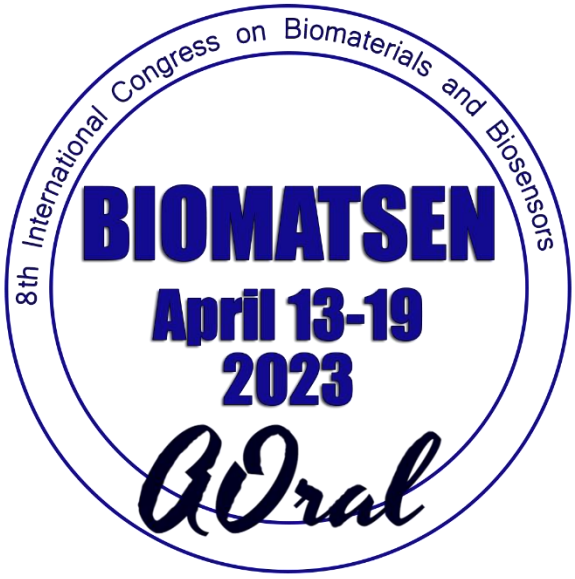
Book of Abstracts
BIOMATSEN 2023



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10th INTERNATIONAL CONGRESS ON BIOMATERIALS & BIOSENSORS (BIOMATSEN 2023)

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PLENARY SPEAKERS

Id-445

Eco-friendly Bioinks for 3D Bioprinting of Soft Tissues

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Abstract: 3D Printing and bioprinting are pioneering technologies that enable fabrication of biomimetic, multiscale, multi-cellular tissues with highly complex tissue microenvironment, intricate cytoarchitecture, structure-function hierarchy, and tissue-specific compositional and mechanical heterogeneity. Given the huge demand for organ transplantation, coupled with limited organ donors, these technologies could solve the crisis of organ shortage by fabrication of fully-functional whole organs. This talk will briefly introduce the concepts and types of 3D bioprinting technologies, the need for these technologies in the field of tissue engineering and its potential applications. Some of the key accomplishments from our lab in the development of new ecofriendly bioinks for bioprinting of soft tissues will be dealt in detail in this talk.

Keywords: Bioprinting, Bioinks, Tissue Engineering, Biomaterials.

PLENARY SPEAKERS

Id-448

Self-assembly and Interactions of Bacterial Lipids

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Abstract: Lipopolysaccharides (LPS) and lipoteichoic acid (LTA) are major components in the membranes of Gram-negative and Gram-positive bacteria, respectively, and their ingeniously designed molecular architectures are very different from common synthetic surfactants and phospholipids. Detailed knowledge of their self-assembly in solution and at interfaces is critical to understanding their roles in causing sepsis and to designing novel effective antibacterial agents (ABAs). Small angle neutron scattering (SANS) has revealed a rich variety of morphologies of the self-assembled structures, such as micelles, worms, and vesicles of different geometries, by these bacterial lipids in solution, complementing direct measurement of interactions between model bacterial membranes using the surface force apparatus (SFA). Our results also show the pronounced effects of multivalent cations and temperature on the self-assembled structure in solution and at interfaces.

Keywords: Bacterial Lipids, Liposomes, Bacterial Membranes

Acknowledgement: Dr Bhavesh Bharatiya, Dr Gang Wang, Ms Xueying Guo, and Dr Christian Redeker

PLENARY SPEAKERS

Id-463

Biomimetic Elastomers and Elastomer Nanocomposites for Biomedical Applications

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Abstract: Soft tissues are highly deformable tissues, which are essential for our body function. However, many patients suffer from severe damage or defects of soft tissues, adversely impacting their health, wellbeing and quality of life. Over the past few decades, various strategies have been proposed to repair or reconstruct soft tissues, among which soft tissue engineering is an important one. Different types of elastomers and their nanocomposites were prepared, which mimic the mechanical properties of different soft tissues such as adipose, oral mucosal, skin, cartilage, ligament and cardiovascular tissues. The chemical structure, mechanical properties, biodegradation kinetics, water swelling behaviour and cytotoxicity of the biomaterials were characterised, and their structure-property relationships were investigated. Porous tissue scaffolds which mimic the morphologies of some native soft tissues were prepared from selected bioelastomers, and their structure, properties and cell proliferation behaviour were assessed. Some of these elastomers demonstrate pH- or temperature-responsive behaviour, which were evaluated as drug delivery systems and actuators. In addition, the application of elastomers and elastomer nanocomposites in sensors and wearable medical devices was also explored.

Keywords: Bioelastomer, Nanocomposite, Soft Tissue Engineering, Drug Delivery, Sensing

PLENARY SPEAKERS

Id-465

Cellulose as Substrate for Active Surfaces: Theory and Applications

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Abstract: The present lecture is focused on the recent advances on surface phenomena of cellulose and it will be divided into four parts:

1. The first part will be devoted to the basic concepts associated with the surface of solids and liquids and the theory behind physico-chemical parameters characteristic to their surface. In this context, the origin of the surface energy, the contaminations, the adhesions, will be discussed, etc [1, 2]. A systematic comparison between bulk and surface properties will be given.

2. The second part will give the most known surface treatments and their effect on the resulting materials. This will include (i) physical (mostly mechanical) (ii) physico- chemical (such as Corona, plasma, UV…); and (iii) chemical treatments like grafting by direct condensation, “grafting from” and “grafting onto” approaches. In this context, recent works investigating green solvent-based or solvent-free systems will be reported [1, 2].

3. The third part will be devoted to the techniques of characterisation and will point out the difficulties associated with such an approach.

4. The last part will be devoted to concrete examples of active surfaces, as applied in several applications, such as medical, packaging…

Some relevant concluding remarks and perspectives will also be given.

Keywords: Cellulose, Surface, Chemical modification.

PLENARY SPEAKERS

Id-480

Superhydrophobicity From Environmental to Biomedical Applications

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Abstract: Superhydrophobic (SH) materials has gained rising interest in the last decades in many research fields from fundamental to applied science ranging from environmental protection, antifouling and corrosion solutions, energy efficiency and biomedical devices. Here, high water/liquid repellent materials in coatings are presented in an overview showing different aspects and problems of their utilization from on-field marine environment to promising solutions for medical devices and in vitro studies.

Keywords: Wettability, Coatings, Superhydrophobic, Surface Chemistry.

INVITED SPEAKERS

Id-456

Additive Manufacturing of Orthopedic Implants with Microplasma Sprayed Hydroxyapatite Coatings

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Abstract: Currently, small-scale production of customized orthopedic implants and prototyping have become more accessible thanks to additive manufacturing (AM). AM allows the design and manufacture of personalized implants, and is also used to produce microporous structures with controlled pore size. Biocompatibility is an important consideration when choosing materials for medical implants. Preference is given to choosing materials such that they are biocompatible, meaning that they do not damage tissues and their rate of degradation is either extremely slow or controlled. An essential aspect related to the choice of materials for medical orthopedic implants, which must grow into the patient's bone, is the requirement to provide a certain porosity of the endoprosthesis. The main biocompatible metal materials for AM porous orthopedic implants are titanium alloys, including powder alloys for Selective Laser Melting (SLM). The biocompatibility of a titanium implant surface can be improved by microplasma spraying (MPS) of biocompatible ceramics, in particular, hydroxyapatite coatings. Hydroxyapatite (HA) is the main inorganic component of mammalian bones, which provides it with properties such as biocompatibility and osseointegration with bone tissue.

The objective of the work was to establish the possibility of combining microplasma spraying (MPS) and additive manufacturing (AM) technologies to obtain patient-specific implants with increased surface biocompatibility, as well as to establish MPS parameters that ensure the chemical purity of the HA coating and satisfactory adhesion of the coatings to the substrate.

Implant parts were fabricated according to their 3D computer models by SLM of Ti6Al4V titanium alloy (powder) using an additive manufacturing system for metal products Mlab cusing R CUSING (Concept Laser, Germany). Microplasma spraying of the HA powders has been carried out by MPS-004 microplasmatron (produced by E.O. Paton Electric Welding Institute, Ukraine) Visualization of AM implants and measurement of their porosity was performed using an industrial computer tomograph Phoenix Vtomex M300 (Waygate Technologies, Germany). The structural-phase composition of the initial HA powder and the plasma-sprayed HA coating was studied by X-ray diffraction analysis and transmission electron microscopy, and the adhesion strength of the coating was tested according to ASTM F1147 standard.

The main results and accomplishments of this study were as follows: the application of the technology of MPS of HA coating with an average thickness of 150±50 μm onto porous substrates obtained by SLM method has been shown. A good correspondence between the external and internal geometry of the cages of 3D-printed titanium implants and their initial stereolithographic models was established, which can further ensure the correctness of implantation and fixation of the endoprosthesis. The parameters of MPS of HA coatings on additively manufactured titanium implants have been found. It is also proved that using the appropriate MPS parameters, it is possible to obtain a HA coating with a 95% level of HA phases and 93% level of crystallinity and the adhesion strength to the substrate of 24.7±5.7 MPa, which complies with the requirements of the international medical standard ISO 13779-2:2018. These results are of significance for a wide range of researchers developing technologies of orthopedic implants manufacturing.

Keywords: Additive Manufacturing, Biocompatibility Microplasma Spraying, Selective Laser Melting, Hydroxyapatite, Orthopedic Implants.

Acknowledgement: This research is funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP13268737).

INVITED SPEAKERS

Id-471

Lanthanide Chelate Nanoparticles as Luminescent Sensors

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Abstract: Luminescent lanthanide complexes have long attracting researchers due to their excellent optical properties. They are widely used as building blocks for luminescent nanomaterials for application in biomedical analysis, medical diagnosis, and cell imaging[1, 2]. Long luminescence lifetimes, sharp characteristic emission bands, and large Stoke's shifts allow getting rid of biological background autofluorescence, which is of great importance when biomedical experiments are conducted.

The wide applicability of lanthanide complexes in fluorescent sensing of residual amounts of drugs, including antibiotics, in water or biological fluids is well-known[3, 4]. In this regard, the synthesis of new lanthanide complexes, where ligand-to-metal energy transfer is enough for sensitizing lanthanide-centered luminescence, and ligand-metal coordination bonds are tight enough for the safe conversion of the complexes into water-dispersible nanomaterial with high lanthanide-centered luminescence is a challenging scientific task.

The applicability of the developed aqueous colloids as nanosensors will be demonstrated by their luminescent reply on ceftriaxone, which is the third generation of cephalosporin antibiotic widely applied in treating of such socially relevant bacterial infections as meningitis, pneumonia and many others as well as fluoroquinolones antibiotics, glyphosate and temperature [5-7].

Keywords: Rare earth elements, Luminescence, Nanoparticles, Energy Transfer.

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INVITED SPEAKERS

Id-474

Development of Magnetic Microwires for Magnetic Sensors Applications

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Abstract: Amorphous magnetic wires have attracted great attention owing to their superior soft magnetic, mechanical and corrosion properties. Excellent magnetic properties such as magnetic bistability or Giant Magnetoimpedance (GMI) effect are suitable for magnetic sensors applications [1]. Recent tendency in devices miniaturization stimulated development of thin (few micrometers diameters) microwires. Sensors play an important role in many industries (microelectronics, security and electronic surveillance, automotive, aerospace and aircraft, home entertainment, computer science, electrical engineering, ...), providing the ability to detect events or changes in the environment and monitor such events through other electronic devices, for example through a computer processor [2]. Magnetic properties of crystalline magnetic materials are linked to their crystalline structure and to a great extent are limited by defects, like grain boundaries, dislocations, texture, etc. Therefore, amorphous magnetic materials with excellent soft magnetic properties, which can be observed in as-prepared materials without additional post- processing, have attracted great attention since the 60-s [2,3]. Among other advantages of amorphous materials are fast and inexpensive fabrication method and superior mechanical and anti-corrosive properties [2,3]. However, conventional amorphous materials (ribbons, wires) are of larger dimensionality, and therefore devices and sensors made from such materials are larger than those made using nanoscaled materials [2,3]. One of such materials, that meet several of the requirements (reduced dimensionality, excellent magnetic softness, biocompatibility, superior mechanical and anti-corrosive properties) and can present high GMI and even GMR effects are glass-coated microwires [4].

Better magnetic softness and higher GMI effect have been reported for Co-rich amorphous microwires, while Fe-rich amorphous microwires present spontaneous magnetic bistability related to remagnetization process through fast domain wall propagation [4]. Less expensive Fe-rich microwires are preferable for the applications. But amorphous Fe-rich materials exhibit rather high magnetostriction coefficient and consequently present quite low GMI effect.

Recently we designed the post- processing allowing further optimization of magnetic properties of Fe- and Fe-Co based glass-coated microwires [4]. Conventional annealing allows considerable improvement of domain wall dynamics in Fe-rich microwires and slight decrease of coercivity, however remarkable magnetic hardening is observed after conventional furnace annealing of Co-rich microwires. Stress annealing of Fe-rich microwires allows considerable magnetic softening and GMI effect enhancement and even more remarkable improvement of domain wall dynamics. In Co-rich microwires stress-annealing allows improvement of GMI effect and even induction of transverse magnetic anisotropy at high enough annealing temperature, however the highest GMI effect is observed for stress-annealed Co-rich microwires which present rectangular hysteresis loops. Consequently, annealed Co-rich microwires can present both fast domain wall propagation and GMI effect.

Consequently, in this paper we will provide an overview of the trends related to optimization of magnetic and magneto-transport properties of glass-coated magnetic microwires potentially suitable for biomedical applications.

Keywords: Magnetic materials, Amorphous materials.

INVITED SPEAKERS

Id-478

VEGF Delivery to be Applied for Angiogenesis of Critical-Sized Craniomaxillofacial Defects

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Abstract: Poor angiogenesis in critical-sized craniomaxillofacial defects can cause specific clinical problems. The large size of the bone defect inhibits vascularity, preventing the penetration of blood components from the surrounding environment into the inner parts of the defect. This can compromise the cell viability in the deep portion of tissue-engineered constructs, resulting in a lack of graft integration and ultimate treatment failure. By recognizing that angiogenesis is the prerequisite for osteogenesis, bone tissue engineering can offer new approaches for handing the critical-sized craniomaxillofacial defects.

In general, five strategies have been identified to enhance bone angiogenesis in tissue engineering, including growth factor delivery, co-culturing systems, mechanical stimulation, biomaterials and nanoparticles, and micro-fabrication techniques. Growth factor delivery, particularly vascular endothelial growth factor (VEGF), has proven to be the most effective approach. However, improper exposure to VEGF can result in improper neovascularization and the risk of tumorigenesis. To mitigate these risks, precise and localized delivery of VEGF is necessary, which has not yet been achieved with current methods. In this talk, new strategies will be presented that offer the potential for controlled and localized delivery of VEGF, addressing the core deficit in current approaches and potentially enabling safe clinical use.

Keywords: VEGF, Angiogenesis, Critical-sized Defects, Oral and Maxillofacial Defects, Tissue Engineering, Regeneration.

REGULAR SESSIONS

Id-406

Immunochromatographic Biosensors for Rapid and Sensitive Control of Authenticity and Composition of Meat Products

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Abstract: Phycotoxins are marine toxins produced by certain types of microalgae and cyanobacteria and can be accumulated in many marine macroorganisms. When entering the human organism with contaminated food, phycotoxins can cause both acute poisonings and long-term adverse effects. Microcystin-LR (MC-LR), domoic acid (DA), and okadaic acid (OA) are hazardous phycotoxins associated with different shellfish poisoning effects. The content of phycotoxins in shellfish is limited by European Union regularities, and several analytical methods are recommended for their detection. However, there is still a demand to develop techniques suitable for the rapid monitoring of phycotoxins. Immunochromatographic analysis (ICA) based on a specific antigen-antibody reaction and chromatography principles can serve as a sensitive, simple, and cost-effective approach for rapid point-of-care control of phycotoxins. The aim of this study was the development of ICAs of MC-LR, DA, and OA with novel solutions aimed at increasing the sensitivity of their determination. In this regard, several approaches were proposed. First, different types of labels including ones based on colloidal gold (traditional gold nanoparticles (AuNPs) and gold nanoflowers) and magnetic particles (MPs) were used for the colorimetric ICAs. The analytical parameters of the corresponding MC-LR assays were compared and the gain in the sensitivity was concluded dependently on the marker system. It was shown that change in the surface geometry of the gold label allowed decreasing the limit of detection (LOD) down to two times (from 2 to 1 ng/mL); use of MPs enabled to decrease LOD by almost 80 times (to 13 pg/mL). The assay duration was 17 min. The second approach was an implementation of the indirect competitive ICA based on labeling secondary antibodies instead of specific ones (which is traditional for the direct ICA). These two formats were carried out for MC-LR, DA, and OA and compared from the point of view of the achieved LODs. It was demonstrated that the indirect assay provided a more sensitive detection: the LODs of MC-LR and DA were decreased down to several times upon the same assay duration.
As the next approach, post-analytical signal amplification was approbated. The first enhanced ICA was based on using MPs as a label and a carrier for horseradish peroxidase as a means of signal amplification. In the second enhanced ICA, silver amplification based on the reduction of silver ions on the surface of AuNPs, which provides a significant increase of initial AuNPs-caused coloration, was applied. It was demonstrated that the signal amplification enabled to decrease of the LODs of MC-LR by several orders

down to the picomolar concentration range. Except for single immunochromatographic detection, a double test system of DA and OA was developed using some of the proposed approaches. The developed ICAs were tested for the determination of MC-LR, DA, and OA in spiked real samples. It was demonstrated that test systems allowed detecting 80–120% of phycotoxins in seawater, fish, shrimps, octopuses, squids, mussels, scallops, whelks, and crabs, which confirmed their effectiveness for phycotoxin determination in real matrices.

Keywords: Phycotoxins, Microcystin-LR, Domoic Acid, Okadaic Acid, Immunochromatographic Analysis, Food safety

REGULAR SESSIONS

Id-442

Antimicrobial Properties of the Triclosan-Loaded Polymeric Composite Based on Unsaturated Polyester Resin: Synthesis, Characterization, and Activity

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Abstract: The manufacturing of sanitary and household furniture on a large scale with inherently antimicrobial properties is an essential field of research. This work focuses on the synthesis of polymer composites based on the unsaturated polyester of resin loaded with 5 wt.%-Triclosan produced by a co-mixing approach on the automated technological complex with a potential for broad applications. According to findings, the polymer composite has a non-porous structure (surface area < 1.97 m^2/g) suitable for sanitary applications to reduce the growth of bacteria. The chemical composition confirmed the presence of major elements, and the inclusion of Triclosan was quantitatively confirmed by the appearance of chlorine on XRF (1.67 wt.%) and EDS (1.62 wt.%) analysis. Thermal analysis showed a difference of 5 wt.% in weight loss, which confirms the loading of Triclosan into the polymer matrix. The polymer composite completely inhibited the strains of S. Aureus 6538-P, S. Aureus 39, S. Epidermidis 12228, and Kl. Pneumoniae 10031 after 5-min contact time. The antimicrobial effects against Kl. Pneumonia 700603, Ps. Aeruginosa 9027, and Ps. Aeruginosa TA2 strains were 92.7%, 85.8%, and 18.4%, respectively. The inhibition activity against C. Albicans 10231 and C. Albicans 2091 was 1.6% and 82.4%, respectively; while the clinical strain of C. Albicans was inhibited by 92.2%. The polymer composite loaded with 5 wt.%-Triclosan displayed stability over the period that illustrates the possibility of washing the composite surface.

Keywords: Polymeric Composite, Triclosan, Antimicrobial, Antibacterial, Polyester Resin.

REGULAR SESSIONS

Id-472

Development of New Microdroplet Microfluidic Techniques for the In Vitro Evolution of Macromolecular Devices Using Numerical Methods

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Abstract: Macromolecular devices (e.g., riboswitches and aptazymes) of modern synthetic biology are capable of highly selectively recognizing and specifically binding various target molecules. Molecular devices are synthesized from nucleic acids (DNA and RNA) and proteins. Such devices perform certain functions: for example, they can test a certain chemical agent in the environment and trigger the fluorescence process (fluorogenic riboswitches), thereby quantitatively indicating the presence of the agent in the environment (environmental applications). Another example is from a biomedical perspective: the devices can highly specifically recognize and bind to antigens on the surface of certain cancer cells and could target these cells with molecules that kill only this type of cells.

Molecular devices are usually synthesized by experimental methods of in vitro evolution (directed evolution). One of the most promising directions in the development of modern technologies for the in vitro evolution are the microdroplet platforms based on the principles of microfluidics. We are developing new approaches for the numerical simulation of in vitro evolution with the prospect of their implementation in experimental microfluidic setups. Despite the impressive progress in the field of directed evolution, the mutation and selection procedures used here are very primitive from the standpoint of the theory and practice of evolutionary algorithms, EA (computer science). Our approach is based on exhaustive testing of a number of heuristic algorithms known in the field of EA for their efficiency. Some of these algorithms have shown very high efficacy in our numerical tests. Based on these found new efficient algorithms, we propose new modules for microfluidic platforms for directed evolution. The strategy we have chosen consists in the step-by-step addition of new modules to the general scheme, dynamic modeling of the processes carried out in these modules, and, finally, numerical tests with appropriate algorithms that allow us to explore and optimally plan the experimental conditions.

In particular, in our numerical tests we have demonstrated the high efficiency of such a well-known algorithm as random mutation hill climbing, RMHC (in its parallel versions). Accordingly, we proposed the implementation of this algorithm as a new module of the microfluidic setup for in vitro evolution. Next, we propose our implementations of the homologous and non-homologous recombination procedures as new

microfluidic modules. We are confident that our approach will allow us to propose a range of new microfluidic modules for modern synthetic biology.

Keywords: Bio-Inspired Computation Techniques, RNA-Sensors,Microfluidic Devices, Lab-On-A-Chip Technology

Acknowledgement: The study is supported by the Russian Science Foundation grant 22-18-00383.

POSTER SESSIONS

Id-455

Ultrafast Laser Processing for Designing of Lab-on-a-Chip Nanobiosensors

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Abstract: Fast development of laser technologies over the past decades led to their active and successful employment in various biomedical applications where they can open up novel promising horizons. Some of them, namely (i) pulsed laser ablation in liquids technique (PLALs), (ii) surface/volumetric modifications of materials using ultrafast laser processing as well as (iii) laser-induced forward transfer (LIFT) are actively employed in the current research in order to achieve the synergy of different applications of lasers with ultrashort pulse duration targeting to develop a compact multi-modal lab-on-a-chip nanobiosensors.

Firstly, PLAL synthesis allowed us to design multi-element nanosensors by combining several materials in the form of one nanoparticle. By choosing appropriate elements, one can easily form multi-component nanosensors with required sensing modalities. In particular, our laser-synthesized nanosensors demonstrated the ability of the detection of different analytes using surface-enhanced Raman scattering (SERS) with tuneable sensing efficiency [1,2]. At the same time, they also demonstrated to be used as nanothermometers. Thus, nanosensors providing various sensing actions can be easily designed using laser ablation in liquid technique.

Secondly, ultrafast laser processing was also employed for the creation of microfluidic channels due to volumetric modifications of the processed materials followed by acid etching [3]. The channels of different patterns, sizes and lengths were formed by adopting experimental parameters of the ultrafast laser treatment. Finally, the LIFT technology [4] was used to deposit previously prepared nanostructures on the specially treated surface in order to increase their adhesion. Depending on a required task, different nanoparticles can be deposited ensuring various actions depending on their composition.

Thus, the combination of the aforementioned ultrafast laser processing techniques, actively progressing at the HiLASE Centre, can develop a new direction of the manufacturing of compact multi-modal lab-on-a-chip nanobiosensors.

Keywords: Nanobiosensors, SERS, Nanoparticles, Ultrafast Laser Processing.

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POSTER SESSIONS

Id-468

Development of Carbon Nanotube-based Composites to Inhibit Single and Dual-Species Biofilms of Uropathogenic Bacteria

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Abstract: Although urinary tract devices (UTDs), such as urinary catheters and ureteral stents, are broadly used for the treatment and mitigation of several pathologies, they are associated with a high incidence of urinary tract infections (UTIs). UTIs are mainly caused by bacterial colonization and biofilm formation on UTDs surfaces. Due to their outstanding properties, including proven antimicrobial activity, carbon nanotubes have been increasingly applied in the biomedical field, particularly in the production of antimicrobial and anti-adhesive surfaces. Therefore, this study aimed to investigate the performance of multi-walled carbon nanotube (MWCNT)/poly(dimethylsiloxane) (PDMS) composites to inhibit single and dual-species biofilm formation of *Escherichia coli* and *Enterococcus faecalis* under conditions that mimic the urinary tract environment. For this purpose, MWCNT/PDMS composites containing different MWCNT loadings (1, 2, and 3 wt%) were produced and characterized regarding their hydrophobicity. The efficacy of these composites to reduce biofilm formation was evaluated using a parallel plate flow chamber for 24 h at the shear rate described for urinary catheters (15 s^{-1}). Biofilm formation was assessed by determining the number of total, viable, and culturable cells. According to the hydrophobicity results, 3% CNT/PDMS composite presented a lower hydrophobic character compared to 1 and 2% CNT/PDMS composites. In addition, biofilm analysis revealed that the 3% MWCNT/PDMS composite was the most effective surface against *E. coli* and *E. faecalis* biofilms. This composite significantly reduced the number of total (63%), viable (74%), and culturable (77%) cells of *E. faecalis* biofilms, and the number of viable (50%) and culturable (64%) cells of *E. coli* biofilms, comparing to the bare PDMS. Moreover, the 3% MWCNT/PDMS composite was able to reduce the number of culturable cells of dual-species biofilms by 32%. Overall,

MWCNT/PDMS composites inhibited biofilm development by uropathogenic bacteria, showing the potential of these carbon materials as a coating for UTDs.

Keywords: Carbon Nanotubes, Composites, Biofilms, PDMS, Urinary Tract

POSTER SESSIONS

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Novel Sensing Technique for Non-Destructive Composites Monitoring

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Abstract: The real time non-destructive monitoring of stresses and temperature is one of the most demanded solutions in the field of sensor technologies.

One of the most prospective technologies addressing this problem is a novel sensing technique for non-destructive monitoring utilizing ferromagnetic wire inclusions presenting the high frequency magnetoimpedance, MI, effect quite sensitive to tensile stress and magnetic field [1]. One of the advantages of this technology is that proposed free space microwave spectroscopy allows remote monitoring of external stimuli, like stress, magnetic field or temperature.

The glass-coated microwires with typical diameters from 1 to 50 μm can provide new functionalities such as improved mechanical and corrosive properties, adherence with polymeric matrices and biocompatibility [2].

In the present paper a novel sensing technique for direct non-destructive and non-contact monitoring of the composite polymerization utilizing ferromagnetic glass-coated microwire inclusions with magnetic properties sensitive to tensile stress and temperature is described. We provide in-situ studies of the evolution of the hysteresis loop of arrays consisting of Co- rich ($Fe_{3.8}Co_{65.4}Ni1B_{13.8}Si_{13}Mo_{1.35}C_{1.65}$) microwires during the composite's matrix polymerization. We observed remarkable change of the hysteresis loops upon matrix polymerization: remarkable coercivity change and transformation of linear hysteresis loop into rectangular in the arrays with Co-rich microwires placed inside the matrix. Using the free space technique, we observed considerable variation of the Transmission parameter of the microwires array in the range of 4-7 GHz upon the matrix polymerization. Observed dependencies are discussed considering heating during the matrix polymerization measured using the thermocouple and the matrix shrinkage and their influence on magnetic properties and MI effect of glass-coated microwires.

Keywords: Magnetic Sensors, Magnetic Materials

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