Raphael (1480-1520) An Allegory (detail)

. The National Gallery London, UK

NATURE INSPIRATIONS POWERING LIFE

Monday, May 22, 17.00 – 19.30, 2017 YOUNG INVESTIGATOR FORUM

Tuesday, May 23, 17.00 – 19.30, 2017 INVITED PRESENTERS SESSIONS

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Bioinspired carbohydrate coatings: modulation of protein fouling and interfacial properties at carbon surfaces

Federico Zen,, Vasilios D. Karanikolas, James Behan, Joana Vasconcelos Jenny Andersson,
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Carbon materials have prompted great interest in the biomedical field due to their good performance as coating for prosthetics and medical devices. However to realize their potential it is critical to control formation and composition of the protein corona in biological media. Mimicking the antifouling properties of the glycocalyx, found in certain cell membranes, offers a promising strategy to prevent clinical problems associated with nonspecific adsorption of plasma proteins on implants. Herein protein adsorption studies were carried out at carbon surfaces functionalized with aryldiazonium layers bearing mono- and di-saccharide glycosides. Localized Surface Plasma Resonance (LSPR) and Quartz Crystal Microbalance (QCM) were used for *in situ* determinations of the dynamic of protein fouling at bare and modified amorphous carbon surfaces. Surface IR reflectance absorption spectroscopy was used to study *ex situ* adsorption of albumin, lysozyme and fibrinogen. Protein adsorption at carbohydrate layers was found to decrease by 30-90% with respect to bare carbon surfaces. Finally, Multisolvent contact angle measurements were used to calculate surface free energy and acid-base polar components of bare and modified surfaces based on the van Oss-Chaudhury-Good model.

May 22nd, 2017 Oral ZGG9V

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Bioinspired material design by hierarchical self-assembly on prepatterned surfaces

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Design of biocompatible surfaces with tailored morphology is crucial for the development of future devices for life science, medical applications and molecular electronics. The directed deposition of functional biological units into regular arrays with defined periodicity and defined amounts of deposited material, i.e. single units, makes conventional surface science compatible with the requirements of hybrid bio-electronic applications. We present two examples for surface nanopatterning with biological units by hierarchical self-assembly.

We use nanosphere lithography [1] to produce a thin film of metallic, semiconducting or dielectric material with self-organized hexagonally arranged circular free substrate antidots. These antidots exhibit a periodical topography and a chemical contrast. In the first example the material contrast between SiO_2 antidots in a platinum film is used for the site-selective deposition of casein micelles into the antidots by enzyme-mediated autodeposition [2]. By tuning the antidot size, we show how single protein micelles can be hexagonally arranged on large areas. In the second example, we combine the antidot patterns with molecular lithography via DNA origami. Single DNA triangles or DNA triangle assemblies are arranged inside mica antidotes in gold films. The DNA origamis themselves exhibit the possibility of their use as templates for the hierarchical assembly of single proteins [3].

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May 22nd, 2017, Oral DW4J8

Tailored antidot patterns created by nanosphere lithography for bioapplications

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Site-selective deposition of biomolecules onto solid surfaces paves the way for the successful integration of biological systems into conventional devices. This site-selectivity can be obtained by surface prepatterning, which offers clearly defined binding sites. We use nanosphere lithography with self-assembled polymer particles as a versatile large-area surface patterning process. Hexagonally arranged monolayers of polymer spheres can be produced on numerous surfaces (SiO_2, TiO_2, mica, Au) and can act as shadow mask in a subsequent material (Au, Pt, SiO_2) deposition process. We show that by controlled shrinking of polymer spheres in plasma processes prior to material deposition, the shape of the shadow mask can be tailored. After material deposition and mask removal antidot patterns are obtained, i.e. material thin films with hexagonally arranged circular free substrate areas. Thus, the antidot patterns exhibit a periodically varying material contrast that defines reactive and inert sites for a subsequent site-selective deposition of e.g. biological units.

We present two examples which rely on the flexibility in the choice of materials. First, we show the site-selective immobilization of chymosin due to patterned platinum films on SiO_2. The chymosin can then be used for the autodeposition of casein micelles. Secondly, patterned gold films on mica provide defined adsorption sites for DNA origami, which in turn can be used for molecular lithography.

May 22nd, 2017, Poster GH3ZN

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A fundamental investigation into the bioresponse of carbon-modified surfaces for the rational design of carbon-based biodevices.

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The ability to control and modulate interfacial interactions between a material and its host is a key factor in the rational design of biodevices. Numerous studies have focused on understanding the interaction of carbon with biomolecules, such as proteins and lipids, in order to explain and tune bioresponse. Carbon bioresponse is thought to depend on the composition/structure of an initially adsorbed protein/lipid layer, however, there is still a great controversy regarding the structure of the adsorbed layer and the role of this layer in terms of the resulting response in biological systems. Herein we report a comprehensive investigation into the correlation between the interfacial and physical-chemical properties of carbon and carbon-modified surfaces with the adsorption of model lipid assemblies on such surfaces. We used a combination of spectroscopic and microscopic techniques in order to evaluate the conformation of lipid adsorption on carbon surfaces. The adsorption of phosphatidylcholine (PC) / phosphatidylserine (PS) liposomes onto carbon and carbon-modified surfaces was investigated regarding buffer composition and surface chemistry. Infrared Reflectance Spectroscopy (IRRAS), Fluorescence and Atomic Force Microscopy measurements were performed in order to understand the conformation of liposome adsorption on carbon surfaces. Finally, these studies allowed us to correlate carbon surface chemistry with the adsorption of model lipid assemblies and ultimately with the bio/hemo-compatibility of such surfaces.

May 22nd, 2017 Oral 0MUSG

Understanding carbon/lipid interaction for the rational design of biomaterials

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When a biomaterial is exposed to biological fluids a series of events occur on their surface after implantation, starting with small biomolecule adsorption in the first seconds followed by cell adhesion after a few minutes. The ability to control the first layer of biomolecules adsorbing on the biomaterial surface is critical for preventing undesirable bioresponses such as thrombosis or infection. Proteins and lipids are an example of biomolecules that adsorb on the biomaterial surface after implantation.1 It is known that protein and lipid adsorption plays an important role as they regulate cell adhesion and receptor binding. Here we report a comprehensive study on the interactions between model lipid assemblies and carbon surfaces using a combination of spectroscopic and fluorescence methods. The adsorption of phosphatidylcholine (PC) / phosphatidylserine (PS) liposomes onto amorphous carbon surfaces was investigated regarding buffer composition and surface chemistry. Infrared Reflectance Spectroscopy (IRRAS) measurements indicate PC/PS liposome adsorption on amorphous carbon (a-C) while oxidized amorphous carbon shows no adsorption when a monovalent ion solution was used as a buffer. When a dication was added as a counterion, the adsorption of PC/PS is seen for all a-C surfaces. AFM was performed in order to understand the type of adsorption on amorphous carbon surfaces. It was showed that PC/PS adsorb on a-C surfaces as a mono/bi layer of phospholipids depending on the surface chemistry and buffer composition. Finally ζ-potential measurements on a-C surfaces gave insights about the electrostatic interactions between PC/PS liposomes and a-C surfaces.

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May 22nd, 2017 Poster JXRDA

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The dynamic response of enteric neurons to polymeric substrates

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The enteric nervous system (ENS) is commonly referred to as the 'second brain' due to its complex networks of neuronal cell types. The abnormalities in or the absence of these neurons have been shown to play a role in diseases of both the ENS and the central nervous system. Accordingly, electrophysiological studies of the ENS are critical in the characterization of the pathophysiology of enteric and neurodevelopmental diseases. However, to-date these studies have been limited by the difficulty of culturing enteric neurons in-vitro, as well as by their poor adhesion properties. Using a rapid and efficient culturing method developed by our group, different polymers were tested in order to assess their ability to promote adhesion of enteric neurons, as confirmed by immunofluorescence analysis. Successfully, the most effective polymer was applied as a coating onto the glass surface of multichannel electrode arrays (MEAs) allowing for the analysis of neuron dynamics, and will continue to be used in order to elucidate fundamental knowledge of how neurons interact with surfaces. These results serve as a significant stepping-stone for the improvement of the in-vitro study of the ENS and will be used to gain a deeper understanding enteric diseases, ultimately contributing to the development of novel polymeric scaffolds for tissue-engineering applications.

May 22nd, 2017 Oral - FT5A8

The dynamic response of enteric neurons to polymeric substrates

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May 22nd, 2017 Poster - ZK9XX

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Nano-bio interfaces for implant osseointegration

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Osseointegration process involves a cascade of biological events which are directly affected by the physical chemistry of the material surface [1], making them key determinants of the implant's success. Nano-surface topography provides a more reliable osseointegration response [2]. Moreover the presence of biomolecules can accelerate bone anchorage to the implant [3]. Since the biological mechanisms at the interface determine the fate of the implant, we hypothesize that the use of oxides in the nanometric scale functionalized with osteogenic peptides may play a central role in osseintegration. TiO_2 and ZnO deposition upon Ti cp substrates was performed by spin coating technique. The samples were functionalized with APPA and MPA spacers and in sequence with peptides derived from DMP_1. Surface characterization, corrosion tests, and biological assays employing hMSC cells were developed. XPS analysis revealed the functionalization success. Surface measurements demonstrated that nano-bio functionalized Ti presented higher surface roughness with improved cell adhesion. Proliferation assay with TiO_2 MPA DMP_1 and ZnO APPA DMP_1 showed enhanced cell viability. Marker genes for osteoblast were upregulated in the presence of the peptides, presenting a positive influence in hMSC osteogenic differentiation. Corrosion tests showed that functionalized samples were more resistant. These findings suggest that nano-bio functionalization is a way for designing relevant implants in regenerative medicine.

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May 22nd, 2017 Oral
DY46O

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The stimuli responsive sensor CNT's nanostructures organized by biomolecular complex: molecular models to nanoimages of nanostructures from CNT's modified by the Cu organic complex – histidine molecules.

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The design concept to create the stimuli responsive photoactive at visible range carbon tubes nanostructures is based on constructed molecular models for the photoemission of semiconductor carbon nanotubes (CNT's) functionalized by attached to the core and ends photoactive molecular complexes: metal (d - transition metal Cu) - organic (azole ligand) complex or by this complexe with coordinative bonded biomolecule (histidine). The tubes are the building blocks for nanostructures organization due to bonds between the metal ions and the ligands or the histidine molecules at different tubes. The architecture (SEM images) and the photoemission (PL spectroscopy) for nanostructures from these functionalized MWCNT in adsorbed layer at silicon substrate are characterized. The SEM images for this layer are interpreted using proposed molecular architectures models for building blocks connected through Cu^{2+} with attached two ligands molecules at different tubes cores and these bonds are partially retain in the complexes with coordinative bonded histedine molecules that can decrease formation of these structures due to their adsorbing on tubes. These layers with namely one and both two types of nanostructures are characterized by photoemission wide bands, having different intensities and different three subbands in visible range.

May 23rd, 2017, Oral NOK8E

Molecular models to nanoimages of nanostructures from CNT's modified by the Cu organic complex – histidine molecules

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May 23rd, 2017, Poster Q5CSZ

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BIOMIMETIC SURFACE STRUCTURING USING CYLINDRICAL VECTOR FEMTOSECOND LASER BEAMS

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We report on a new, scalable method to fabricate at single-step, highly ordered, multi-directional, complex surface structures that mimic the unique morphological features of certain species found in nature. Biomimetic surface structuring was realized utilizing the unique and versatile angular profile and the electric field symmetry of cylindrical vector (CV) femtosecond laser beams. It is concluded that, highly controllable, periodic structures exhibiting sizes at nano-, micro- and dual-scale micro/nano scales can be directly written on Ni surfaces upon line and large area scanning with radially and azimuthally polarized beams. Depending on the irradiation parameters, new and more complex multi-directional nanostructures, inspired by the Shark's skin morphology, as well as superhydrophobic dual-scale structures mimicking the Lotus' leaf water repellent properties can be attained. It is concluded that the versatility and features variations of structures formed upon scanning with CV beams is by far superior to those obtained via laser processing with linearly polarized beams. More important, by exploiting the capabilities offered by fs CV optical fields, the present technique can be further extended to fabricate even more complex and unconventional structures. We believe that our approach provides a new concept in laser processing of materials, which can be further exploited for expanding the breadth and novelty of potential applications.

May 22nd, 2017, ORAL- HR0MO

ULTRAFAST LASER FABRICATION OF BIOMIMETIC MICRO AND NANO STRUCTURED SURFACES

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The fabrication of artificial biomimetic surfaces fabricated via femtosecond laser processing is presented. Metallic, semiconductor and dielectric surfaces were irradiated and Laser Induced Surface Structures (LIPSS) were observed in each type of material surface. In particular femtosecond laser pulses with linear, circular, radial and azimuthal polarization states were utilized for structuring steel (metallic), silicon (semiconductor) and fused silica (dielectrics) surfaces. Experimental results showed that the direction of LIPSS in each case proved to be polarization dependent. A complete study was carried out for the investigation and understanding of LIPSS dependence on fluence value and the number of pulses per spot at variable beam polarization states and irradiation strategies, enabling the creation of new and more complex surface structures. Furthermore, we present a novel way to control the different LIPSS morphologies and geometries which were observed. Additionally large area surfaces were fabricated, tailored with various micro and nano structures bearing great structural resemblance with surfaces found in nature such as lotus leaf, shark skin and butterfly Greta Oto wing. Those bioinspired surfaces were found to exhibit remarkable optical and wetting properties which were attributed to the specific surface morphology. Thus femtosecond laser processing can be a novel and one single-step method for the fabrication of functional surfaces on almost all classes of solid materials.

May 22nd, 2017, Poster - HR0MO

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Tailoring mechano-sensitive liposomes for targeted vasodilation

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Heart diseases are among the top causes of death worldwide: up to 50 % of people struck by heart attack die before arriving at the hospital. The blood flow in diseased human coronary arteries is significantly altered compared to the healthy situation. Therefore, one may use a purely physical trigger to overcome the systemic delivery of vasodilators such as a drop in the blood pressure. Here, we propose mechano-sensitive liposomes of nanometer size as containers [1]. *In vitro* and *in vivo* studies have been performed to investigate their compatibility with the immune system both in human sera and pigs [2]. The properties of such containers have to be tuned to ensure the release of the payload preferentially at the constricted area. The mechanical properties of the mechano-sensitive liposomes are currently investigated using microfluidics combined with small-angle X-ray scattering (SAXS): the scattering signal through micro-channels containing the liposomes reveals information about deformation and/or rupture under selected shear stress values. To determine the shear stress threshold for release, the morphology of the diseased and healthy human arteries has to be investigated. Micro computed tomography (μCT) is a valid technique for the three-dimensional visualization of the human coronary artery morphology [3]. These tomography data are the ground for flow simulations providing the wall shear stress range between healthy and stenosed regions of blood vessels [4].

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May 22nd, 2017, Poster - SXMI6

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Photophysical properties of peptide nanostructures induced by beta- sheets

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Bioinspired nanostructures demonstrate fundamental physical properties such as piezoelectric, nonlinear optical, electrooptical and optical waveguiding effects [1, 2]. This work is focused on a new phenomenon of a deep modification of electron-optical properties resulting in visible fluorescence of peptide triphenylalanine (FFF) nanoensembles folded into a beta-sheet secondary structure. Found two wide spectral bands of optical absorption and photonic emission in blue and green regions are attributed to a strong reduction of the energy gap of intermolecular hydrogen bonds of antiparallel beta-sheet supramolecular structures. Found intrinsic visible fluorescence in FFF-nanostructures is also observed in biological nanostructures of a different complexity from simple ultrashort aromatic and aliphatic di- , tri-peptides to long, containing dozens peptides, neurodegenerative amyloidogenic proteins [3] that allows to consider it as an optical signature of a fundamental biological beta-sheet biomolecular organization. It can be used both in bio-nano-photonics and medical diagnostics of protein misfolding diseases. The authors appreciate support of Ministry of Science, Technology & Space of Israel.

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May 23rd, 2017, Poster
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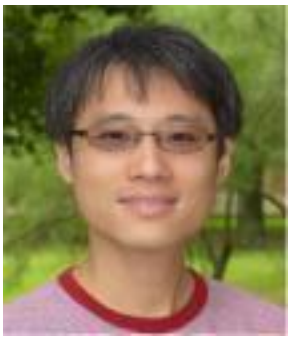

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Spectral Triangulation: a 3D method for locating single-walled carbon nanotubes in vivo

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Nanomaterials with luminescence in the short-wave infrared (SWIR) region are of special interest for biological research and medical diagnostics because of favorable tissue transparency and low autofluorescence backgrounds in that region. Single-walled carbon nanotubes (SWCNTs) show wellknown sharp SWIR spectral signatures and therefore have potential for noninvasive detection and imaging of cancer tumors, when linked to selective targeting agents such as antibodies. However, such applications face the challenge of sensitively detecting and localizing the source of SWIR emission from inside tissues. A new method, called spectral triangulation, is presented for three dimensional (3D) localization using sparse optical measurements made at the specimen surface. Structurally unsorted SWCNT samples emitting over a range of wavelengths are excited inside tissue phantoms by an LED matrix. The resulting SWIR emission is sampled at points on the surface by a scanning fiber optic probe leading to an InGaAs spectrometer or a spectrally filtered InGaAs avalanche photodiode detector. Because of water absorption, attenuation of the SWCNT fluorescence in tissues is strongly wavelengthdependent. We therefore gauge the SWCNT–probe distance by analyzing differential changes in the measured SWCNT emission spectra. SWCNT fluorescence can be clearly detected through at least 20 mm of tissue phantom, and the 3D locations of embedded SWCNT test samples are found with submillimeter accuracy at depths up to 10 mm. Our method can also distinguish and locate two embedded SWCNT sources at distinct positions.

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May 23rd, 2017, Poster
8ZHAX

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Development of gold-curcumin nanoconjuagtes for photodynamic therapy in cancer and multidrug resistance pathogen infections

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The use of light i.e. lasers, over the past few years, has emerged to be highly promising for cancer therapy modalities, most commonly the photothermal therapy method, which employs light absorbing dyes for achieving the photothermal damage of tumors, and the photodynamic therapy, which employs chemical photosensitizers that generate singlet oxygen that is capable of tumor destruction. Photo-thermally treated colon cancer cells, control treated cells imaging used.

However, recent advances in the field of nanoscience have seen the emergence of noble metal nanostructures with unique photo-physical properties, well suited for applications in phototherapy. Noble metal nanoparticles, on account of the phenomenon of surface plasmon resonance, possess strongly enhanced visible and near-infrared light absorption, several orders of magnitude more intense compared to conventional laser phototherapy agents. The use of plasmonic nanoparticles as highly enhanced photo-absorbing agents has thus introduced a much more selective and efficient cancer therapy strategy, viz. plasmonic photothermal therapy (PPTT). The synthetic tunability of the optothermal properties and the bio-targeting abilities of the plasmonic gold-graphene nanostructures make the PPTT method furthermore promising. Photo-thermally treated Multidrug resistance pathogen *S. aurus* (a) control (b) treated cells (examples).

In the present work, we prepared gold-graphene nanostructures for possible photodynamic therapy. We studied Raman spectroscopy, XPS spectroscopy, XRD, TEM of these nanostructures to identify Gold-curcumin conjugation. Further photoactive Gold-curcumin nanoconjuagtes are employed in photodynamic therapy on cancer cells and pathogenic bacteria. Work highlight the in vitro cancer cell and pathogenic bacteria killing success using gold-curcumin coupled with near-infrared lasers and shown efficient mediator in Nano biotechnological applications.

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May 23rd,2017, Oral XDMIV

Multifunctional biocompatible superparamagnetic nanoparticles encapsulated in a polymer matrix for cancer cell destruction and magnetic resonance imaging

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Superparamagnetic nanoparticles (SPMNPs) used for magnetic fluid hyperthermia (MFH) cancer therapy and magnetic resonance imaging (MRI) techniques frequently face trade-off between a high magnetization saturation and their biophysical properties such as good colloidal stability, high specific absorption rate (SAR) and most importantly biological compatibility. This necessitates the development of new nanomaterials as MFH and MRI are considered to be one of the most promising combined noninvasive tumor treatment. In the present study, we investigated polyethylene glycol (PEG) functionalized superparamagnetic nanoparticles for efficient cancer hyperthermia therapy and MRI application. The superparamagnetic nanomaterial revealed a high saturation magnetization, colloidal stability, high SAR and excellent biocompatibility. A high SAR of 390 W/g was observed due to higher colloidal stability leading to an increased Brownian and Neel's spin relaxation. Biocompatibility of PEG capped nanoparticles is up to ~ 80% on different cell lines tested rigorously using different methods. PEG coating provided excellent hemocompatibility to human red blood cells as PEG functionalized SPMNPs reduced hemolysis efficiently compared to its uncoated counterpart. Magnetic fluid hyperthermia of SPMNPs resulted in cancer cell death up to 80% within 60 min near 43-44 °C. Additionally, improved magnetic resonance imaging (MRI) characteristics were observed for the PEG capped La1−xSrxMnO3 (LSMO) formulation in aqueous medium compared to the bare LSMO. Taken together, PEG capped SPMNPs can serve as a promising candidate for effective diagnosis, efficient magnetic fluid hyperthermia and multimodal cancer treatment as the amphiphilicity of PEG can be easily utilized to encapsulate hydrophobic drugs.

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May 23rd, 2017 Poster XDMIV

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Cellular response to semi-ordered/biomimetic nanotubular surfaces

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Understanding cell behaviour at the material-host tissue interface is a fundamental prerequisite for designing the next generation of biomaterials, capable of directing cellular events towards desired biological outcomes. Nanoscale features are known to effect cellular phenomena and exert a direct mechanotransductive effect on cells. However, there is a dearth of studies addressing precise relationships between spatial arrangement of nanofeatures and specific cellular functions, such as focal adhesion (FA) formation. These clusters of adhesion molecules dictate cellular fate, and have been indicated as a key element in determining how cells sense and respond to substrates. To address this challenge, we developed semiordered nanotubular surfaces on titanium, the gold standard in medicine, tunable in terms of diameter and spacing. In addition, for the first time, a 3-dimensional hierarchical surface that mimics that of biologically successful life forms such as diatoms was created with a simple anodization approach. This additional surface will allow the probing of the effects of a nanotopographical height gradient. This study will distinctively (i) cast new light on the mechanisms that control cell-surface interactions by correlating the geometrical arrangement of nanoscale features to specific cellular functions, in particular the establishment of focal adhesions and (ii) evaluate the effects of a vertical nanotopographical gradient by exploiting a bioinspired surface.

May 22nd, 2017, Oral FMOX5

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Artificial Organic Photoreceptors for Photo-Electrical Stimulation of Neuronal Cells

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In many blindness-causing diseases, photoreceptors degenerate whereas second order and projecting neurons are largely unaffected. Thus, one promising avenue to restore vision in affected patients is to develop artificial photoreceptors for retinal prosthetic devices [1]. Artificial photoreceptors based on organic semiconductors emerged as promising alternative for inorganic materials due to increased biocompatibility and the feasibility of direct optical stimulation [2]. We follow an electrophysiological patch clamp approach to conduct fundamental mechanistic studies on a model system, which consists of murine neuroblastoma (N2A) cells grown on a textured small molecular organic semiconductor thin film under physiological conditions. We have chosen a custom-made anilino-squaraine dye, shortly named SQIB, blended with a commercial fullerene as active layer of the artificial photoreceptor. Patch clamp recordings showed, that photoexcitation of the system with short light pulses, stimulated fast capacitive transmembrane currents in the N2A cells [3]. The electrical coupling between the artificial photoreceptor and the neuronal cells was fast and direct, but still was only of passive nature. To increase the capacitive coupling, we deposit an additional dielectric coating such as silicon dioxide onto the active layer. We conduct a systematic investigation of the impact of the dielectric coating on transient photocurrents within the electrolyte and the consequential transmembrane currents. Additionally, we monitor the stability of the modified artificial photoreceptor in physiological environment under illuminated conditions by atomic force microscopy.

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May 23rd, 2017, Poster - U4KU4

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Cell Specific Electrode Array on All Biomimicking Polymers toward Long Term Stable Electrical Interfacing

Si-Hao Qian, Yong He, Bo Zhu

Bioelectronic devices have potential diagnostic and therapeutic applications in diverse medical fields such as the bionic ear and brain-computer interface. Electrode between the biotic and abiotic worlds has been demonstrated to be the most important part of these devices. However, implanting electrode inside the nervous system often incurs inflammatory response, which will lead to fibrous encapsulation, cutting off the connection between electrodes and electro-active cells and increasing the electrical impedance of the bioelectronics interface. Consequently, there is a high expectation for electrode coating of low impedance, high selectivity, high resolution and long-term stability. In early research, we have successfully developed a biomimetic conducting polymer film to facilitate a selective interaction to neural cells.1 However, the recording site is not the only part of an implanted electrode. The Insulating layer occupies the most part of the electrode, which plays very important role in the biocompatibility of the whole electrode. Therefore, we synthesized a protein/cell resistant poly(p-xylylene) thin film for the dielectric barrier. The design of bionic insulation significantly reduces the nonspecific adhesion of proteins/cells. We further integrated the biomimetic PEDOT derivatives with the bionic insulating material to fabricate an electrode array of all biomimicking polymers. We demonstrated that the feature of all biomimicking design ensures not noly a excellent proteins/cells resistance for the whole electrode but also a selective electrical interfacing of recording sites to neural cells.

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May 23rd, 2017, Poster - H8L2A

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A Reversibly Electro-Switchable PEDOT Matertial toward On-Demand Drug Delivery

Ya-Qiong Zhang, Bo ZHU

The local drug delivery by implanted devices or materials is an effective approach to manage chronic diseases. The electro-responsive platform supplies not only a chance to load a spatial-, temporal- and dosage-control on drug delivery, but also a potential to realize the on-demand delivery by a portable electric stimulus, which is particularly critical when a emergent medication become necessary. However, the electro-responsive delivery systems are challenged by the slow delivery rate, the poor reproducibility of drug release between the ON/OFF stimulation, and the PH variation during delivery. Toward solving these critical issues, we fabricated a reversibly electro-switchable drug delivery system based on electro-responsive PEDOT Materials. It complexes with functional molecules under reduction, while releases them quickly via applying a small value of oxidation potential. As the electro-switch is reversible, we could reload the drug molecules into the depot by applying a small reduction potential. We further demonstrated the release of molecules could be tuned precisely from a stable controlled rate to a burst release.

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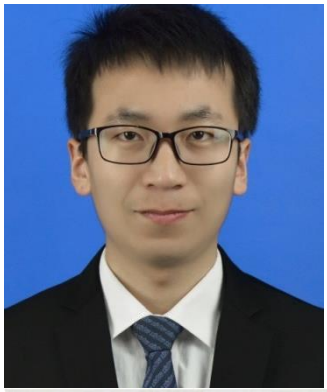

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3-Dimensional Conducting Platform toward Efficient and Selective Capture of CTCs

Qi-Chao Pan, Ya-Qiong Zhang, Haichao Zhao,Yaopeng Zhang, Bo Zhu

Capture and isolation of circulating tumor cells (CTC) hold a great potential in cancer diagnosis, prognosis and personalized therapy, and tons of efforts have been carried out in recent years1. Most of the previous cell-capture platforms have a very high capture efficiency, but suffering from poor capture selectivity due to the presence of nonspecific interaction. In this study, to ensure both efficiency and selectivity at cell-capture, we fabricated a 3-dimensional conducting platform, which consists of a membrane mimicking PEDOT substrate2 and low density of membrane mimicking polymer chains grown from the conducting substrate. Its membrane mimicking feature promises the high selectivity of this conducting platform due to the absence of nonspecific interaction. Furthermore, the low density of cell-capture chains combines the softness and high density of accessible antibodies to ensure the high efficiency at cell-capture. The 3D conducting platform successfully demonstrated its superior performance at capturing CTCs than the previous nanodot PEDOT system3. We are now utilizing it as an electrochemical sensor to detect CTCs, and wish to report it in the near future.

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Template-free Assembling of Bio-functionalized Poly(3,4-ethylenedioxythiophene) with Controllable Nanostructures and their Applications in Tumor Cell Capturing

Zhi Geng , Qichao Pan, Zhengwei You, Bo Zhu

Conducting polymers had been widely used in the fields of cell-related diagnostic and therapeutic platforms. Among them, researchers showed great interests on poly(3,4-ethylenedioxythiophene) (PEDOT) due to its excellent properties of low structure defects, high aqueous stability and biocompatibility. Meanwhile, properly nanostructures could extremely enhance the tumor cell-capturing efficiency of bio-functional PEDOTs1. Several approaches have been made to fabricate PEDOT materials with nanostructures via template method, seeding, interfacial polymerization, vapor polymerization, and self-assembly approach. However, most of them require hard-templates or surfactants, which would complicate the preparation process and reduce the quality of the obtained materials. Therefore, we have proposed the approach for fabricating template-free bio-functional poly(3,4-ethylenedioxythiophene) with controllable nanostructures via electrochemical deposition. By tuning the experimental condition, controllable switching nanodots and nanotube structure of PEDOT, PEDOT-OH and PEDOT-COOH could be fabricated. Meanwhile, changing of electric charges and physical structures of nanodots and nanotube PEDOT-OH films were studied to explain the morphology transformation. Besides, the cell-capturing efficiency was characterized of the nanodots and nanotube structure EDOT-COOH films after bio-conjugated. We hope this current study would provide a simple and effective method for fabricating high efficiency tumor cell-capturing materials.

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May 23rd, 2017, Oral -VD72K

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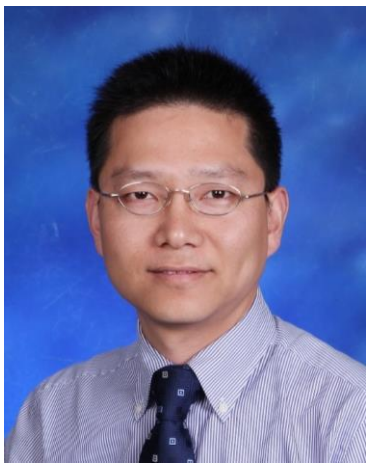

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A conductive biomaterial: regenerated silk fibroin conductive film modified by poly(hydroxymethyl-3,4-ethylenedioxythiophene) through in situ chemical oxidative polymerization

Ao Zhuang, Yongjun Bian, Jianwei Zhou, Huili Shao, Xuechao Hu, Bo Zhu*, Yaopeng Zhang*

Silk fibroin is a good candidate to fabricate conductive biomaterial for bioelectrical applications because of its excellent mechanical property, biocompatibility and biodegradability. The modification by conductive polymer can endow silk fibroin with novel conductive functionality. Poly(hydroxymethyl-3,4-ethylenedioxythiophene) (PEDOT) and its derivatives are very potential for the modification due to the high conductivity, biocompatibility, environmental stability and light transmittance. However, the hydrophobic PEDOT monomers have difficulties in absorbing and synthesizing on the surface of silk fibroin. In order to improve the efficiency of the polymerization, sodium dodecyl sulfate (SDS) was adopted as surfactant while ammonium persulfate (APS) was used as oxidant. Poly(hydroxymethyl-3,4-ethylenedioxythiophene) (PEDOT-OH) was polymerized and covalently deposited as a conducting layer on the surface of RSF film. The effects of the dosages of surfactant and oxidant, initial pH value and monomer concentration on the conductivity and morphology of the film were investigated. Results showed that SDS plays an important role to construct smooth conductive coating with several microns. The conductive RSF film shows a square resistance on the order of 105Ω or a conductivity on the order of 10-3 S/cm. This modification can be applied for RSF materials with various forms including fiber, film, foam, mats and 3D scaffolds. It is also possible to construct a microfluidic device with integrated conductive RSF channel for further applications of biosensor, tissue engineering and organic electronics.

May 23rd, 2017, Oral - PPC31

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Exploring the interaction of DNA nanostructures with lipid bilayers

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Membrane proteins contribute to a number of crucial roles such as transport, mechano-regulation or signal transduction. For this reason, engineered proteins interacting with the cell membrane are expected to offer novel added functionalities. However, current protein engineering strategies often take considerably long time and show difficult tunability, making this process difficult to scale up and hindering the use of high throughput approaches.

However, it seems DNA nanotechnology could overcome this issue. Although the use of free DNA as vaccination method has been reported, there is little research concerning its interaction with lipid membranes. Nevertheless, recent studies suggest that lipid-decorated DNA structures can bind to and penetrate lipid bilayers.

Hence, we will exploit the tunability of water-soluble DNA nanostructures to explore how their interaction with lipid membranes differs according to their shape and functionalization. By using a fluorescent readout, we expect to elucidate how we can tune the degree of binding and penetration of these constructs.

If successful, our results could be extrapolated to protein engineering, enabling faster paces and allowing a high throughput approach. Furthermore, the use DNA nanostructures for replicating membrane proteins could be assessed, potentially enabling the creation of novel therapies.

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A 3D model for bone tissue engineering

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One of the latest trends in the fields of tissue engineering as well as oncological research is the development of in vitro systems mimicking specific target tissues. In this way, models will be available that replicate the tridimensional structure and microenvironment experienced by cells in the target tissue more closely than the 2D systems employed so far. Interestingly, in addition to chemical and mechanical cues, certain tissues are known to be regulated by endogenous bioelectrical cues. One such tissue is the bone. Indeed, it has been demonstrated to exhibit piezoelectric properties in vivo, generating electrical potential upon mechanical deformation and responding to electrical stimulation. Electrical stimulation has been proven to sustain cell proliferation as well as to boost the expression of genes related to stem cells osteogenic differentiation. The device that will be developed will consist of 3D electroactive porous scaffolds allowing both electrical stimulation of stem cells and the analysis of the differentiation process towards bone-forming cells.

May 23rd, 2017, Poster - KB6RS

Smart Scaffolds for 3D models: Electroactive scaffolds for in vitro cells monitoring and stimulation

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Large research efforts are being applied to develop alternatives to the current practices in the field of animal studies. The aim is to give an answer to the drawbacks of the use of animals to test drugs and medical devices for human use, meeting the so-called 3Rs principals of reduction, refinement and replacement in this field.[1] One powerful way in this diretion is represented by in vitro models where specific organs or tissues are recreated, recapitulating the in vivo mechanical and chemical environments experienced by cells in our body. We aim to reproduce the in vivo environment and to endow our device with the possibility of both monitoring cells processes and actively addressing them (i.e. electrical stimulation). To this end the scaffold material plays a pivotal role. A tridimensional electroactive scaffold has been developed starting from the conductive conjugated polymer PEDOT:PSS. Organic bioelectronic devices represent a novel technology allowing for label-free, non -invasive monitoring of cells through an electronic readout, additionally providing real-time measurements. In addition to the obvious advantages of low cost processing, compatibility with large area applications, and tunability of properties through chemical synthesis, organic electronic materials transcend the current state of the art in transduction and stimulation of electrical activity in cells displaying the ability to conduct ions, thereby providing a lower impedance connection to cells.[2] The developed scaffolds were showed to allow cells proliferation and its monitoring via an electronic read out (scaffolds impedance). The achieved results pave the way for the successful development of 3D models of different tissues and organs (i.e. blood brain barrier, bone) where it will be possible not only to monitor cells state but also actively stimulate them.

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Injectable polyamidoamine-based hydrogels for biomedical applications

Leana Travaglini, Federica Fiorini, Giuseppe Alonci, Elena Longhi, Pietro Riva, Silvana Perretta, and Luisa De Cola

Since their first introduction in 1960 [1] hydrogels have been firmly established as ideal materials for biomedical applications and tissue engineering due to their attractive features. Biocompatibility, high water content, [2] tissue-like elastic properties and 3D porous structures, which allow for the permeation of oxygen and nutrients, [3] made possible to widely exploit hydrogels as drug delivery systems, biosensors and scaffolds for cell culture.[4,5] Moreover, the possibility to introduce addressable groups in the gel network allows to finely tune the properties of the hydrogels in order to obtain smart biomaterials. In this presentation we report on some recent advances that have been made in our group in the preparation of biocompatible injectable polyamidoamine-based hydrogels for biomedical and imaging applications. Various hydrogels with different morphological, swelling and mechanical properties have been investigated in order to evaluate their properties as injectable adhesive sealants for tissue repair, showing outstanding properties.

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Polyamidoamine hydrogels for innovative biomedical applications

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Hydrogels have been extensively investigated for biomedical applications and tissue engineering. Their biocompatibility and resemblance with living tissues make them ideal materials to be applied in drug delivery, biosensing and as scaffolds for cell growth.[1-4] Notably, the possibility to introduce various functional groups into the polymeric network provides wide scope for tuning the hydrogel properties, obtaining smart biomaterials. Herein we report the synthesis and characterization of polyamidoamine-based hydrogels with equilibrium water content (EWC) up to 96%. The properties of the material were tuned by varying reaction conditions, such as pH and the relative concentrations of monomers, obtaining hydrogels with improved swelling properties. In vitro and ex vivo tests assessed their efficacy as adhesive sealants for gastrointestinal fistulas. Our injectable hydrogels could pave the way to endoscopic non-invasive procedures for fistula treatment. Further experiments are still in progress to optimize the properties of these scaffolds and to explore their biocompatibility.

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On the design of low rigidity biocompatible Ti-xNb (0 < x< 35) alloys by density functional theory calculations

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In this work, we present a systematic ab initio study on the structural, electronic and mechanical properties of Ti-xNb (x < 35at%) alloys. This necessity is originated from the currently used Ti-6Al-4V implants that consist of cytotoxic elements and exhibit higher Young's modulus (E~112GPa) compared to a bone (E < 30GPa), resulting in bone atrophy and implant loosening. Our results predict a variety of phases (including ω, α', α'' and β) depending on the Nb concentration, in agreement with previous works. The α′ and ω are favorable for Ti-xNb (x ≤ 6.25%at), the β phase is stable at high Nb compositions (x ≥ 18.75at%) while the α″ phase may form in intermediate concentrations. The α′ and ω hexagonal phases become unstable at high Nb content due to the electronic band filling at the Fermi level (EF), while in the cubic β-Ti-25 at%Nb the depletion of the occupied electronic states at EF results in a stable β-TiNb structure. Our results exhibit the Eω > Eα′ > Eα″ > Eβ sequence, revealing the importance of the phases coexistence for the E reduction. The Young's modulus surface revealed high anisotropic E values for all Ti-Nb phases, while the Eβ along the [100] direction exhibits an E under 30GPa suggesting the importance of a Ti-Nb single-crystal growth for the design of low rigidity alloys. These results could enlighten the electronic origin of the Ti-Nb phase stability and thus be used for the design of novel alloys suitable for biomedical applications.

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Patterned CNT growth with BNCD coatings for applications in neuronal intra–cellular recording

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To learn more about neurological diseases such as stroke, Parkinson's and dementia, it is of upmost importance that neuronal behaviour and electrical activity of 3D neural networks is understood. Present electrophysiological techniques using 2D microelectrode arrays (MEAs) allow for extracellular recording of non–specific collections of neurons. 3D electrodes are highly desirable as they allow for a better electrode–neural interface, with a larger surface area and the ability to record from within the cell. Current optimisation of MEAs is ongoing, and devices, which are able to facilitate location traced simultaneous recording and stimulation of large populations of individual neurons, are required.

Boron–doped nanocrystalline diamond (BNCD) coated carbon nanotubes (CNTs) have shown to be an attractive choice of material for neural interfacing due to the low impedance, high capacitance and biocompatibility observed[1], [2]. Here at UCL, CNT growth, which is performed in a DC plasma CVD process, is optimised in order to produce both patterns of vertically aligned and individual CNTs for intra–cellular recording application. Since combining individual BNCD coated CNT electrodes with 3D hydrogels is planned, controlled location and size of CNTs is desired. Therefore, we have developed recipes in which specific dimensions of CNTs can be grown, followed by diamond coating.

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The interaction and differentiation of human Neural Stem cells on oxygenated nanodiamonds

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Neural stem cells (NSCs) have great potential for inducing repair in damaged areas of the nervous system. NSCs have the ability to self-renew, but also are able to differentiate into neurons, oligodendrocytes and astrocytes, which are the main cells in the central nervous system (CNS). Understanding the differentiation into these cell lineages is critical for regenerative therapy treatment of diseases such as Parkinson?s and Alzheimer?s, as detailed knowledge of how these specific cells are affected by disease is vital(1) In order to utilise the potential of stem cells in the field of regenerative medicine, it is essential that we are able to isolate the cells from their natural setting, propagate the cells in culture, and introduce the cells to a foreign environment(2). Given the outstanding biocompatibility of nanodiamonds (NDs) towards neuronal cells(3), nanocrystalline diamond (NCD) towards hNSCs(4) and their excellent ability to promote neuronal cell adhesion and outgrowth, the proliferation and differentiation of human NSCs (hNSCs) and their relationship with functionalised ND coatings has been investigated.

Firstly, the interaction of hNSCs with varying surface functionalised NDs is investigated; with Oxygen-terminated functionalised surfaces favouring the proliferation of hNSC, compared to those with a Hydrogen-terminated surface. Quantitative cell count data of the hNSCs has been determined on the varying functionalised NDs as well as glass and tissue culture polystyrene (TCPS), along with contact angle and protein adsorption investigations suggesting a hypothesis for this result. Secondly ND surfaces of different functionalisation (H/O) are shown to influence the differentiation and proliferation of hNSCs in varying ways. hNSCs fate has been investigated via inducing and spontaneously differentiating the cells on varying nanodiamond substrates.

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Adipose (fat tissue)-derived stem cell- nanodiamond interaction for the development of differing cell lines

Despoina Paschou, Dr Alice Taylor, Sungmyung Kang, Eleonora Zucchelli, Prof Patrizia Ferretti, Prof Richard Jackman

Adipose- derived stem cells (ADSCs) are a novel type of mesenchymal stem cells (MSCs). MSCs are widely used for differentiation to tissues and cells such as bone and muscle. Up until recently, the most common type of MSCs for clinical application were Bone Marrow-derived MSCs (BM-MSCs). Although BM-MSCs and ADSCs are similar in nature, ADSCs possess the superior capability of being easier to harvest: In the case of BM-MSCs, the procedure is more invasive and requires penetration of the hipbone. On the other hand, ADSCs can be obtained in a safer way and larger amounts, by using subcutaneous fat tissue. This makes them far more applicable in cases where invasive surgery is not an option, such as on infants and young children. ADSCs can differentiate into a range of cell types, such as bone, chondrocytes and neurons. Due to their accessibility, ADSCs are a particularly attractive solution for the correction of congenital defects, such as craniofacial defects using autologous grafts. Autologous grafts are of great significance for tissue engineering and regenerative medicine, as they are mitigating the risk of rejection, because they are derived from the patients' own body. In the past, the interaction between human Neural Stem Cells (hNSCs) and nanodiamonds (NDs) has been widely investigated by our team [1]. NDs possess great biocompatibility properties and they have been shown to interact particularly well with hNSCs. Early in vitro results have also shown significant compatibility with ADSCs. In proof-of-concept experiments, oxygen-terminated NDs have been shown to function as a more efficient environment for the proliferation and differentiation of ADSCs than other types of ND-based microenvironments, creating optimal conditions for the development of a range of tissues potentially both in-vitro and in-vivo.

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May 23rd, 2017, Oral – U9ZW8

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On demand Drug-Eluting, Cancer Cell-Repellent Multifunctional Stent

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Stent is an essential medical device to prolong survival when plaque blocks body conduits or tubular organ. However, a conventional bare-metal stent (BMS) has been faced with restenosis problem caused by tissue hyperplasia secondary to BMS placements. Drug-eluting stent (DES) has been introduced to lower rate of restenosis. Especially reservoir-based DES has attracted lots of attention due to advantages of high capacity and uniformity of drugs. However, it is hard to fabricate reservoir structure with simple and time-efficient process. In addition to DES, to treat restenosis, controlling of the cell behavior that interact with implanted bio-devices has been also considered as desirable strategy because there is a need to limit the adhesion and viability of cells on stent. In order to effectively inhibit restenosis, we suggest multifunctional DES combined physically cell repellent approach with drug treatment using nanoturf structure. An ultraviolet (UV)-curable polysiloxane acrylate (PSA) is used to fabricate multifunctional nanostructure using two consecutive steps: UV induced polymerization and reactive ion etching (RIE) with time-efficient process because it demands only a few minute to fabricate. We elucidate tumor cell-repellent property by showing reduced focal adhesion and monitor number of attached tumor cells on the nanoturf structures compared with flat surface while maintaining biocompatibility. Furthermore, we showed the possibility of localized drug elution via near-infrared (NIR) irradiation. Our study has a great potentials to widen other biomedical implants that use a surface needed to control cell behavior and release a drug

May 23rd, 2017, Poster – Q5CSZ

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Hollow PLGA particles for encapsulation and delivery of peptide GLP-1 to overcome the limitations of solid particles

Sharad Kharel, Say Chye Joachim LOO

Biodegradable polymer particulate systems, such as poly(d-lactic-co-glyocolic acid) (PLGA), are frequently used as vehicles for controlled release of bioactive molecules. However, these systems suffer from the inherent problem of acidification of the internal environment due to the acidic degradation products during the release period. This has been reported to perturb the configuration of encapsulated peptides. Additionally, unrealistically slow and incomplete release of bioactive molecules are also other shortcomings of this otherwise very capable delivery system. To mitigate these issues, hollow PLGA particles are fabricated through a novel one-step osmogen mediated oil-in-water emulsion solvent evaporation technique. These hollow particles are loaded with Glucagon-like peptide-1 (GLP-1), an incretin hormone, to evaluate the efficacy of the system over the solid particles as a delivery vehicle. While the solid particles are shown to be suffering from incomplete release of the peptide, the hollow particles are shown to be easily optimized to achieve various release profiles, including complete release, by simply adjusting the amount of osmogen in the formulation. Additionally, these hollow particles are also shown to be effective in maintaining the structural integrity and bioactivity of the encapsulated peptide, while degradation of the encapsulated peptide was observed in the solid particles during the release study.

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FABRICATION OF MICROCAPSULES CONTAINING CLOVE OIL AND ITS APPLICATION FOR ANTIBACTERIAL PURPOSES

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Essential oils (EOs) produced from plant extracts have gained wide attention in recent years owing to its multifunctional properties. EOs have low toxicity and degrade quickly in soil and water, rendering them with environmental friendly property. Among the EOs, clove oil has been studied extensively due to its antimicrobial effect against a wide range of bacteria strains. However, the volatility and chemical instability of clove oil has severely limited its potential uses. In this study, clove oil is encapsulated using both in-situ and interfacial polymerization to enhance its chemical stability and prevent premature leakage under harsh environment. The formation of double layer polyurethane/poly (urea-formaldehyde) (PU/PUF) shell was confirmed through the cross-sectional view which shows distinct porous PU and dense PUF layers. Several reaction parameters were studied to fabricate microcapsules with different release profiles. Moreover, the release profile of these microcapsules was found to fit the Baker-Lonsdale model which identifies diffusion as the release mechanism. Through the standard plate count method, these microcapsules containing clove oil was proven to exhibit antibacterial activity against V. Coralliilyticus, a temperature dependent global marine pathogen that can cause coral diseases and contribute to marine biofilm. These microcapsules containing clove oil have great potential to be an eco-friendly solution to replace existing toxic antifouling agent.

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Silk/Cellulose Nanocrystal Nanocomposite Films with Enhanced Barrier Properties

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Packaging materials that cover or protect products to prevent deformation or spoiling have received much attention in polymer science and engineering fields over the last several decades. The recent increase in environmental concerns has demanded replacing conventional petroleum-derived plastics with alternative packaging materials based on bio-resources. Thus, diverse biopolymers such as poly(lactic acid), poly(hydroxy acid), and polycaprolactone have been widely investigated as eco-friendly packaging materials.

Silk, a natural biopolymer, has been utilized in textile and biotechnological applications because of its exceptional mechanical and bio-relative properties. In addition, silk can be easily formed into mechanically robust films with excellent surface qualities (surface roughness rms <5 nm), high transparency (>90% transmission in the visible range), and good chemical resistance properties. Thus, silk is a good candidate for packaging material. However, the harsh conditions required for its regeneration deteriorate the crystal structure of silk films, resulting in insufficient barrier properties for practical use. In this work, we prepared silk/cellulose nanocrystal (CN) composite films containing different CN loadings and investigated the changes of crystal structure according to the incorporation of rod-like nanoparticles with exceptional strength and modulus, as well as the mechanical and barrier properties of the composite films.

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Multifunctional conductive bionanocomposite hydrogels for wound healing

Federica Leone, Barbara Onida, Karen Wright, John G. Hardy

Wound dressings are materials designed to cover wounds, prevent infections and help injured tissues to repair and regenerate. This project aims to develop multifunctional conductive materials and test their efficacy for improving wound healing using an *in vitro* wound model. The bionanocomposite materials prepared are in principle capable of simultaneously delivering therapeutically active biomolecules and electrically stimulating cells, potentially thereby enhancing the rate of wound healing. The nanocomposite materials are based on polymers (e.g. polyacrylates and/or conducting polymers based on derivatives of 3,4-ethylenedioxythiophene and pyrrole monomers), and optionally inorganic materials such as nanostructured ZnO (synthesised using sol-gel techniques and loaded with drug models using established methods). The properties of the materials were characterized spectroscopically, thermally, microscopically, electrochemically, and mechanically. The *in vitro* delivery of therapeutically relevant model drugs was assessed spectroscopically, and *in vitro* cell culture experiments of a wound healing paradigm with/without electrical stimulation were carried out with relevant cells, and they have long term potential for optimization for different wound niches.

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Multifunctional conductive bionanocomposite hydrogels for wound healing

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Wound dressings (WD) are materials designed to cover wounds, prevent infections and help injured tissues to repair and regenerate. This project aims to develop multifunctional conductive hydrogel-based WD and test their efficacy using an in vitro wound model. The conductive bionanocomposite hydrogels (based on chitosan, zinc oxide and conducting polymers [CP]) prepared were capable of simultaneously delivering therapeutically active biomolecules and electrically stimulating the wound, enhancing the rate of wound healing. Nanostructured ZnO was synthesised using sol-gel techniques and loaded with drug models using established methods (supercritical CO2 and adsorption techniques). CP were synthetized, based on derivatives of 3,4-ethylenedioxythiophene (EDOT) and pyrrole monomers. The CP were attached to the hydrogel matrix and mixed with drug-loaded nanostructured ZnO. The properties of the materials were characterized spectroscopically (IR, XPS), thermally (DSC, TGA), microscopically (optical, SEM, TEM), electrochemically (CV, conductivity), and mechanically (DMA and rheology). The in vitro delivery of therapeutically relevant model drugs was assessed spectroscopically (UV), and in vitro cell culture experiments of a wound healing paradigm with/without electrical stimulation were carried out with fibroblasts/epithelial cells, suggesting their potential for in vivo testing in the future, to optimize the efficacy of this novel class of biomaterials for different wound niches.

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Interfacial Nanoshell Formation Using Ferric Ion and Tannic Acid for Cell Encapsulation

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The nanoshell formation in cell encapsulation aims to isolate and protect living cells from harmful, often lethal, external environment in vivo and in vitro. So it has recently attracted a great deal of attention because of its potential applications in various fields, such as cell therapy, biocatalysts and sensors, and regenerative medicine, as well as providing research platforms for fundamental studies on single-cell biology. Although several strategies are available to form nanometric shells for cell encapsulation, most methods heavily reply on the time-consuming and multi-step processes. Therefore, it is highly desired in the field of cell nanoencapsulation to develop simple, fast, and cytocompatible chemical methods for nanoshell formation.

We developed a chemical method of nanoshell formation via the interfacial supramolecular self-assembly of ferric ion (FeIII) and tannic acid (TA), and this synthetic strategy was applied to cell nanoencapsulation under various expermental settings by taking advantage of its superior characteristics, including simple and fast reaction under cytocompatible conditions. Its versatility is demonstrated with various interfaces: hollow microcapsules, encasing microbial or mammalian cells, are generated at the water-oil interface in the microfluidic device; a cytoprotective FeIII-TA shell forms rapidly on the surface of the alginate microbead that entraps probiotic Lactobacillus acidophilus; moreover, Saccharomyces cerevisiae, fed with FeIII, responds to TA in the outside medium and forms a pericellular FeIII-TA shell. This reaction system will advance chemical manipulability of living cells and also suggest a new structural motif in materials science.

May 22nd, 2017, Oral - MJUGL

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Toxicological Evaluation of TiO2 and ZnO Nanoparticles on Fibroblasts and Keratinocytes

Archana Gautam, Luong T. H. Nguyen, Kee Woei Ng

The rapid development in the field of nanotechnology has offered new prospects in various sectors. The engineered nanoparticles have been used extensively in myriad of applications due to their unique physiochemical properties. TiO_2 and ZnO in particular are highly favored as UV-filters in skincare products. Despite them being considered innert at bulk phase, suggestion of their ability to penetrate the skin to reach viable cells and exert physiological influences has raised concerns. However, understanding of nanoparticle-mediated toxicity in skin is still limited. In light of this, this study reports on the toxicity of TiO_2 and ZnO nanoparticles (pristine size 22±4 nm and 20±2 nm, respectively) on primary human skin cells- keratinocytes and fibroblasts. Using various in vitro assays to measure cell proliferation (Picogreen assay), cell metabolism (AlamarBlue assay), oxidative stress (2',7'-dichlorodihydrofluorescein diacetate (H2DCFDA) and MitoSOX ™ Red mitochondrial superoxide indicator) and autophagy (Monodansylcadaverine staining), the effects of these nanoparticles were studied. Our 2D in vitro tests showed that, ZnO was significantly more toxic than TiO_2 to both cell types. ZnO at 50 µg/ml caused acute cell death after 4-hour exposure and upon increasing the exposure to 24 hours, a lower concentration of 10 µg/ml was able to cause acute cell death. On the other hand, TiO_2 at 1 mg/ml showed minimal toxic effects to cells after 4-hour exposure while 24-hour exposure to 100 µg/ml TiO2 caused significant toxicity. Analysis of oxidative stress via measurement of ROS and mitochondrial superoxide showed that both TiO_2 and ZnO caused oxidative stress in cells at sub toxic concentration (10 µg/ml) which increased with dose and exposure. These nanoparticles were also able to induce autophagy in keratinocytes at very low concentrations (100 fg/ml and 500 pg/ml of TiO_2 and ZnO, respectively). With these results as a benchmark, our next objective is to study and correlate the effects of these nanoparticles on skin cells in 3D cultures using our established full thickness organotypic skin model.

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A DNA Assay on a string

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Single-molecule nucleic acid electronic sensing has the potential to be developed into rapid, sensitive, accurate and low-cost point-of-care biosensors. In single-molecule electronic sensing, analytes are driven through a nanopore via electrophoresis. The temporary blockage of the pore will register an ionic current fluctuation. The electrical signal (current amplitude change, duration of fluctuation, substructure) reflects the identity of the analyte. To achieve the detection of specific nucleic acid sequences, we propose a sensing strategy that involves the attachment of complementary single-stranded DNA (ssDNA) probes as overhangs on a long dsDNA carrier strand. Complementary target sequences will hybridise to the probes, transforming the overhangs from a compact coil (unhybridised ssDNA) to a stiff rod structure (dsDNA). Thus, a large secondary current drop can be detected when a hybridised probe on the DNA carrier strand translocates through the nanopore. Multi- analyte detection will be investigated by attaching different probes on the same carrier DNA (from bacteriophage M13). Our group has recently reported the use of custom-designed, low noise (high current resolution), high bandwidth (detect fast events) current amplifiers to enhance signal output. The custom-designed electronics will allow us to detect and differentiate between hybridised and unhybridised overhangs.

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Strategies for using biomaterials for targeting intracellular pathogens

Rajeev Mudakavi, Surya Vanamali, Dipshikha Chakravortty, Ashok M.Raichur

Biomolecules engineered onto non-biological surfaces can be used to achieve specific effects in the biological system. One such requirement is to control the fate of the particles after endocytosis inside the cell. The handle on the endocytosed particle can lead us to target any particular organelle or part in a cell for therapy of cancer or intracellular infections. The intracellular vacuoles formed by certain pathogenic bacteria confer protection against host cellular defenses and render the currently used antibiotic therapy ineffective in clearing of the pathogen. The development of growing resistance in these intracellular pathogens is a direct consequence of insufficient antibiotic concentrations reaching such a shielded intracellular site. The shielded intracellular niche, in this case a specific vacuole created by Salmonella bacteria is called a Salmonella containing vacuole (SCV). This requires delivering higher antibiotic concentration in the infected cells. The ability to target infected cells and leave the uninfected cells requires active targeting by the nanoparticle system. This is achieved by employing arginine decorated particles to carry the antibiotics, by making use of enhanced arginine requirement by intracellular pathogens. The synthesized nanoparticle is able to enter the infected cell and deliver the antibiotic at the vacuolar site. This work translates from our group?s previous work demonstrating the enhanced arginine requirement by intracellular pathogens. Salmonella is used here as a model intracellular pathogen and this work finds easy translatability to other diseases caused by intracellular pathogens such as Tularaemia and Tuberculosis (TB).

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Fractionation of cellulose nanocrystals: from liquid crystal self-assembly to the formation of structural films

Camila Honorato-Rios, Jan Lagerwall

Cellulose nanocrystals (CNCs), nanorods produced by acid hydrolysis of cellulosic sources, are emerging as a new class of functional biomaterial. CNCs present a broad range of uses, for example in composites, cosmetics, security paper and medical devices [1]. The fascinating ability of CNCs to self-organize into a cholesteric liquid crystal phase, with a helical arrangement of the nanorods, is attracting substantial interest across different research fields [2]. It is important from an applied point of view since this arrangement gives a photonic band gap to the final dried CNC films, but also from a fundamental soft matter physics perspective, as many details of the CNC liquid crystal formation are far from being understood. A critical problem from an analytical, and likely also from an applied perspective, is the high length polydispersity of as-produced CNC samples. In this study, we introduce a method for fractionating the CNC nanorods, utilizing the spontaneous phase separation between isotropic and liquid crystalline phases, allowing us to narrow down the length distribution. The aspect ratio (length/diameter) has a strong effect on the period of the cholesteric helix, affecting the iridescent colors appearing in dried CNC films. We believe that a reduced polydispersity will allow us to better control the color of the finally dispersed films, compared to the natural polydisperse samples that are now being used in the community. We present how this affects the self-assembly process, and consequently the color formation in such bio-derived structural films.

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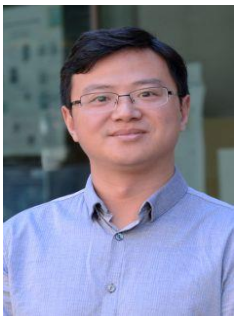

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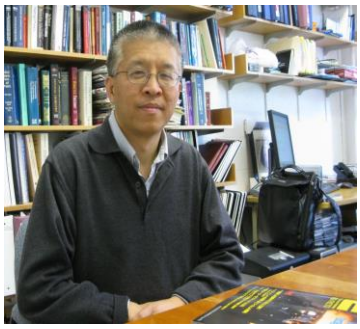

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Spectral changes of agarose-based ultrasonic tissue-mimicking gel under different temperatures

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Spectrophotometric results for a well-known agarose-based ultrasonic tissue-mimicking gel phantom material, as developed by Madsen and colleagues, are reported for the purpose of temperature change detection. The gel consists of a combination of agarose, distilled water, n-propanol, and evaporated milk. Gels were cast into 2 mm thick cuvettes and allowed to cool to room temperature. Spectra obtained include those at room temperature and those following heating to temperatures between 30 and 80 degrees centigrade. Temperature elevation causes substantial irreversible changes in gel absorption spectra, with increased absorption between wavelengths of 800 to 1000 nm. Such spectral changes with heating may provide a means for estimating ultrasonically induced localized heating in this material, for instance with high-intensity focused ultrasound or other ultrasonic exposures.

May 22nd, 2017, Poster – GCMVT, K.FPI.3

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Interfacing Enzymes with Silicon Nanocrystals through Thiol-Ene Reaction

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Disease states are typically caused by accumulation of metabolites and biological intermediates that disrupt the normal operation of cells and tissues. The introduction of enzymes, catalytic protein molecules essential for normal biological function, which act on such metabolites into diseased tissues provides an attractive alternative for curing such diseases. Silicon nanocrystals, owing to their nontoxicity and photostability, offer a safer and more efficient bioimaging platform compared to status quo organic dyes. Thus, a hybrid material consisting of enzyme molecules that have been interfaced with silicon nanocrystals can potentially be used for simultaneous imaging and therapy. This study reports, for the first time, a procedure for the preparation of enzyme-conjugated silicon nanocrystals from native enzymes and alkene-terminated silicon nanocrystals through photochemical thiol-ene reaction. Glucose oxidase and lactase were successfully immobilized on silicon nanocrystals as demonstrated by Fourier transform infrared spectroscopy and X-ray photoelectron spectroscopy. Moreover, single reaction and cascade kinetic assays confirm that the immobilized enzymes retain catalytic activity. The method reported is general and can be used to prepare enzyme-silicon nanocrystal hybrids that can be employed in personalized medicine for targeting and potentially treating diseases like cancer and other metabolic disorders.

May 22nd, 2017, Oral – XUAGW, K.FI.6

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Multifunctional Graphene-wrapped ZnO Nanocarriers for Chemo-Photothermal/Photodynamic Cancer Therapy in Vitro

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Nanoparticles are being increasingly recognized due to their potential utility in various sectors including nanomedicine. Herein, we have demonstrated a new strategy to synthesize multifunctional GO-wrapped ZnO nanoparticles (GO-ZnO nanohybrid) for targeting photodynamic therapy (PDT) under visible light irradiation. Folic acid (FA), a targeting agent toward cancer cells, was conjugated onto graphene oxide (GO) via imide linkage. The nanohybrids have shown pronounced improvement in tumor targeting, which has been demonstrated by MTT and cellular uptake assay. Due to the high electrical conductivity of GO, the interaction between GO and ZnO, and the inhibition of aggregation, the hybrid of GO-FA and ZnO significantly enhances the photodynamic activity, mediated by reactive oxygen species (ROS) generation under visible light irradiation. The study presents a novel tumor targeting photosensitizer and a promising strategy in PDT for cancer treatment.

May 23rd, 2017, Poster - 3Y0X1, K.FPII.9

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Assembly of Sub-Compartmentalized Microreactors and Hepatocytes for Bionic Tissue Formation

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Live cells are the basic working units in the biological tissue, performing different functions as natures' microreactor. Assembly of sub-compartmentalized microreactors has become an important approach to mimic cells due to the structure similarity, ease of encapsulation of different subunits with multiple cargos, and the controllable activity initiation. With the aim to make artificial hepatocytes, we designed different sized microreactors with entrapped enzyme loaded liposomal subunits using droplet microfluidic or the layer-by-layer assembling technique. First, the synthetic partner particles or capsules were co-cultured with biological hepatocytes and successfully incorporated into the growing cell culture, forming bionic tissue with artificial and biological components. The surfaces of the particles or capsules coated with different polymers facilitated a beneficial biological response, i.e., the integration of the artificial and biological hepatocytes in a co-cultured tissue sheet as well as co-cultured cell tissue spheroids. The biological hepatocytes proliferation in the bionic tissue was assessed. Furthermore, detoxification, a key function of liver cells, was performed by loading the enzyme catalase, which can remove the cytotoxic compound hydrogen peroxide (H2O2), into the liposomal subunits of the artificial hepatocytes. The viability of hepatocytes in the bionic tissue was improved in the presence of active microreactors. These findings are a major step towards the beneficial combination of biological and synthetics entities with potential impact in regenerative medicine. Key words: cell mimicry, sub-compartmentalized microreactor, hepatocytes, detoxification, bionic tissue.

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Superparamagnetic nanoparticles: Characterising motion and velocity through viscous media for in-vivo applications

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At present, superparamagnetic (SPM) nanoparticles are being used in a variety of biomedical applications in order to facilitate both laboratory-based diagnostics, as well as therapeutic and diagnostic applications in-vivo, e.g., localised drug delivery. This is due to their high magnetic susceptibility, biocompatibility and tuneable characteristics. In this research, SPM iron oxide nanoparticles (NPs) are being applied in the development of a non-invasive method for protein biomarker detection in interstitial environments. The extracellular matrix (ECM), which is situated in the dermal layer of the skin, is comprised of extracellular molecules secreted by the cells that provides structural and biochemical support to the surrounding cells.The interstitial fluid within this matrix is understood to contain a wealth of biomarkers at concentrations ranges significantly higher than that in blood. Thus, it is of increasing interest to develop new approaches to diagnostics for interstitial fluid given it can be accessed in a minimally-invasive manner and is known to contain a host of biomarkers. Hence, the goal of this research is to establish a method to characterise the NP motion under magnetic field in viscous media (where viscosity ranges are similar to that of the ECM), and use this method to elucidate the factors that affect rates of NP velocity. In this research, an agarose hydrogel is used as the viscous media. The movement of NPs under magnetic field through this media is monitored using an imaging technique. The primary forces influencing magnetic NP mobility in a biological system are the drag force (F_D) and the external magnetic force (F_M). It is critical to have stable, mono-disperse and biocompatible NPs, whose presence in-vivo does not generate an immune response and whose movement through the ECM can be controlled using an external magnetic field. Thus, the influence of core size and surface coating chemistry on mobility and stability in viscous media is investigated using our method.

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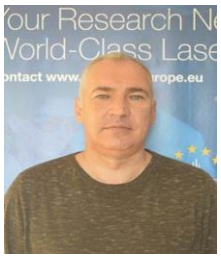

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Elaboration and characterization of bare laser-synthesized silicon for biomedical tasks

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Based-on Silicon element widely distributed in mammalian tissues, bare laser-synthesized Si nanoparticles (Si-NPs) appear promising tools for biomedical tasks. Here, we employ ultra-short laser method in aqueous solution to elaborate extremely stable colloidal Si-NPs solutions. The nanoparticles appear spherical with low size distribution ranging from few nm to tens of nm. Structural analysis evidences that Si-NPs are composed of Si nanocrystals surrounding with thin layer of SiOx (1?x?2) and exhibiting a negative charge surface of -35 mV ± 0.10. Moreover, by monitoring the amount of dissolved oxygen into the synthesis medium, we report a dependence of the dissolution rate of NPs in aqueous environment on the presence of oxidation-induced defects in the core of Si-NPs. By examining the interaction of bare Si-NPs with human cells after 72 h of incubation at different concentrations, we report no adverse effects up to high concentrations (50 µg/mL) and a good internalization via classical endocytosis mechanism. In addition, intravenous administration of Si-NPs using small animal model reveal any toxicity confirmed by behavior of mice, histological analysis and other key biochemical parameters. These encouraging results open exciting perspectives to develop bare laser-synthesized Si NPs as promising platforms in nanomedicine.

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Gold nanoparticles for non-invasive cell tracking

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Cell-based therapy is the transplantation of living cells for the treatment of diseases and injuries. Such therapy offers a promising solution for the treatment of various pathologies that conventional medicine cannot cure effectively, thus encouraging future medical breakthroughs. For instance, cancer-fighting T cells may be injected in the course of cancer immunotherapy, and stem cells may treat neurodegenerative diseases, heart disease, muscular dystrophy and diabetes. A major obstacle in the advancement and implementation of cell therapy is the challenge of no-invasively tracking transplanted cells in the body. In vivo cell tracking could elucidate essential knowledge regarding mechanisms underlying the success or failure of therapy. An optimal solution for the challenge of cell tracking does not yet exist hence the need for an accurate imaging technique. We developed a novel methodology for longitudinal and quantitative in vivo cell tracking, based on the combination of CT as an imaging modality and gold nanoparticles as labeling agents. We were able to show that uniting the superior visualization abilities of classical CT with state-of-the-art nanotechnology is the key for high-resolution cell tracking. In the future, this technology has the potential to be applied clinically and to serve as an early warning system for patients after cell transplantation.

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Polyelectrolyte and enzyme functionalized layered bionanomaterials for antioxidant applications

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Antioxidant enzymes are widely used in biomedical treatments or in chemical manufacturing processes to convert reactive oxygen species (ROS) into oxygen and water. However, the operating conditions (pH, temperature, ionic strength, etc.) can affect the enzyme properties and their reusability is often limited. To increase their functional stability and recyclability, enzyme immobilization on nanoparticles is a promising approach. We have investigated antioxidant systems based on layered nanomaterials such as titania nanosheets (TNS) or layered double hydroxides (LDH). Immobilization of antioxidant enzymes or enzyme-like complexes on the nanomaterials occurred through electrostatic and hydrophobic interactions. As the nanomaterials possessed limited stability at low/moderate salt concentrations, they were functionalized with polyelectrolytes in order to increase the colloidal stability of the system and also to further protect the enzymes. Upon polyelectrolyte adsorption, charge neutralization (aggregating system) or overcharging (stable suspension) of the particles could be observed at appropriate doses. The fully coated nanomaterials resulted in stable suspensions where primary particles were observed. Finally, the catalytic activity of the immobilized and embedded enzymes were measured and compared to the native one.

May 23rd, 2017, Oral - 5IR0Y, K.FII.5

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Testing of Nanoparticles in Cardiac-Associated Patients Targeting Reduction of Oxidative Stress

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Cardiovascular diseases constitute a major public health concern in industrialized nations. Oxidative stress induced free radicals play a critical role in cellular processes implicated in atherosclerosis and many other heart diseases. Quercetin (Qu) is an antioxidant drug which is shown that effectively protects against cardiovascular diseases (CVDs). Encapsulation of drugs in polymeric NPs are widely used in producing sustained and controllable drug release, or to avoid degradation of non-released drugs. In this current work, a novel system of polymeric PLGA monodispersed NPs loaded with Qu, was fabricated via electrohydrodynamic atomization process (EHDA) in order to improve poor aqueous solubility and stability of the drug with the aim of preventing atherosclerosis. The results of atomic force microscopy (AFM) analysis confirmed the fabrication of monodispersed spherical polymeric nanoparticles with diameter ranging from 100nm to 150nm, narrow size distribution and smooth surface. This measurement revealed also the presence of chitosan coating layer on the particles surface. The release profile of quercetin from the particles was investigated by determining the drug amount released at specific intervals for 1 month by luminescence. Furthermore, XRD analysis was used to determine the physical status of Qu encapsulated in NPs compared with that of pure Qu as well as the physical status of chitosan in the case of coated PLGA NPs. The information obtained from this study was further used in coronary patients in order to test in vivo the reduction of oxidative stress levels. Successfully it was facilitated that the design and fabrication of polymeric nanoparticles is a unique and possible delivery system for encapsulation, protection and controlled release of the *flavonoid quercetin which is* aiming to protect against CVDs.

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Cellulose nanocrystal/poly(butylene succinate) nanocomposites: Influences on their mechanical properties and biodegradation

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With increasing environmental awareness, biopolymers from renewable resources such as poly(butylene succinate) (PBS), polycaprolactone, poly(hydroxy acid), and poly(lactic acid) have attracted much attention as replacements for conventional petroleum-based synthetic plastics. However, the practical use of these biopolymers is limited by their insufficient performance and relatively high cost as compared to those of petroleum-derived plastics. The preparation of composites with nanomaterials has been proposed as an alternative method to enhance the material properties of biopolymers. Cellulose nanocrystals (CNs), which are rod-like nanoparticles, are one of the most promising reinforcements in bio-nanocomposite materials because of their renewable nature, as well as their exceptionally high specific strength and modulus, low density, chemical tunability, and low cost. However, the number of hydroxyl groups in CNs makes it difficult to achieve acceptable dispersion levels of nanofillers in the nonpolar plastic matrix. In the present study, we performed surface modification of CNs by the acetylation method in order to enhance dispersion and we prepared PBS/CN nanocomposites. The influence of the CN loading level (from 0.1 to 1) and the degree of substitution (from 0.04 to 2.77) on the microstructure and morphology, as well as on the mechanical properties and biodegradability of the nanocomposites, was investigated.

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Investigating structure-function properties of biosystems by Advanced Scanning Probe Microscopy

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Hierarchically organized nanoscale structures act as building blocks in the formation of both natural and man-made biosystems. Supramolecular interactions are involved in the assembly of highly ordered structures which are ultimately responsible for shape, structure and function of such biosystems. Whereas the overall assessment of these systems role is obtained by macroscopic evaluations, their nanoscale characterization is fundamental to uncover important underlying molecular mechanisms governing their complex behavior. Here we show how advanced scanning probe microscopy techniques can be successfully employed to characterize self-assembled bio-nanostructures thanks to their ability to simultaneously correlate the morphology with local properties at the nanoscale. Conductive Atomic Force Microscopy (C-AFM) for example is used to probe electrical conduction within nanostructures obtained by the self-assembly of biomolecules with organic polymers. Conductive polymers are here used to coat proteins superstructures, such as amyloid fibers,[1, 2] or to be incorporate into model lipid membranes,[3] by exploiting non-covalent interactions. In this way, the conductive properties of conjugated organic polymer are combined with the high structural order of biomolecular nanotemplates, with the perspective to be exploited in a variety of functional components, or possibly integrated into biological systems. The nanoscale characterization of bio-nanostructures by advanced Scanning Probe Microscopy opens fascinating perspectives for accessing new properties and processes within biosystems in a non-destructive manner, possibly enabling new modes of observing biological processes.

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Bioinspired silica-enzyme nanocomposite as a robust biocatalyst for biomimetic CO2 sequestration

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This study reports on the development and characterization of a carbonic anhydrase (CA)-based biocatalyst encapsulated in a biosilica matrix for use in CO2 sequestration. Encapsulation occurred simultaneously with autonomous silica synthesis by silica-condensing R5 peptide that was fused to recombinant CA. The encapsulation efficiency was greater than 95%, and the encapsulated CA was not leached from the silica matrix, demonstrating the highly efficient R5-mediated auto-encapsulation process. The catalytic efficiency for CO2 hydration was pH dependent, suggesting that proton transfer from silica to water is a rate limiting step for the fast catalysis. In addition to good reusability, the encapsulated CA exhibited outstanding thermostability, retaining 80% activity after 5 days at 50?C. The thermoactivity was also remarkable, showing ~10-fold higher activity at 60?C compared to that at 25?C. The physical structure was observed to be highly compact with a low surface area, stressing the importance of the outermost surface for catalytic performance. We also demonstrated the applicability of the silica nanoparticle to the sequestration of CO2 in carbonate minerals. The rate of CaCO3 precipitation was remarkably accelerated by the encapsulated biocatalyst. Thus, this silica-CA nanocomposite, efficiently synthesized via a biomimetic green route, can be successfully used as a robust biocatalyst for biomimetic sequestration of the greenhouse gas CO2.

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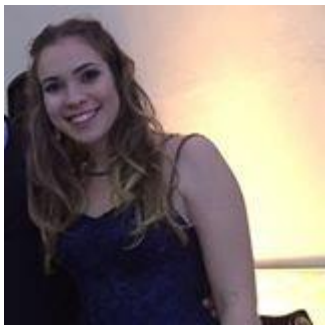

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Photodynamic activity of erythrosin: from Langmuir monolayers toward oropharyngeal cancer (HEp-2) cells

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Photodynamic therapy (PDT) has proven to be a promising alternative for treating different types of cancers. The preferential sites of photodynamic action are the cell membranes, but the underlying mechanisms involved in membrane lipid oxidation are not fully understood. In order to investigate these mechanisms, suitable methods are required not only to mimic the cell membrane but also to obtain specific molecular information. Langmuir monolayers of 1,2-dioleoyl-sn-glycero-3-phosphocholine (DOPC) and 1,2-dipalmitoyl-sn-glycero-3-phosphocholine (DPPC) were applied here as cellular membrane mimetic systems to unravel the adsorption mechanisms of the photosensitizer erythrosin towards the membrane and the molecular-level effects that follow lipid oxidation. It was found that erythrosin adsorbs to the monolayer driven by attractive electrostatic interactions with the choline groups of both DOPC and DPPC. Upon irradiation, the modifications of DOPC monolayers are consistent with the hydroperoxidation process. Nevertheless, low levels of cytotoxicity were found in PDT experiments with in vitro culture of cells derived from oropharyngeal cancer (HEp-2), incubated with different concentrations (10-3 ? 10-6 mol/L) of erythrosin in dark. Ongoing experiments of cytotoxicity upon irradiation have shown promising results in terms of photo-induced cell death, revealing the potential of erythrosin as photosensitizer in PDT applications.

May 23rd, 2017, Poster – RRJVR, K.FPII.13

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Development of magnetically-modified electrospun chitosan-based nanocomposite fibrous materials and their bioapplications

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Magnetically-modified (nano)fibers produced by electrospinning attract high attention in various areas of medicine, biosciences and biotechnology. This study deals with the developing of polyvinyl pyrrolidone/chitosan (PVP/CS) crosslinked electrospun fibrous platforms and their further modification by employing a post-magnetization process (i.e. the chemical co-precipitation method) for introducing magnetic iron oxide nanoparticles (FexOy NPs) onto their surfaces. These materials were characterized in regards to their composition, morphology, and thermal properties by XRD, SEM, TEM and TGA.

The resulting magnetic electrospun fibrous (nano)textile were further evaluated as magnetoactive substrates for the immobilization of microbial cells, enzymes and low-molecular-weight affinity ligands. Acknowledgements The research was supported by the projects LD14075 and LO1305 (Ministry of Education, Youth and Sports of the Czech Republic) and the University of Cyprus Grant "Post-doctoral Researchers" supporting Dr. I. Savva. We are also grateful to Dr Eugenia Vasile (University Politehnica of Bucharest) for the TEM measurements.

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Fabrication and testing of topologically interlocked architectured ceramics with improved impact resistance

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Natural hard materials such as mollusk shell, tooth enamel and bone possess outstanding combinations of stiffness, strength and toughness, which outclass most engineering materials. These natural materials are composed of stiff and strong building blocks which are arranged in designed architectures and interact through weak interfaces. The stiffness and strength of the materials come from the blocks, while their toughness come from intricate interplays between the architecture of the materials and their weaker interfaces. Inspired by these materials, this study demonstrates how simple cutting/assembling of ceramic bocks can be used to develop topologically interlocked ceramic panels with combinations of stiffness, strength, and impact resistance. The fabrication process results in low porosity ceramic blocks with smooth surfaces which were then assembled manually to make architectured panels. The panels were tested in impact loading condition.

Compared to plain ceramic panels, the architectured panels was 50 times more impact resistant (in energy terms), at the expense of only 50-60 % decrease in stiffness and strength. This material demonstrates how bioinspiration, weak interfaces and material architecture can be harnessed to expand the capabilities of materials towards new directions.

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Nanophotonics in natural photosynthesis

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Photosynthesis, the conversion of sunlight to chemical energy, holds huge promise for energy production and storage, in both biological systems and inorganic bio-inspired ones. In higher plants, the light-dependent reactions of photosynthesis occur in sites with nanoscale geometry and heterogeneous protein composition: the thylakoid membranes inside chloroplasts. In these sites, ray optics fails to adequately describe light absorption.
We address the complexity of thylakoid membranes, in terms of structure and light-harvesting protein composition, with a rigorous nano-optical approach. Remarkably, we demonstrate that the thylakoid membranes provide additional photonic functionalities to photosynthesis.
Thylakoid membranes are arranged in cylindrical stacks called grana, and in neighboring lamellae. The light-harvesting complexes I and II are preferentially concentrated in the lamellae and in the grana, respectively. We study the effects of grana shape, size and separation by full-wave electromagnetic solvers, and correlate them to protein distribution. Our results reveal that photonic resonances and interferences are accountable for a rational light management in chloroplasts. Providing description of complex bio-systems in a rigorous approach used for solid-state photonics, our study unveils original aspects of natural photosynthesis and sets novel directions for bio-inspired inorganic light conversion devices.

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Thank you very much in advance for your active collaboration for your and Seventh Symposium K's success.

Young Investigators – Sixth Symposium B, E-MRS Fall Meeting Warsaw 2016 – presentations were successfully.

Welcome! Young Investigator Forum Organizers/Chairs Federico Z. and Valentine B.