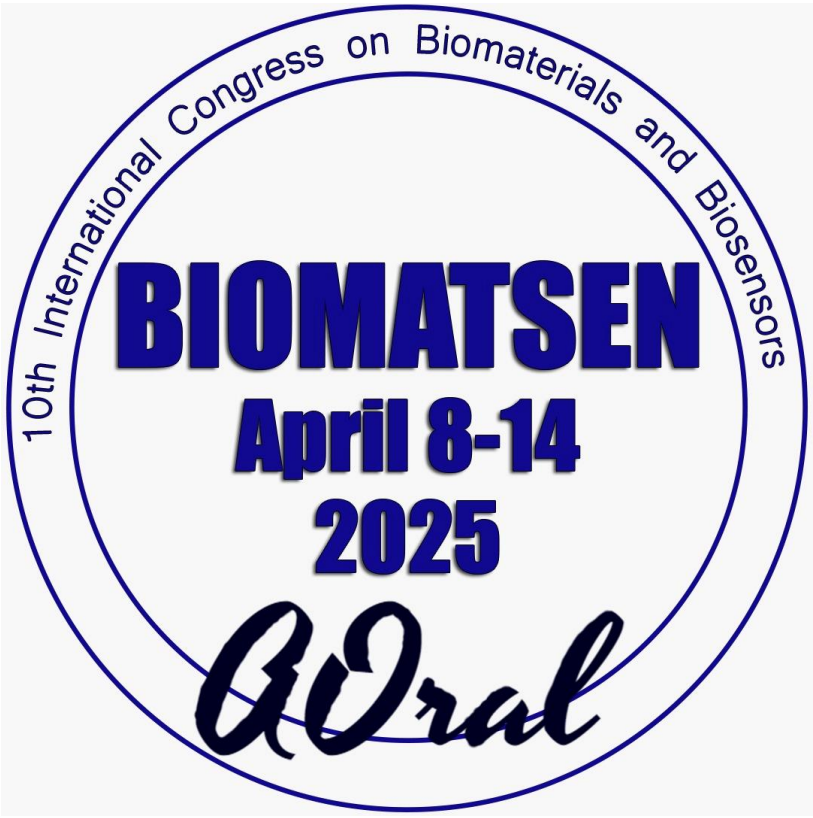
Book of Abstracts

BIOMATSEN 2025



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10th INTERNATIONAL CONGRESS ON BIOMATERIALS AND BIOSENSORS (BIOMATSEN 2025)

Oludeniz, Turkiye

APRIL 8-14, 2025

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Ivana Savić Gajić	Faculty of Technology, University of Niš, Serbia
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Vasa Radonic	BioSense Institute, Serbia
Livia Alexandra Dinu	CS II - IMT National Institute for Research and Development in Microtechnologies, Romania
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PLENARY PRESENTATION

Id-523

Nanoparticles of Oxides Doped with Rare Earth Ions for Theranostic Applications

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Abstract. Relatively large nanoparticles (NPs, 50 – 100 nm of size) of wide band gap oxides (ZnO, ZrO_2, Y_2O_3, TiO_2 and HfO_2) activated with rare earth ions were successfully applied by us for early detection of cancer, first, as fluorescence markers (FMs), then as contrast agents for magnetic resonance imaging (MRI). Recently two new possibilities were demonstrated, allowing the use of NPs for cancer therapy. NPs of ZnO were used as transporting agent, transporting given medicine directly to the area of tumor. Moreover, the same NPs can be used for cancer photodynamic therapy (PDT). Regarding safety aspects, ZnO and ZrO_2 were favored by us for further studies, due to bio-safety of these materials. The performed studies proved high selectivity of NPs distribution in the body. An effective trafficking of FMs to the areas of lung cancer was observed, whereas surrounding tissue was impermeable for NPs.

Keywords: Oxides; Nanoparticles; Fluorescence Labels; MRI; Cancer.

PLENARY PRESENTATION

Id-526

How Have We Eliminated Infection? Nanotechnology Human Clinical Studies

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Abstract. The plenary talk will discuss how we have used nanotechnology eliminate infections in over 30,000 humans to date. It will discuss how medical devices have been modified to have nanoscale surface features that repel bacteria while promoting tissue growth. Moreover, it will discuss how we are using artificial intelligence (AI) to design better biomaterials for various biomedical applications. In particular, AI is being used in implantable nano sensor design to prevent, diagnose, and treat various diseases from cancer to infection. Specifically, here, implantable sensors were designed, fabricated, and tested. Such sensors can detect the type of cell that attaches to an implant, communicate such information to a handheld device, and respond to ensure implant success. In particular, such sensors have been tested in animal studies in which sensors were inserted into the calvaria of rats, bacteria purposedly injected, and sensors used to detect bacteria presence as well as on-demand release antibiotics to eliminate infection. Further, AI has been used in such sensors to predict what types of drug delivery vehicles will be most effective for that particular patient based on prior patient health data and real time response to therapies. It is well known that due to variations in immune systems from patient to patient, patients will respond differently to the same biomaterial and drug treatment, thus, personalized or tailored treatments are necessary and can result from AI. In vitro, in vivo, and human clinical studies will be presented in which AI has already improved medicine. In this manner, this presentation presents a positive view on the implementation of AI into medicine via sensors showing how it can be used to improve disease prevention, diagnosis, and treatment.

Keywords: Infection; Nanotechnology; Implants; Humans; AI.

10th International Congress on Biomaterials and Biosensors

INVITED PRESENTATION

Id-528

Advancing Electrochemical Sensing and Biosensing with Nanozymes and Artificial Recognition Elements

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Abstract. The field of electrochemical sensing and biosensing has experienced transformative progress through the integration of advanced nanomaterials and artificial recognition elements. This talk will delve into the latest developments that leverage these innovative components for enhanced analytical performance. Nanozymes, a class of nanomaterials exhibiting enzyme-like catalytic properties, have emerged as powerful tools due to their high stability, low cost, and tunable activity. These properties make them particularly effective in electrochemical sensors where conventional enzyme-based systems face limitations, such as susceptibility to denaturation and high production costs. This presentation will highlight recent breakthroughs in the synthesis and functional optimization of nanozymes, focusing on their application in the detection of environmental pollutants and pharmaceutical compounds. Complementing the role of nanozymes, artificial recognition elements, such as molecularly imprinted polymers (MIPs) and synthetic receptors, offer specificity and selectivity in target analyte recognition. By mimicking the affinity and selectivity of natural biological elements, these synthetic counterparts enhance the robustness and reusability of sensors, facilitating more reliable and reproducible measurements. Case studies will be discussed where these recognition elements, integrated with nanostructured platforms such as sulfur-doped graphene and MXene materials, contribute to improved sensor performance. Key examples will include the electrochemical detection of phenolic compounds like hydroquinone, catechol or tannic acid or pesticides employing hybrid nanomaterials for nanozymes-based sensors and biopolymers for MIP-based sensors combining gold and carbon-based substrates. Additionally, the talk will outline also the design strategies for the three-electrode systems tailored for environmental analysis. Attendees will gain insights into the synergistic effects of nanozymes and artificial recognition elements, learning how their combination is paving the way for next-generation sensors characterized by enhanced sensitivity, stability, and environmental applicability. This discussion aims to inspire further research and collaboration in developing practical, scalable solutions in the realm of electrochemical sensing and biosensing.

Keywords: Nanozyme; Molecularly Imprinted Polymers; Electrochemical Sensors; SPE; Microfabricated Electrodes.

10th International Congress on Biomaterials and Biosensors

INVITED PRESENTATION

Id-532

The Constitutive Modelling of The Venous Valve and Its 3D Fluid-Structure Interaction Simulation

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Abstract. Veins are important components of the cardiovascular system, responsible for transporting blood from muscles and organs back to the heart. Veins contain paired semilunar valves that act as "one-way valves" to ensure unidirectional blood flow. Abnormalities in venous function may lead to venous diseases such as varicose veins and deep vein thrombosis. Studies on the hemodynamics of the venous system help elucidate the pathophysiological mechanisms of venous diseases, providing effective support for the clinical diagnosis and treatment of venous diseases, as well as the design of artificial valves. In this study, numerical simulation was constructed to explore the fluid-structure interaction between intravenous blood and valves based on the immersed boundary-finite element method. The structure-based constitutive modelling of venous valve leaflet tissue was proposed to characterize its unique planar dispersed and gradually recruited fibres. Results demonstrated periodic characteristics of valve movement and intravenous blood flow. Important physiological data such as blood pressure, flow rate, valve opening area and venous valve surface stress and strain distribution were discussed and quantified throughout a dynamic cycle. In addition, the effects of fibrosis and atrophy of venous valves on venous hemodynamics were compared and analyzed. The synergistic mechanism among sequential valves was also investigated. This 3D fluid-structure interaction numerical model was expected to provide important references for revealing the development and mechanism of venous diseases and provide a scientific basis for their prevention, diagnosis and treatment.

Keywords: Modelling 3D fluid Venus.

INVITED PRESENTATION

Id-533

Robotic Microplasma Spraying of Zirconium Coatings on Endoprostheses as An Alternative to Conventional Materials and Technologies

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Abstract. The global demand for new materials and advanced technologies to produce patient-specific orthopaedic implants, such as hip and knee endoprostheses, continues to grow. This trend is driven by the increasing number of joint replacement surgeries, especially among younger patients, who require faster recovery times and the ability to return to an active lifestyle. These challenges push the boundaries of conventional titanium (Ti)-based materials and abrasive surface treatment methods. As an alternative, this study proposes enhancing the bioactivity of endoprosthetic surfaces through robotic microplasma spraying (MPS) of zirconium (Zr) coatings.

Zirconium and its alloys offer superior biocompatibility, higher corrosion resistance, and lower rejection rates compared to Ti-based alloys. With its high melting point, Zr requires thermal plasma spraying, but this process risks overheating and deforming the implant substrate. Achieving uniform coating thickness, strong adhesion, and controlled porosity on complex implant geometries is also challenging. Robotic MPS of Zr wire on Ti6Al4V alloy substrates was optimized to address these issues. Low spraying power minimizes overheating, while automated robotic programming ensured precise control over the coating process. This resulted in a uniform coating with controlled porosity and good adhesion. The influence of coating material, porosity, and surface roughness on bioactivity remains a topic of ongoing research. *The objective of the work was* to establish such characteristics of the Zr coating as porosity, surface roughness, adhesion, corrosion resistance in saline and biocompatibility to provide scientifically based recommendations for the selection of parameters for robotic MPS of Zr coatings that increase the bioactivity of endoprosthetic implants. It is significant to establish patterns of influence of robotic MPS parameters on the microstructure and properties of Zr coatings. *The main results and accomplishments of this study* were as follows: it was demonstrated that the use of robotic MPS of Zr coatings on endoprostheses made of Ti6Al4V alloy allows obtaining coatings with a given uniform thickness of 300 ± 10 μm, a volume porosity of 20.3 ± 2.0%, surface roughness of 17 ± 0.1 μm and an adhesion strength of 26 ± 2.1 MPa, which meets the requirements of ISO 13179-1:2021 (more than 22 MPa), with corrosion resistance in saline solution better than that of uncoated Ti6Al4V alloy and with such bioactivity characteristics as assessment of cytotoxicity, proliferation, osteogenesis and angiogenesis. According to the lactate dehydrogenase activity assay, Zr coating neither possesses cytotoxic effects nor inhibits cell proliferation *in vitro* in bone marrow-derived mesenchymal stem cells (BM-MSCs). It affects osteogenesis by increasing the osteogenic differentiation of BM-MSCs by 5% compared to the Ti6Al4V alloy. Also, the effect on the angiogenesis was analyzed to ensure maximum biocompatibility during the regeneration process. The analysis was performed on human umbilical vein endothelial cells and evaluated with ImageJ Angio Plugin. The results revealed the profound effect of the Zr coating on parameters such as the number of junctions and master junctions, total master segment length, number of branches and total branch length.

Significance: Robotic MPS shows great potential for producing bioactive Zr coatings on complex implants, with precise control over properties ensuring biomedical suitability. Future *in vivo* tests will validate clinical efficacy. This technology advances medicine, surface engineering, and robotics, setting a benchmark for next-generation implant modifications to enhance performance and patient outcomes.

Keywords: Robotic Arm; Trajectory; Spraying Distance; Biocompatibility; Porosity.

10th International Congress on Biomaterials and Biosensors

INVITED PRESENTATION

Id-536

Electrochemical Detection of Salmonella and Listeria with Functionalized Magnetic Nanoparticles

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Abstract. Contaminated food, particularly by food-borne pathogens such as *Salmonella* and *Listeria*, represents a significant global public health challenge, leading to severe gastrointestinal illnesses and thousands of fatalities annually [1]. Traditional pathogen detection methods are labor-intensive, time-consuming, and require specialized equipment and trained personnel. Rapid and accurate pathogen detection on site is vital for ensuring environmental and food safety and consequently public health. Electrochemical detection using gold electrodes with magnetic nanoparticles offers a promising platform for rapid and sensitive pathogen detection which allows incorporation of pre-concentration step as well. By functionalizing magnetic nanoparticles with specific aptamers or antibodies, this method achieves high specificity for targeted pathogens, without the the necessity of direct biomolecule immobilization onto the electrode. This study presents an innovative approach utilizing nanoparticles functionalized with aptamers to detect Listeria and Salmonella on a low-cost gold leaf electrochemical transducing platform [2]. Electrochemical impedance spectroscopy (EIS) was used to detect varying bacterial concentrations in both, buffer and complex matrices. The developed sensor demonstrated specific recognition of *Listeria* and *Salmonella*, achieving a detection limit of 10^1 cfu/mL. The results demonstrate a clear and linear increase in impedance with rising bacterial concentrations, confirming the sensitivity and effectiveness of the platform.

Keywords: Biosensors; Electrochemical; Pathogens; Magnetic Particles; Salmonella; Listeria.

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INVITED PRESENTATION

Id-539

Dual Growth Factor-Integrated Engineered Hydroxyapatite (HA) Scaffold with Alendronate for Osteoinductive Bone Repair

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Abstract. The creation of biomimetic scaffolds is emerging as a transformative approach in bone tissue engineering. The incorporation of drug delivery systems and the controlled release of bioactive substances has gained significant attention in this field. Bisphosphonates (BPs) is a class of drug that works by reducing excessive bone resorption that indirectly support osteoblast activity, promoting bone formation and stabilization of the bone matrix. However, there is a notable lack of studies focusing on the systematic delivery of BPs . In this study, bisphosphonates—Alendronate (Aln) was integrated into a hydroxyapatite (HA) scaffold combined with MC3T3-E1 cells and dual growth factors (VEGF and BMP-2). The *in vitro* assessment of the engineered scaffold was conducted by evaluating cell viability using the MTT assay. The scaffold's characterization was performed using field emission scanning electron microscopy (FESEM), while its elemental composition was analysed through energy-dispersive X-ray (EDX) analysis. The rate of mineralization was quantified by assessing alkaline phosphatase (ALP) expression. To further strengthen the findings, *in vivo* analysis was conducted by implanting the engineered HA scaffold into femoral defects induced in Sprague Dawley rats. Histological analysis with Haematoxylin and Eosin (H&E) staining showed significantly improved bone regeneration in the Engineered HA scaffold group, with increased in trabecular bone formation. Immunohistochemical analysis revealed higher expression of osteogenic markers Osteoprotegerin (OPG) and Osteopontin (OPN), indicating enhanced bone formation and matrix mineralization. Thus, the synergistic effects of VEGF and BMP-2-loaded HA scaffold demonstrate its potential to enhance bone formation and support osteoblastic cell function in bone tissue engineering. *In vivo* results further support this approach.

Keywords: BMP-2; VEGF; Hydroxyapatite (HA); Bone Regeneration; Bone Tissue Engineering.

10th International Congress on Biomaterials and Biosensors

INVITED PRESENTATION

Id-543

Polymeric Nanoparticles in the Treatment of Hypertension and Hyperlipidemia

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Abstract. Nowadays, targeted nanoparticle delivery systems in the field of cardiovascular and metabolic disease are under intensive investigation. Minimizing the side effects while maximizing the drug effectiveness by targeted delivery poses a big challenge in the treatment of hypertension and hyperlipidemia. Aliskiren, a direct renin inhibitor, represents an effective tool for decreasing a blood pressure, while simvastatin belongs among gold standard drugs to reduce LDL-cholesterol in hyperlipidemic conditions. With the exception of natural polymers, the synthetic polymers mainly include poly (lactide) acid (PLA), poly (lactide-co-glycolide) copolymers (PLGA), poly (ε-caprolactone) (PCL), and poly (amino acids). In our experimental studies we have used aliskiren-loaded PLA nanoparticles (25 mg/kg/day for 3 weeks) to decrease blood pressure in spontaneously hypertensive rats and simvastatin-loaded PLGA nanoparticles (15 mg/kg/day for 6 weeks) to decrease LDL-cholesterol in obese rats with metabolic syndrome. Blood pressure of the animals was measured every week. Distribution of polymeric nanoparticles was analyzed by confocal microscopy. After the treatment, the lipid profile in the plasma and the concentration of conjugated dienes (marker of reactive oxygen species production) in the heart and liver were determined. (Pro)renin receptor (*Atp6ap2*), angiotensin II type 1 receptor (*Agtr1*), and angiotensin-converting enzyme (*ACE*) gene expressions were measured in the heart. Nitric oxide synthase (NOS) activity, Akt, endothelial NOS (eNOS), phosphorylated eNOS (p-eNOS), neuronal NOS (nNOS), nicotinamide adenine dinucleotide phosphate (NADPH) oxidase, and nuclear factor kappaB (NF-kappaB) protein expressions were determined in the heart and aorta. The fluorescent signals of nanoparticles were visible in cardiomyocytes, tubular system, vessel walls, and erythrocytes. Aliskiren-loaded nanoparticles decreased the gene expression of *Atp6ap2* and *ACE*, while increased nNOS expression in the heart. Concentration of conjugated dienes was decreased in both heart and liver. We hypothesize that aliskiren-loaded nanoparticle-mediated downregulation of *Atp6ap2* and *ACE* and upregulation of nNOS may also contribute to a decrease in reactive oxygen species generation leading to blood pressure reduction and beneficial effects in the heart. Simvastatin-loaded nanoparticles decreased plasma LDL-cholesterol level and in combination with coenzyme Q10 increased NOS activity and the expression of Akt, eNOS, and p-eNOS in both the heart and aorta. Both aliskiren- and simvastatin-loaded nanoparticles decreased NADPH oxidase in the heart and NF-kappaB protein expression in the aorta which indicates their antioxidant and anti-inflammatory properties in the respective tissues. In conclusion, PLA and PLGA polymeric nanoparticles may represent a promising tool for the treatment of cardiometabolic diseases.

This study was supported by the national grant agency VEGA 2/0025/23 and 1/0048/23.

Keywords: Polymeric Nanoparticles; Hypertension; Hyperlipidemia; Cardiometabolic Diseases.

INVITED PRESENTATION

Id-546

Bone Protective Effects of *Ficus carica* on Biomechanical Bone Strength of Postmenopausal Osteoporotic Rat Models

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Abstract. Osteoporosis results in millions of fracture cases globally every year with the vast majority involving postmenopausal women. Postmenopausal women are exposed to 20% lifetime risk of hip fracture and 50% risk of any osteoporotic fracture which may decrease quality of life. The pharmacological treatments of postmenopausal osteoporosis are estrogen replacement therapy (ERT), bisphosphonates, denosumab and teriparatide. Although these agents are known to be effective, long-term use may result in many adverse effects. This has led to a search for alternative anti-osteoporotic agents with minimal adverse effects. *Ficus carica* (FC) or known by the locals as fig or 'buah tin', has been reported to contain abundance of bioactive compounds and minerals such as calcium, magnesium and strontium which are vital for bone health. This study was done to evaluate the effects of FC on bone biomechanical strength on post-menopausal osteoporotic rat models. Forty Sprague Dawley female rats were divided into five groups. Group I comprised the sham-operated rats, while group II-V were ovariectomized rats. After ten weeks of treatment, the femur and tibia bones were harvested and stored at -80°C prior to analysis. Group I and II were given distilled water at 0.2 ml/100g daily via oral garbage. Group III was given estrogen replacement therapy (ERT) at 64.5 µg/kg daily via oral gavage. Group IV and V were given dried and raw figs respectively at the dose of 1000 mg/kg via oral gavage. Biomechanical analysis revealed that the Young's Modulus for the FC treated group were increased significantly compared to control group ($p<0.05$), meanwhile the flexure strain showed that the control groups were significantly increased than treated groups. However, the flexure force and stress were consistent among all the groups ($p>0.05$). FC supplementation at the dose of 1000mg/kg showed potential superior to ERT in reversing ovariectomy-induced bone biomechanical changes. However, more conclusive research needs to be done.

Keywords: Osteoporosis; Biomechanical; Ficus Carica; Fig; Bone.

INVITED PRESENTATION

Id-547

Improving the Sensitivity of Surface-Enhanced Raman Scattering based on Non-metallic Plasmonic Nanostructures of TMDCs/Graphene Heterostructures for Biosensing Applications

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Abstract. Surface-enhanced Raman spectroscopy (SERS) is a useful spectroscopic method for accurately and sensitively detecting molecules adsorbed on nanostructures or rough metal surfaces. SERS relies on electromagnetic (EM) and chemical (CM) mechanisms. EM is the predominant action in the Raman scattering enhancement which involves the increase of the local electromagnetic field on rough metal surfaces or plasmonic metal nanostructures (PMNs) due to resonance excitation localized surface plasmonic resonance (LSPR) in the metal. The CM depends on an effective charge transfer between the probe molecules and SERS substrates. LSPR has drawn intensive attention from researchers in recent years and a large variety of PMNs have been developed with the advantage of improved light-matter interactions as illustrated in the enhanced light absorption on these PMNs. More recently, studies have demonstrated that strong LSPR can be generated on non-metallic nanostructures of two-dimensional atomic materials and their heterostructures, providing more advantages than their metallic counterparts, including possibly lower Ohmic loss and low cost. This work will present a review of the recent progress on the design and fabrication of new SERS substrates based on transition metal dichalcogenides (TMDCs) nanostructure/graphene heterostructures.

Keywords: TMDC/Graphene Heterostructure; Surface-Enhanced Raman Scattering; Biosensing.

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INVITED PRESENTATION

Id-548

Catechol-Functionalized Linear-Dendritic Bloc Copolymers: Biomimetic Adhesion and Hydrogelation

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Abstract. Catechol moieties are found in several proteins secreted by mussels and other bivalves. These proteins, named mussel foot proteins (mfps), allow the mussels to firmly stick on the sea reef in a large variety of conditions and environments. Indeed, catechols can foster strong adhesive interactions with the reef by means of H-bonding, π-π stacking, metal chelation and covalent bonding.[1] Hence, mimicking the mussels foot proteins, a library of catechol-containing copolymers has been synthesized as new adhesives.[2] In the present work,[3] two series of Linear-Dendritic Block Copolymers (LDBCs) have been synthesized. They contain: *(i)* a linear polyether polymer, *(ii)* 2,2-bis(hydroxymethyl)propionic acid dendritic blocks of generation 0, 1 and 2 and *(iii)* terminal catechol moieties. Two different linear polyether polymers were used: either poly (ethylene glycol) *(PEG-LDBC series)* or poly(ethylene glycol)-poly(propylene glycol)-poly(ethylene glycol), also called Pluronic F-127, *(Pluronic-LDBC series).* When used as adhesives, the two series PEG-LDBC and Pluronic-LDBC showed good adhesion strength when applied onto aluminum substrates, with adhesion values up to 7 MPa. More interestingly, a clear positive dendritic effect was observed: the higher the dendritic generation, the higher the adhesion. Moreover, Pluronic F-127 derivatives can self-assemble in water forming micelles and hydrogels depending on the concentration and temperature. Hydrogels are highly relevant materials for bioadhesion due to their soft structure and high biocompatibility.[4] Therefore, the hydrogelation of the previously synthesized Pluronic-LDBC series was studied observing the formation of hydrogels at body temperature. Their morphology was studied using CryoSEM revealing a different pore size according to the dendritic generation. Their adhesiveness was studied ex-vivo on porcine skin, showing adhesion with values up to 3 kPa. These values were similar to those of Tisseel, a commercial FDA-approved tissue sealant, paving the way for a possible future application of this material in biomedicine.

Keywords: Biomaterials; Adhesion; Hydrogels; Dendrimers; Biomimicry.

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10th International Congress on Biomaterials and Biosensors

INVITED PRESENTATION

Id-549

Natural Polysaccharides for the Preparation of Hydrogels as Drug Carriers: Challenges and Innovations

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Abstract. Natural polysaccharides have garnered significant attention recently because of their promising potential in preparing hydrogels for drug delivery applications. Their biocompatibility, biodegradability, and natural abundance make them ideal candidates for the development of advanced drug delivery systems. The main focus of this review is on polysaccharides, such as alginate, chitosan, pectin, and agarose, offering versatile platforms for controlled drug release. These polysaccharides are particularly attractive because they are derived from renewable sources, often have a low toxicity profile, and can be used to satisfy specific therapeutic needs.

Hydrogels obtained from these natural polysaccharides provide unique advantages, including enhanced stability, tunable mechanical properties, and the ability to improve drug solubility. The hydrophilic nature of polysaccharides allows for high drug-loading capacity, making them ideal for the encapsulation of both hydrophobic and hydrophilic drugs. Moreover, these hydrogels can be tailored for controlled and sustained release, ensuring that bioactive compounds are delivered over an extended period, thus improving therapeutic efficacy and reducing side effects.

However, the incorporation of natural polysaccharides into hydrogel formulations presents several challenges. Variability in the properties of polysaccharides, depending on their source and extraction methods, can lead to inconsistencies in hydrogel properties. Additionally, the mechanical strength of hydrogels made from natural polysaccharides is often insufficient for certain applications, particularly in load-bearing or structural applications. Another challenge is the limited control over the gelation process, which can impact the reproducibility and scalability of these hydrogels. Significant efforts are being made to address these challenges and enhance the properties of natural polysaccharide-based hydrogels. Innovations in crosslinking techniques, such as physical, chemical, and enzymatic crosslinking, have been explored to improve the stability and mechanical strength of these hydrogels. Furthermore, modifications to the chemical structure of polysaccharides and the incorporation of functional agents, such as nanoparticles or bioactive molecules, are being studied to improve their drug-loading capacity, release profiles, and target specificity.

This study highlights the recent advancements in natural polysaccharide-based hydrogels, exploring their potential as effective drug delivery systems. The ongoing innovations in this field are expected to overcome existing limitations and expand the application of these biopolymers in modern medicine, offering eco-friendly and sustainable alternatives to synthetic materials.

Keywords: Polysaccharides; Extraction; Modification; Hydrogel; Drug Delivery System; Encapsulation.

INVITED PRESENTATION

Id-550

Hydrogels as Material Carriers for Microbial Cultivation in Biocarpet Engineering

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Abstract. Hydrogels, three-dimensional polymer networks capable of retaining large amounts of water, have emerged as promising materials in the field of biocarpet engineering, particularly as carriers for microbial cultivation. These versatile materials offer an ideal environment for the immobilization of microorganisms, facilitating their growth, metabolic activity, and interaction within a controlled matrix. The ability of hydrogels to swell and retain water makes them particularly suited for nutrient delivery, and waste removal, which are crucial for sustaining microbial life and enhancing performance. In biocarpet engineering, hydrogels serve as a platform for the development of biologically active mats that can be used for a variety of environmental and industrial applications, including bioremediation, waste treatment, and sustainable agriculture. By optimizing the properties of the hydrogel matrix, such as porosity, biodegradability, and mechanical strength, it is possible to improve the efficiency and longevity of microbial activities within the biocarpet. This lecture will explore the role of hydrogels based on alginate and cellulose as material carriers for cyanobacterial cultivation in biocarpet engineering, highlighting the preparation methods and functional properties of these hydrogels. Additionally, the challenges associated with the long-term stability and scalability of such systems will be discussed. The potential benefits of using hydrogels as carriers in biocarpet engineering are vast, ranging from the development of self-sustaining, eco-friendly systems to the advancement of innovative solutions for addressing environmental challenges. Biocarpets can be used in the treatment of the loess plateau to prepare the soil for further stimulation of plant growth by enhancing soil structure, improving water retention, and promoting microbial activity. These biocarpets, which are commonly composed of natural materials integrated with beneficial microorganisms, help combat the erosion and degradation of the plateau's fragile soils. Through the creation of a stable, moisture-retentive environment, biocarpets not only prevent soil erosion but also support the development of healthy plant root systems. This, in turn, boosts soil fertility and promotes the sustainable cultivation of vegetables, helping to restore the ecological balance of the loess plateau and improve agricultural productivity in the region.

Keywords: Cyanobacteria; Polysaccharides; Hydrogel; Biocarpet; Swelling; Loess Plateau.

10th International Congress on Biomaterials and Biosensors

INVITED PRESENTATION

Id-554

DNA-Based Biosensors for The Detection of Cancer-Associated Nucleic Acids and Mutations

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Abstract. The detection of cancer-associated nucleic acids and mutations through liquid biopsy hold great potential as non-invasive approach for early cancer detection and monitoring. Considering the fact that the concentration of circulating nucleic acids in biological samples is in the range of low femtomolar (fM) to picomolar (pM), highly sensitive and specific detection methods are needed. In my talk, I will first showcase the ultrasensitive and multiplexed detection of miRNAs using a DNA origami nanoarray providing distance-dependent recognition of miRNAs by applying super-resolution microscopy technique; DNA-PAINT (point accumulation for imaging in nanoscale topography). The developed nanosensor can detect up to 4 miRNAs either separately or in combination based on the relative distance to the boundary markers on the 300 nm-long structure. Then, as an alternative approach, I will demonstrate a detection technique using primer exchange reaction (PER) based signal amplification strategy that enables the rapid, sensitive and specific detection of fragmented mRNAs and cancer-specific mutations using flow cytometry and lateral flow assay. In both detection systems, we could reach a limit of detection down to the low femtomolar range (11 fM - 27 fM) without need for pre-amplification. Our detection systems can discriminate single base mismatches in miRNAs and frequently occurred mutations in cancer-associated genes including KRAS, PIK3CA and P53 that are obtained from cell extracts and circulating tumor DNAs (ctDNAs) with low false positive rates. Importantly, our detection strategy enabled the detection of single mutation even in the presence of 1000-fold excess of wild type (WT) DNA using multi-color flow cytometry detection approach. Using our strategy, we demonstrate the versatile detection of endogenous nucleic acids not only from cell extracts of cancer cell lines but also from plasma samples of breast cancer patients. Overall, these results show the potential of our biosensors to be used in the clinics for early cancer detection, but also as a companion diagnostics test for personalized cancer therapies and disease monitoring. In a broader perspective, the use of developed biosensors can be expanded to detect nucleic acids and mutations in other disease conditions as well, in particular, cardiovascular, metabolic, inflammatory, autoimmune, infectious and neurodegenerative diseases.

Keywords: DNA Biosensor; DNA Origami; Cancer Detection; Super Resolution Microscopy; Flow Cytometry.

10th International Congress on Biomaterials and Biosensors

INVITED PRESENTATION

Id-557

Allergic Reactions and Toxicity, The Dark Side of Titanium Implants

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Abstract. Titanium has been considered a biocompatible material for dental implants due to its corrosion resistance and Osseointegration properties. However, emerging evidence suggests that some patients may experience some adverse reactions, including hypersensitivity and toxicity, leading to implant failure and systemic effects. My lecture will explore the mechanism of titanium sensitivity, including immune-mediated responses and contact allergies, as well as the potential release of titanium particles and ions leading to local and systemic toxicity. Clinical manifestations, diagnostic approaches and management strategies will be discussed, emphasizing the importance of patient selection, material alternatives, future directions in biomaterial research.

Keywords: Dental Implant; Titanium; Corrosion; Hypersensitivity; Toxicity.

10th International Congress on Biomaterials and Biosensors

INVITED PRESENTATION

Id-558

Free Volume in Polymers and Nanocomposites for Biosensors

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Abstract. Free volume plays a special role in polymeric materials, which are the basis for creating amperometric biosensors. An important stage in obtaining high sensitivity and high quality of the biosensor as a whole is to ensure good adsorption of the enzyme, i.e. to ensure optimal geometric and energy characteristics of the adsorption centers in meso- and nanopores. Therefore, in the process of manufacturing the device, it is necessary to pay attention to the structural aspects associated with free volume and adsorption properties in the sample that have specified structural and electronic characteristics. Linseed or soybean oil and vanillin-based photocross-linked and ureasil-based polymers, microporous carbon fibers and mesoporous titanium dioxide doped with sulfur nanocomposites were selected as immobilizing matrixes in construction of amperometric biosensors for the analysis of xenobiotics in water. Among the photocross-linked polymers, the best sorption/desorption properties are demonstrated by the sample AESO:VDM=1:1 (mol) and is the most promising matrix in the design of amperometric biosensors. At the same time, the ureasil-based polymers containing chalcogenide clusters (As_2S_3 and/or S) showed the highest biosensor's sensitivity, but the reason is still under research. The network properties (free volume and crosslinking) of the investigated polymers studied using positron annihilation lifetime spectroscopy and swelling measurements, were taken into account for comparative analysis. A correlation of network properties of polymer matrixes with parameters of amperometric biosensors is found to be fundamental in origin. The topological, chemical and topological-chemical mechanisms for effective enzyme immobilization at the construction of xenobiotic amperometric biosensors are established using the investigated materials as holding matrixes.

Keywords: Polymers; Free Volume; Adsorption Properties; Positron Annihilation; Biosensors.

10th International Congress on Biomaterials and Biosensors

ORAL PRESENTATION

Id-552

Nanozyme-Enhanced Immunochromatographic Analysis of Fluoroquinolone Ofloxacin for Food Control

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Abstract. The widespread application of antibiotics in husbandry for the treatment and prevention of livestock animal infections can lead to their accumulation in agricultural products. Consumption of antibiotic-containing food can cause severe harm to human health and provoke strong antibiotic resistance. Ofloxacin (OFL) is an antimicrobial that belongs to the fluoroquinolone group of antibiotics and is widely used due to its broad spectrum of action and high pharmacokinetic properties. OFL exists in the form of two stereoisomers, but only the S-isomer has biological activity and effectively interacts with molecular targets, which requires its selective detection in food products. Immunochromatographic analysis (ICA) is a promising approach for screening many food samples during mass control of their contamination with antibiotics. ICA is not only sensitive but also a rapid method that allows for analyte detection in non-laboratory conditions without special equipment. Among other benefits, low cost and methodological simplicity can be mentioned. The prepared test strip is ready to use, and the detection is performed by incubating it with the tested sample and visually assessing the colored lines. In this study, the sensitive ICA of OFL was developed using anti-S-OFL monoclonal antibodies and bimetallic core@shell Au@Pd nanozyme label having peroxidase-like catalytic activity. Nanozyme enables the increase in the colorimetric signal on the test strip due to an extra coloration of the product of the enzymatic reaction catalyzed by the label. This allows for the assay sensitivity gain compared to the ICA based on the classic gold nanoparticle (AuNPs) label. Bimetallic nanozyme was synthesized using AuNPs as a core. Pd shell was formed by the reduction of the related salt with sodium ascorbate on the gold surface. Characterization of nanozymes by composition, dimensions, and form was conducted using a complex of physicochemical methods. The panel of OFL-protein and OFL-linker-protein conjugates as coating antigens were synthesized by carbodiimide technique and the ones supplying the most effective OFL detection were chosen. The ICAs were performed in the indirect competitive format, where anti-species antibodies were labeled with AuNPs or nanozymes. In nanozyme-based ICAs, the peroxidase substrate was added to test strips after the lateral flow procedure followed by the formation of the colored oxidized product. Catalytic enhancement of the analytical signal enabled varying the immunoreagent concentrations and, consequently, a substantial decrease in the OFL detection limit compared with AuNPs-based analysis (from 0.1 down to 0.01 ng/mL, respectively). The characterization of assay specificity demonstrated that the ICA allowed for the stereospecific determination of the S-isomer of OFL. The developed test systems were validated for effective OFL detection in foodstuffs (milk and meat extracts). Nanozymes with other shell compositions (Pt and Ag) were also synthesized and proved to be appropriate labels in signal-enhanced ICAs for sensitive OFL detection. The

proposed approach based on the nanozyme-mediated signal amplification can be recommended for rapid and sensitive detection of other food contaminants.

Keywords: Ofloxacin; Fluoroquinolone; Lateral Flow Immunoassay; Nanozymes; Food Safety.

ACKNOWLEDGMENT

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POSTER PRESENTATION

Id-544

Biomaterial Patches for Vascular Remodelling: A Comprehensive Review of Innovations in Healing and Regeneration

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Abstract. Biomaterial patches technology has revolutionised vascular remodelling, offering novel solutions for arterial repair and regeneration. These patches, ranging from tissue-engineered scaffolds to 3D-printed hydrogels and extracellular matrix (ECM)-based materials, are designed to integrate seamlessly with the host vascular system. They aim to restore structural activity integrity while promoting endothelization and vascular healing. This review presents the latest innovations, assessing their clinical potential in vascular remodelling. A structured literature review was performed using PubMed, Scopus, Web of Science and artificial intelligence generated website such as SCISPACE to identify articles published from January 2015 to December 2024. Keywords included “biomaterial patches,” “vascular remodelling, “arterial repair,” “3D printing in vascular applications,” and “extracellular matrix patches.”. The search yielded 60 to 100 articles, of which 10 were selected after screening the relevance, originality, and clinical applicability. Studies were categorized into preclinical and translational with a focus on innovation and outcomes in vascular remodelling. Recent advancements demonstrate a significant shift towards biomaterials that offer both mechanical support and bioactivity. Tissue-engineered scaffolds are increasingly incorporating endothelial and smooth muscle cells to mimic native vascular architecture. 3D-printed hydrogels enable patient-specific customization and incorporate bioactive agents to enhance integration. ECM-based patches, derived from decellularized tissue, provide natural biological signals that promote neovascularisation and cellular adhesion. Despite these advancements, challenges such as mechanical durability, immunogenicity, and scalability persist, necessitating further research. Biomaterial patches represent a pivotal innovation in vascular remodelling, with potential to improve outcomes in procedures like endarterectomy and aneurysm repair. Continued interdisciplinary research is essential to overcome existing challenges and drive clinical translation. By bridging engineering ingenuity with biological function, these technologies promise a transformative impact on regenerative medicine.

Keywords: Biomaterial Patches; Vascular Remodelling; Tissue Engineering; 3D Matrix; Regenerative Medicine.

POSTER PRESENTATION

Id-545

Magnetron Sputtering of Ta-Cu Oxides and Nitrides onto Medical Products to Increase Their Bactericidal Resistance Along with Reduced Coating Cytotoxicity

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Abstract. In recent years, due to the continuous development of biomaterial technologies, there has been significant progress in the production of coatings for medical implants and instruments. New ideas and technologies are emerging for the development of antibacterial and wear-resistant coatings that also possess biocompatibility properties. These advancements aim to reduce postoperative complications, extend implant longevity, and better meet the needs of both patients and surgeons. Bioactive coatings for implant-endoprostheses must exhibit multiple properties simultaneously: suppress microbial colonization, promote osseointegration, and possess sufficient mechanical strength. Notably, achieving both bactericidal properties and biocompatibility can be challenging. For example, copper coatings, known for their excellent antibacterial properties, often exhibit cytotoxicity toward osteoblast cells. In this regard, studies on magnetron sputtering of thin Ta-Cu coatings, as well as their oxides and nitrides, are of particular interest. These coatings, as shown on laboratory samples, can create a localized antibacterial environment while remaining relatively non-toxic to human osteoblast cell lines (hFOB). Currently, commercially available implant coatings include titanium nitride (TiN), titanium-niobium nitride (TiNbN), oxidized zirconium (OxZr), and zirconium nitride (ZrN). However, modern research is not limited to these but also focuses on coatings based on the aforementioned Ta-Cu nitrides (TaN) and oxides (TaO). *The objective of this work* was to optimize magnetron sputtering parameters to achieve the desired composition and thickness of Ta-Cu oxide and nitride coatings with satisfactory adhesion to titanium alloy substrates. The coatings were then tested in vitro to establish their antimicrobial and biocompatibility characteristics, providing scientifically grounded recommendations for selecting magnetron sputtering parameters for titanium implant coatings that ensure enhanced bactericidal properties alongside reduced cytotoxicity. *The main results and accomplishments of this study were as follows:* the dependencies between coating thickness and composition on sputtering parameters have been established, enabling the production of thin coatings (2 μm thick) containing 25 at.% Cur (Group 1) and 50 at.% Cu (Group 2). All coatings demonstrated excellent adhesion to the substrate, a high Young's modulus (determined by nanoindentation), and reliable antimicrobial efficacy against Staphylococcus aureus, Pseudomonas aeruginosa, and Candida albicans. Cytotoxicity is a critical factor in evaluating the biocompatibility of biomedical materials, with ISO 10993-5: Biological Evaluation of Medical Devices – Part 5: Tests for In Vitro Cytotoxicity being the most widely

referenced standard. This standard defines materials as non-cytotoxic if cell viability exceeds 70%. Our study investigated the cytotoxicity with CCK8 assay of various oxide and nitride coatings applied via magnetron sputtering to titanium-based substrates. The results demonstrated that Oxide Group 1 exhibited the highest biocompatibility, with cell viability around 80%, classifying it as non-cytotoxic. Nitride Group 1 displayed mild cytotoxicity, with 52% cell viability. Oxide Group 2 were moderately cytotoxic, with 47% cell viability. Nitride Group 2 were classified as severely cytotoxic, with 17% cell viability. These findings highlight the potential of Oxide Group 1 for biomedical applications due to its superior biocompatibility. Future work will focus on optimizing these coatings' structural and compositional properties to enhance their performance further and reduce cytotoxicity. Future plans include X-ray diffraction phase analysis of the coatings to determine the relationship between structural-phase composition and coating properties.

Keywords: Medical Instruments; Implants; Biocompatibility; Cell Viability; Antimicrobial Efficacy.

POSTER PRESENTATION

Id-553

Immunochromatographic Tests for Rapid Monitoring of Antibiotic Residues in Meat Products

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Abstract. Meat products are an essential component of the human diet. Therefore, toxicant detection in raw materials and finished meat food products is an important task. For this purpose, immunochromatographic tests (ICTs) are an efficient means due to rapid analytical procedure and simple result interpretation. However, the competitive potential of ICTs depends on the achieved detection limits and ease of sample preparation. Therefore, new developments aimed at improving these parameters are in demand. Among them, control of intermolecular interactions during the assay and an enhancement of the recorded signals seem promising. In this work, two approaches to reach lower limits of antibiotic detection by ICTs were considered. For tylosin detection, two kinds of ICTs were developed and compared, namely, with direct antibody labeling (specific antibodies were conjugated with gold nanoparticles) and an indirect one (i.e., a combination of free specific antibodies and anti-species antibodies conjugated with the gold nanoparticles). Indirect labeling provided integration of high signals and efficient revealing of low tylosin concentrations. Due to this, its detection limit was lowered by 7 times – up to 0.07 ng/mL. The developed ICTs allowed for determining 92-113% of tylosin in raw meat samples. For the detection of tetracycline, the given approach of indirect labeling was combined with the intrinsic peroxidase-like activity of gold labels. The corresponding assay included the transformation of the peroxidase substrate containing 3,3′,5,5′-tetramethylbenzidine, H_2O_2, and dextran sulfate under the optimized conditions. The ICT was characterized by an instrumental limit of tetracycline detection of 0.03 ng/mL, which was 7.6 times lower than that in the ICTs without the catalytic enhancement. The assay duration was 18 min including a three-minute catalytic reaction. The obtained results demonstrated the significant potential of new and improved ICTs and the prospects of these tests as an efficient instrument for mass control of antibiotics in food products.

Keywords: Meat products; Antibiotics; Food safety; Lateral flow immunoassays; Gold nanoparticles.

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	549 - Natural Polysaccharides for The Preparation of Hydrogels as Drug Carriers: Challenges and Innovations

	550 - Hydrogels as Material Carriers for Microbial Cultivation in Biocarpet Engineering
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