID-19.	125,00 zł	200,00 zł
Srebrna Antybakteria	Etanol 96% z dodatkiem propan-2-olu i nanosrebra	Produkt biobójczy i bakteriostatyczny przeznaczony do mycia i dezynfekcji powierzchni oraz urządzeń w laboratoriach, zakładach przemysłowych, instytucjach użyteczności publicznej, w magazynach, warsztatach. Do dezynfekcji opakowań transportowych, wnętrz samochodów do przewozu żywności, chłodni, lodówek, zamrażarek oraz urządzeń mających kontakt z żywnością i środkami żywienia zwierząt. Do prac dezynfekcyjnych przy przygotowywaniu materiału siewnego.	145,00 zł	-

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PRODUKTY O ZASTOSOWANIU LABORATORYJNYM

Nazwa	Skład	Zastosowanie	Kanister 4 kg	Kanister 8 kg
Line-EtOH acetonówka	Etanol 96% z dodatkiem eteru dietylowego i acetonu	Produkt wykorzystywany w mikroskopii do czyszczenia i odtłuszczania szkiełek mikroskopowych oraz w biologii molekularnej, a także przy przygotowywaniu preparatów histopatologicznych (etap nanoszenia materiału).	105,00 zł	165,00 zł
Line-EtOH eterówka	Etanol 96% z dodatkiem eteru dietylowego i eteru tert-butylowo-metylowego	W histologii jako środek zastępujący ksylen przy obróbce preparatów tkankowych. Medium w syntezie organicznej. Stosowany do czyszczenia szkła optycznego, a także jako środek do czyszczenia powierzchni szklanych z pozostałości środków klejących - najczęściej pozostałości po usuniętych etykietach.	105,00 zł	165,00 zł
Line-EtOH synt B	Etanol 99,9% z dodatkiem eteru dietylowego i heksanu	Stosowany przez histopatologów do odtłuszczania, czyszczenia i odparafinowania preparatów, przez chemików do syntezy organicznej i jako eluent w chromatografii kolumnowej. Szczególnie przydatny przy usuwaniu pozostałości żywic, olejków, smarów. Wykorzystywany także przez informatyków przy czyszczeniu podzespołów komputera.	120,00 zł	180,00 zł
Line-EtOH do mycia B	Etanol 99,9% z dodatkiem eteru dietylowego i acetonu	Stosowany zamiennie z Line-EtOH acetonówka przy przygotowywaniu preparatów histopatologicznych oraz czyszczeniu i odtłuszczaniu szkiełek mikroskopowych. Wykorzystywany jako środek myjąco-dezynfekujący.	120,00 zł	180,00 zł
Line- EtOH do mycia	Etanol 96% z dodatkiem eteru dietylowego, acetonu i 1,2-propanodiolu	Szczególnie przydatny jako środek myjąco - dezynfekujący.	105,00 zł	165,00 zł

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NOWOŚCI DO DEZYNFEKCJI

PRODUKT BIOBÓJCZY Line-Antybakteria 70

Produkt poddano badaniom mikrobiologicznym w certyfikowanym laboratorium według norm wykazujących skuteczność w działaniu na wybrane szczepy grzybów, bakterii, pleśni i ludzkiego koronawirusa .

Nazwa	Skład	Nawilżone chusteczki	100 ml z atomizerem	1l z nakrętką	1l ze spryskiwaczem	1l z pompką
Line-Antybakteria 70	Etanol 70% z dodatkiem propan-2-olu i propan-1-olu	0,81 zł netto 1,00 zł brutto	7,41 zł netto 8,00 zł brutto	16,67zł netto 18,00 zł brutto	18,52 zł netto 20,00 zł brutto	18,52 zł netto 20,00 zł brutto
		Kanister 4kg	Kanister 8kg	Dwupak 1l sprysk.+ nakr.	Trójpak 1l sprysk+nakr.+pomp.	Dwupak 4kg+1l pomp.
		88,89 zł netto 96,00 zł brutto	138,89 zł netto 150,00 zł brutto	30,56 zł netto 33,00 zł brutto	46,30 zł netto 50,00 zł brutto	97,22 zł netto 105,00 zł brutto

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Nazwa	Skład	Nawilżone chusteczki	100 ml z atomizerem	1l z pompką	Kanister 4kg
Jedwabna Antybakteria o zapachu aloesu	Etanol 70% z dodatkiem propan-2-olu, propan-1-olu, substancji nawilżającej - olejku jedwabnego, aromatu	0,81 zł netto 1,00 zł brutto	8,13 zł netto 10,00 zł brutto	16,26 zł netto 20,00 zł brutto	89,43 zł netto 110,00 zł brutto
Jedwabna Antybakteria o zapachu grejpfruta	Etanol 70% z dodatkiem propan-2-olu, propan-1-olu, substancji nawilżającej - olejku jedwabnego, aromatu	0,81 zł netto 1,00 zł brutto	8,13 zł netto 10,00 zł brutto	16,26 zł netto 20,00 zł brutto	89,43 zł netto 110,00 zł brutto
Jedwabna Antybakteria o zapachu truskawki	Etanol 70% z dodatkiem propan-2-olu, propan-1-olu, substancji nawilżającej - olejku jedwabnego, aromatu	0,81 zł netto 1,00 zł brutto	8,13 zł netto 10,00 zł brutto	16,26 zł netto 20,00 zł brutto	89,43 zł netto 110,00 zł brutto

Nazwa	Skład	50 ml
Żel Jedwabna Antybakteria o zapachu aloesu	Etanol 70% z dodatkiem propan-2-olu, propan-1-olu, substancji nawilżającej - olejku jedwabnego, substancji zagęszczającej, aromatu	6,50 zł netto 8,00 zł brutto
Żel Jedwabna Antybakteria o zapachu grejpfruta	Etanol 70% z dodatkiem propan-2-olu, propan-1-olu, substancji nawilżającej - olejku jedwabnego, substancji zagęszczającej, aromatu	6,50 zł netto 8,00 zł brutto
Żel Jedwabna Antybakteria o zapachu truskawki	Etanol 70% z dodatkiem propan-2-olu, propan-1-olu, substancji nawilżającej - olejku jedwabnego, substancji zagęszczającej, aromatu	6,50 zł netto 8,00 zł brutto

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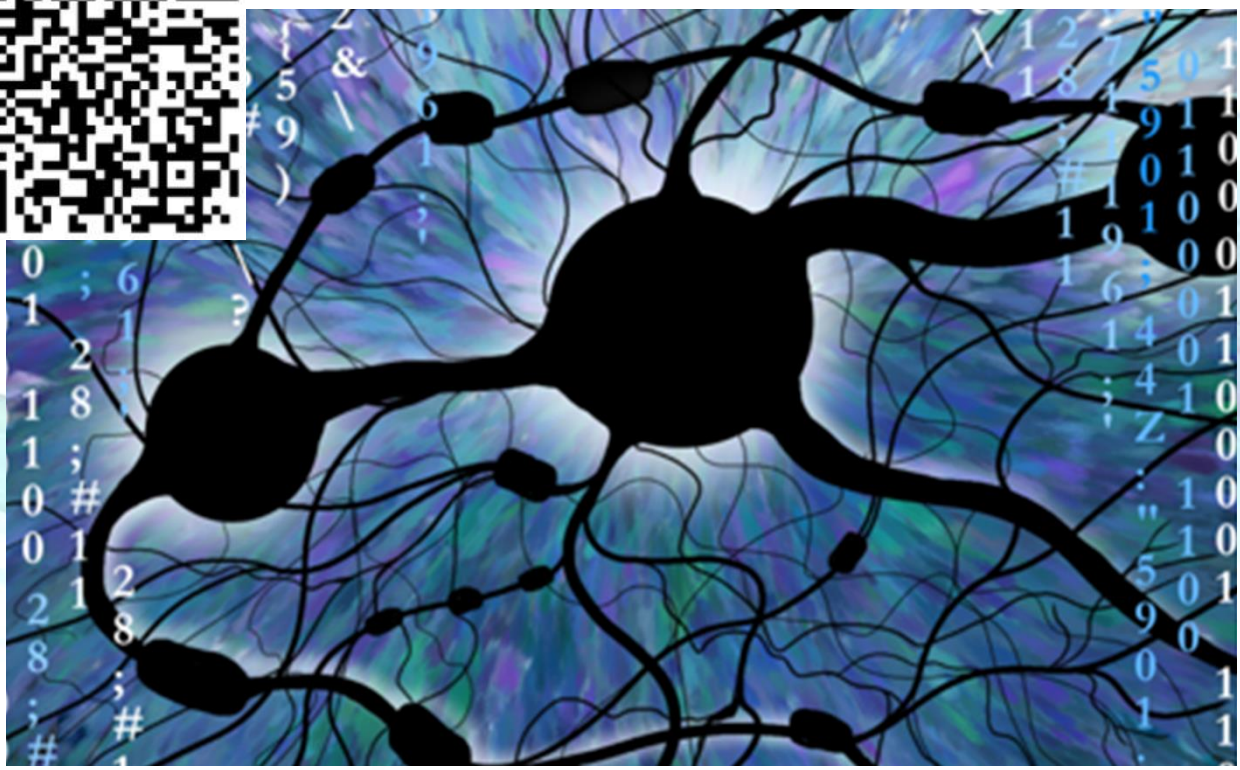

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