Frontiers in Nano - materials/systems/interfaces Multifunctionality for Human Well – being

Tuesday, September 18, 9.00 – 18.30, 2018

YOUNG SCIENTIST FORUM Presenters Profiles

1

PhD **Katharina Brassat** received her master degree in Chemistry in 2012 at Paderborn University, Germany. She then transferred to the Physics department, where she performed her PhD in the ‚Nanostructuring, Nanoanalysis and Photonic Materials' group of Prof. Dr. Jörg K. N. Lindner. Her work was partly funded by the DFG (German Research Foundation) Graduate Program GRK1464. Her thesis dealt with ‚Surface nanopatterning by self-assembly techniques: Nanosphere- and block copolymer lithography'. She received her PhD (with honours) in Physics in 2018. Dr. Brassat is (co-) author of 8 papers published in international peer-reviewed journals and gave so far 18 oral presentation (4 invited) on national and international conferences.
She is currently working as a post-doctoral researcher at Paderborn University and investigates the tailored design of materials surfaces for their application as bio-interfaces. She is interested in the directed positioning of proteins, DNA origamis or catalytic nanoparticles into regular arrays on large areas. Within national and international collaborations, she investigates the advantages of her nanopatterning techniques for the development of next-generation implants, the control of cellsurface interactions and the creation of functional bio-coatings. Several research projects are supported by the ‚Center of Optoelectronics and Photonics Paderborn (CeoPP), and the ‚Institute of Lightweight Design with Hybrid Systems (ILH)'. web: blogs.upb.de/kbrassat

YSF Keynote Presentation

Protein and DNA origami arrays on large areas by directed self-assembly

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Biological and bioinspired units such as protein micelles, lipid vesicles or peptide macromolecules offer manifold functionalities at high specificity. Research in life and materials sciences develops methods to make these functional bio units accessible for next generation devices for e.g. sensing, molecular electronics or bio photonics. Most bio units form in liquid suspensions. This is a suitable environment for e.g. drug delivery systems, however is a drawback for the integration of bio units into electronic devices. Facing this challenge, here we present an approach for the site-selective deposition of single functional bio units, i.e. protein micelles and DNA origamis, into ordered arrays on large areas of solid surfaces. In particular, we use nanosphere lithography as a bottom-up approach for the nanopatterning of different material surfaces. We create nanohole arrays, i.e. ordered cylindrical holes in thin films, exhibiting a surface topography along with a local material contrast. We use these nanoholes as templates for the site-selective deposition of casein micelles. We take advantage of the templates chemical contrast. We locally perform an enzyme mediated autodeposition and create nanostructured biocoatings. In another example, we site-selectively adsorb DNA origamis inside the nanoholes. These origamis are for instance suitable transporters for quantum dots enabling bioinspired next generation nanoelectronics.

YSF Invited Poster Presentation

Ti-6Al-4V alloy: 3D printing of lightweight implants and nanopatterning by self-assembly

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Additive manufacturing allows for custom-made design of implants and medical devices. Here, the Ti-6Al-4V alloy, which is known to show good biocompatibility, is exploited as printing material of in-vivo used elements. Besides the general materials biocompatibility, the control of cell adhesion on a surface depends strongly on the surface morphology. In this paper, we present an interdisciplinary approach combining the expertise of mechanical engineering and nanotechnology to face this problem on different size scales. On the one hand, we investigate a tailored macroscopic architecture of an additively manufactured element. The freedom of 3D device architecture allows for a local adjustment of the mechanical stability while providing lightweight design. Experimental results and numerical simulations for design rules for an optimum device performance are presented. On the other hand, we show an approach to control the cell-implant interactions on a nanopatterned 3D printed Ti-6Al-4V surface. To this end, we present results on the creation of ordered nanopore arrays by self-assembly processes in block copolymer thin films. The block copolymer lithography allows for large-area surface patterning with sub 20 nm features, which are in particular interesting as the nanopore diameter matches the size of the focal adhesions of a cell allowing for the control of cell adhesion. Both aspects together, we sketch an overall approach for improved implant performance bridging size scales from centimeters to nanometers.

2

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Research Interest: **Diamond Nanotechnology and Biomolecular Interfaces.** Diamond is chemically and physically robust, and radiation 'hard' – electronics formed from diamond should not only perform at the highest levels, but should also be capable of operation in extreme environments. Using diamond as a gemstone is a waste of its true potential! It can also be considered to be biocompatible, in that it is simply carbon, and is also not prone to unwanted cell adhesion or particulate generation when inside a living body

YSF Keynote Presentation

Observing the behaviour of stem cells on diamond

Alice C. Taylor[1], Citalali H. Gonzalez[2], Patrizia Ferretti[2], Stoffel Janssens[1], Richard B. Jackman[1], Eliot Fried [1]

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[1] Patterned neuronal networks using nanodiamonds and the effect of varying nanodiamond properties on neuronal adhesion and outgrowth, Edgington R, Thalhammer A, Welch J, Bongrain A, Bergonzo P, Scorsone E, Schoepfer R and Jackman RB, Journal of Neural Engineering,**10**(2013), 056022

[2] Biocompatibility of nanostructured boron doped diamond for the attachment and proliferation of human neural stem cells, Alice C. Taylor, Barbora Vagaska, Robert Edgington, Clément Hébert, Patrizia Ferretti, Philippe Bergonzo and Richard B. Jackman, Journal of Neural Engineering,**12**(2015), 066016

[3] Surface functionalisation of nanodiamonds for human neural stem cell adhesion and Proliferation, Alice C Taylor, Citlali Helenes González, Benjamin Miller, Robert J. Edgington, Patrizia Ferretti, Richard B Jackman Scientific Reports (Submitted).

3

Dr. **Nanasaheb Thorat**, MSc, PhD, (Gold Medal) MRSC, is an outstanding Researcher currently working in Bernal Institute, University of Limerick Ireland with Prof. Tofail Syed (www.mosaicteam.eu). He is a recipient of various prestigious fellowships including Marie Skłodowska-Curie Fellowship (IF) in Poland/Switzerland 2018, Japanese Society for the Promotion of Science (JSPS) Fellowship in Japan 2017, Government of Ireland IRC fellowship Ireland 2015, Government of Israel PBC Outstanding Fellowship in Israel 2015. In addition to his current research, he has been deeply engaged in collaborative work with the many eminent scientists from Japan, USA, Germany, Korea, Ireland, India, Poland, Saudi Arabia and Australia. He has also an excellent collaboration and interactions with over 30 junior and senior colleagues in India, South Korea, Japan, Taiwan and Ireland with whom he has co-authored his publications. Dr. Thorat has published ~42 peer reviewed journal articles and 2 book chapters (total citations ~1000, H index: 20), presented 1 Keynote Speech, 4 Invited Talks and 2 oral presentations at prestigious scientific peer-conferences, received international acclaims and awards for research contribution, generated research fund in excess of > €350,000, supervised students/junior researchers and actively participated in outreach and scientific dissemination for the service of wider community. He is recipient of many prestigious awards such as, Young Scientist Awardee through open competition by Lindau Nobel Laureate Foundation in the 67th Lindau Nobel Laureate Meeting 25th to 30th June 2017 in Lindau, Germany, Gold Medal for Ph.D. D.Y.Patil University, Kolhapur, India, 2014, Excellence in Research Award 2013-2014, D. Y. Patil University, Maharashtra, India, 2014. Dr. Thorat's contribution in the area of nano-biotechnology and theranostics have been recognised by Royal Society of Chemistry (RSC,UK) and admitted him Member of The RSC and entitled the designation MRSC in the year Oct 2017.

YSF Keynote Presentation

Functional Silica Hybrid Nanocarrier for the delivery of targeted cargo to overcome chemoresistance in cancer cells

Nanasaheb D. Thorat1, Joanna Bauere2 and Syed A.M. Tofail1

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Cancer cells can become resistant to chemotherapeutic drugs and pose a challenging impediment for oncologists in providing effective chemotherapy treatment. Nanomedicine may allow overcoming chemoresistance and is the focus of our investigation. Here we show the validity of nanomedicine approach for targeted chemotherapeutic cargo delivery to overcome chemoresistance in cancer cells both in vitro and in vivo. For this, we functionalise ~100 nm long porous silica nanoparticles (~20 nm diameter ordered pore structure) by conjugating anticancer drug, cytochrome c enzyme and dual-function anticancer aptamer AS1411 in single supra-assembled nanocargos. The supra-assembly on the porous silica nanostructure allows for a high loading of catalytic enzyme cytochrome c, anticancer drug and aptamer. The silica supra-assembly is characterized by transmission electron microscopy (TEM) and BET analysis. Conjugation of cargoes has been monitored at each step by UV-Vis and Fluorescence spectroscopy. Finally, the constructed supra-assembled nanocarrier tested in vitro and in vivo. A pH-responsive, intracellular theranostic cargo delivery has been achieved and the triple action of the nanocargo made an efficient killing of drug resistance colon cancer cells in vitro by supressing the P-glycoprotein (P-gp) level. The nanocargos displayed triplex therapy effects on the drug resistance cancer cells both in vitro and in vivo.

YSF Invited Poster Presentation

Magneto-photodynamic hyperthermia study of core shell hybrid nano structures

Nanasaheb D. Thorat, Syed A.M.Tofail
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Magnetic (Fe3O4) nanoparticles coated with platinum i.e. core shell nanoparticles are synthesized through simple and cost-effective co precipitation method. As prepared nanoparticles was studied in detail by using TG-DSC and FTIR for amine coating. TEM images shows formation of spherical core shell nanoparticles with sizes less than 15 nm. High magnetization value of about 59 emu/g at room temperature is obtained for core shell. To control temperature elevation and heat distribution after application of alternation magnetic field and NIR LASER during the internalization of magnetic nanoparticles (MNPs) in magnetic fluid hyperthermia is one of the main challenges. This challenge is well studied in current work.

Dr. **Indranath Chakraborty** earned a Ph.D. in physical chemistry from the Indian Institute of Technology Madras (IIT M). He is an eminent scientist in the sub-nanometer particle regimes. He was an IIT Madras Institute Postdoctoral Fellow. Later, he was a postdoctoral research associate at the University of Illinois at Urbana–Champaign, IL, USA. Then he moved to Germany as an Alexander von Humboldt Postdoctoral Research Fellow at Philipps University of Marburg. Currently, he is a Junior group leader at Center for Hybrid Nanostructure (CHyN), University of Hamburg, Germany in AG Biophotonik. His major research interests are nanoclusters, single nanoparticle spectroscopy and nano-bio interactions. He has authored 35 scientific papers in journals and is an inventor in four patent applications. He is a recipient of the prestigious J. C. Bose Patent Award and the Malhotra Weikfield Foundation Nanoscience Fellowship Award.

YSF Keynote Presentation

Understanding Protein Mediated Shape Control of Metal Nanoparticles

Dr. **Indranath Chakraborty**, Junior Group Leader,

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Tuning nanoparticles surfaces is very important to introduce new properties to the system such as solubility, self-assembly, sensing, biocompatibility, etc.1, 2 This talk will explain the growth of silver nanoparticles in aqueous solution, without the presence of typical surfactant molecules, but under the presence of different proteins.3 The shape of the resulting silver nanoparticles could be tuned by the selection of the types of proteins. The number of accessible lysine groups was found to be mainly responsible for the anisotropy in nanoparticle formation. Viability measurements of cells exposed to protein capped spherical or prism-shaped NPs did not reveal differences between both geometries. Thus, in the case of protein protected Ag NPs, no shape-induced toxicity was found under the investigated exposure conditions.

PhD **Zhi Geng** is lecture and postdoc in Donghua University. He works on nano assembly of functionalized poly(3,4-ethylenedioxythiophene) materials and the application in biosensing. He has published more than 10 papers in international journals including 'Journal of Materials Chemistry A', 'Nanoscale', 'ACS Applied Materials &Interfaces'. Meanwhile, he has been supported by National Nature Science Foundation of China and China Postdoctoral Science Foundation.

YSF Invited Oral Presentation

Template-free Assembling of Functionalized Poly(3,4-ethylenedioxythiophene) with Controllable Nanostructures and Their Applications in Bioelectronic Devices

Zhi Geng, Bo Zhu*

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Poly(3,4-ethylenedioxythiophene) (PEDOT) materials were considered as star materials for fabricating bioelectronic devices [1-4] due to its excellent electrical conductivity and electrochemical stability[5,6]. Decoration with functional groups and introducing nanostructures would enhance the electric and biological properties of PEDOT materials, which could expand the potential applications in the fields of bioelectronics. Therefore, it was important to design simple but controllable nano-assembling methods for functionalized PEDOT materials. Compared to traditional template assembling, template-free method had the beneficial of easy fabrication in large scale and integrated preservation of achieved nanostructures, which would make it possible for fabricating nano electronic devices in wafer-scale. Several methods had been reported to realize nano assembling PEDOT materials, however, few of them could realize fabricating different types of nano-morphologies for various functionalized EDOT monomers with one simple method. Herein, we proposed template-free method for fabricating various functionalized PEDOT thin films with nanodot and nanotube morphologies via electrochemical depositing. The morphology parameters could be tuned including diameter, length and density. Glancing incident wide angle XRD was measured to testify the difference of crystal orientation for the achieved nanodot and nanotube thin films. Meanwhile, possible formation reason and process of nanodot and nanotube morphologies were proposed. Besides, simulation tests were carried out and verified the beneficial of the PEDOT and functionalized PEDOT thin films with nanotube morphology using in bioelectronic devices. We hoped the achieved template-free assembling method could be expanded to other kinds of bio-functionalized PEDOT materials and designed PEDOT thin films with proper bio-functional groups and 3D nanomorphologies based on the requirements in practical application of bioelectronic devices.

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YSF Invited Poster Presentation

Controllable Assembling of Functionalized PEDOT via Template-free Method and the Applications in Bioelectronics

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Decoration with functional groups and introducing nanostructures would enhance the electric and biological properties of PEDOT materials, which could expand the potential applications in the fields of bioelectronics. Therefore, it was important to design simple but controllable nano-assembling methods for functionalized PEDOT materials. Compared to traditional template assembling, template-free method had the beneficial of easy fabrication in large scale and integrated preservation of achieved nanostructures, which would make it possible for fabricating nano electronic devices in wafer-scale. Several methods had been reported to realize nano assembling PEDOT materials, however, few of them could realize fabricating different types of nano-morphologies for various functionalized EDOT monomers with one simple method. Herein, we proposed template-free method for fabricating various functionalized PEDOT thin films with nanodot and nanotube morphologies via electrochemical depositing. The morphology parameters could be tuned including diameter, length and density. Glancing incident wide angle XRD was measured to testify the difference of crystal orientation for the achieved nanodot and nanotube thin films. Meanwhile, possible formation reason and process of nanodot and nanotube morphologies were proposed. Besides, simulation tests were carried out and verified the beneficial of the PEDOT and functionalized PEDOT thin films with nanotube morphology using in bioelectronic devices. We hoped the achieved template-free assembling method could be expanded to other kinds of bio-functionalized PEDOT materials and designed PEDOT thin films with proper bio-functional groups and 3D nanomorphologies based on the requirements in practical application of bioelectronic devices.

6

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YSF Invited Oral Presentation

Low-temperature synthesis of multilayer graphene on glass by Ni-induced layer exchange

Hiromasa Murata, Takashi Suemasu, and Kaoru Toko

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Multilayer graphene (MLG) has been actively investigated because of its high electrical and thermal conductivities. Because graphene has a unique two-dimensional structure, its characteristics are anisotropic. Therefore, large-grained highly oriented MLG on insulators is highly desirable. Metal-induced layer exchange (MILE) is a promising technique allowing for large-grained, highly-oriented Ge and Si on glass [1]. In this study, we applied MILE to amorphous carbon (a-C) and fabricated high-quality MLG at as low as 500 °C. Ni and a-C thin films (each 50 nm thick) were sequentially prepared on glass using magnetron sputtering. Samples were annealed at 500 °C for 50 h. The Ni layers were then etched away. The Raman spectra of back side of the samples have sharp D, G, and 2D peaks corresponding to MLG, indicating the layer exchange between the C and Ni layers [2,3]. The cross-sectional TEM analyses showed that the layers of a-C and Ni were exchanged and {002} oriented MLG formed on glass substrate. The grain size was approximately several hundred nm. After the removal of the Ni layers, the MLG covered the entire substrate. The electrical conductivity was approximately 400 Scm^{-1}. The uniformity and electrical conductivity are the highest level among the MLG directly formed on glass at low temperature. [1] Toko et al., APL. 104, 022106 (2014). [2] Murata et al., APL. 110, 033108 (2017). [3] Murata et al., APL. 111, 243104 (2017). (Highlighted in Nature INDEX.)

YSF Invited Poster Presentation

Guidelines for metal selection to induce layer exchange growth of multilayer graphene

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Multilayer graphene (MLG) on insulators will lead to various advanced electronic devices. Graphene has a unique two-dimensional structure, whose characteristics are anisotropic. In line with this, large-grained, highly oriented MLG on insulators has been widely investigated. We previously reported the formation of large-grained, highly-oriented MLG on insulators at low temperature by metal-induced layer exchange. However, it was still not clear what type of metal induces the layer exchange growth of MLG. This study investigates the effect of the species of transition metal in the layer exchange growth of MLG. 50-nm-thick metal (Fe, Co, Ni, Ru, Ir, Pt, Ti, Mo, Pd, Cu, Ag, or Au) and 75-nm-thick amorphous carbon (a-C) thin films were prepared onto a glass using magnetron sputtering. The samples were annealed at 600-1000 °C for 1 h. The metal layers were then etched away. Interactions between transition metals and a-C were classified into 4 groups: (1) Layer exchange (Fe, Co, Ni, Ru, Ir, Pt), (2) Carbonization (Ti, Mo), (3) Local formation of MLG (Pd), and (4) No reaction (Cu, Ag, Au). Thus, the layer exchange was achieved for late transition metals. The metals in group (1) were divided into 2 types: low temperature growth or high crystallinity growth of MLG. Pd has an intermediate characteristic because it is located in the middle in the early and late transition metals. The guidelines for selection of catalyst metal species in the layer exchange growth of MLG will be presented based on the periodic table.

7

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YSF Invited Oral/Poster Presentations

Highly efficient intense pulse light(IPL) annealing process for photoluminescence efficiency improvement of quantum dots

Chulhee Lee, Taeyoung Song, Im Tae Hong, Keon Jae Lee, Duk Young Jeon.

A typical method to increase photoluminescence efficiency is shell formation on quantum dots (QDs) cores for removing surface trap sites. However, insulating property of QDs shell hinders efficient hole and electron injection between shell-coated QD layer and adjacent transport layers leading to decreased device efficiency when the QD layer is applied in optoelectronics. To solve this issue, thermal annealing is usually adapted to increase photoluminescence efficiency by controlling optimum amount of defect sites. On the other hands, relative high temperature used during thermal annealing may cause deterioration of interface between core and shell of QDs. To avoid the deterioration of the interface, Intense pulse light(IPL) annealing can be introduced as an alternative to thermal annealing as it almost instantaneously supplies heat within very short time and brings enough energy to QDs. In this study, we aim to maximize the photoluminescence efficiency of the QDs by controlling the defect sites of the core through a IPL annealing technique while maintaining the interface between core and shell of QDs intact. IPL annealing technique is possible to efficiently remove the defect sites by applying optimum amount of heat to quantum dots core using very short pulse. It is because IPL annealing can avoid over heating on QDs very easily by controlling pulse width. We have observed considerable improvement of quantum efficiency of the QDs by using the afore-mentioned IPL annealing process.

8

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YSF Invited Oral Presentation

Multi-walled Carbon Nanotube Reinforced Natural Rubber Composite and DR2 Foot: Suing for Home-grown Prosthetic Foot Material

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The desire to restore the quality of life to transtibial amputees in Nigeria has been on the front burner in recent years. In this study, a home-grown nanocomposite (NC) material (multi-walled carbon nanotube reinforced natural rubber) and multiflex dynamic response 2 foot (a common foreign foot prosthetics in Nigeria) were investigated with a view to comparing their water absorption capacity, thermal stability, wear resistance and morphological properties. The inherent challenge of ensuring uniform distribution of multi-walled carbon nanotube (MWCNT) in the host matrix was addressed by the use of sodium dodecylbenzene sulfonate ($C_{18}H_{29}NaO_3S$). The CNT was synthesised via catalytic chemical vapour deposition (CCVD) technique and the NC was produced using an electrically heated hydraulic press. While the initial decomposition temperatures (T_{onset}) of the materials show that the newly developed NC with 260.01 ^oC is more thermally stable than M. DR2 foot with the temperature of 238.17 ^oC, incorporation of MWCNTs into the unfilled NR matrix shows a significant change in T_{onset}. MWCNT loading was found to influence the moisture content of the reinforced matrix by about 7% with the NC being 35% more thermally stable than M. DR2 foot. SEM/EDS micrographs indicated complete embedment of MWCNTs in NR matrix thereby making it more suitable than M. DR2 foot which was inundated with cavities. While it takes both NR/MWCNT and DR2 foot 120 days to attain saturation point in water, the former is 93% more dimensionally stable than the latter and also demonstrated better resistance to wear than the latter. It can, therefore, be concluded from the foregoing that the home-grown material is to be preferred to its foreign counterpart for anthropomorphic prosthetic foot application.

9

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YSF Invited Oral/Poster Presentations

Interfacing Enzymes with Silicon Nanocrystals

Christopher Jay T. Robidillo, Jonathan G.C. Veinot

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Diseases typically result from the accumulation of substances that disrupt the normal operation of cells. The introduction of enzymes, catalytic protein molecules essential for normal biological function, which act on such substances into affected tissues provides an attractive alternative for curing such diseases. Silicon nanocrystals, owing to their limited toxicity and photodynamics, offer a potentially safer and more efficient bioimaging platform compared to status quo organic dyes. Thus, a hybrid material consisting of enzymes that have been interfaced with silicon nanocrystals could offer simultaneous imaging and therapy. This study reports, for the first time, methods for the preparation of enzyme-conjugated silicon nanocrystals from native enzymes and acid or alkene-terminated silicon nanocrystals through the amide coupling and thiol-ene reactions, respectively. Model enzymes, glucose oxidase and lactase were successfully immobilized on silicon nanocrystals as confirmed by Fourier Transform Infrared Spectroscopy and X-ray Photoelectron Spectroscopy. Moreover, single reaction and cascade kinetic assays confirm that the conjugated enzymes retain their catalytic activity. The hybrids manifested either excellent solubility or good dispersibility in buffer, and were photostable, exhibiting bright orange photoluminescence even after more than a month of dispersion in an aqueous medium. The methods reported herein are general and can be used for the preparation of bioinorganic silicon-based hybrids that can be employed in personalized medicine for targeting and potentially treating diseases like cancer and other metabolic disorders.

10

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YSF Invited Poster Presentation

Microstructural characterization of laser structured titanium grade 2 for biomedical applications

Donata Kuczyńska, Agata Sotniczuk, Piotr Kwaśniak, Halina Garbacz

The long-term integration of the implants with human body depends on the chemical and physical surface properties of the substrates. Therefore, surface engineering of biomedical materials, is consider to be major technique for improving processes on the implant/body interface. A technique that can modify the titanium possessing initial, not flat topography is Direct Laser Interference Lithography (DLIL), without the deformation thereof. It can generate complex types of texture with high resolution, resulting in micrometer size patterns. Expect for modifying the surface appearance, laser irradiation, with the specific thermal characteristic, can generate appropriate microstructures below the free surface including nanocrystalline or metastable phases. The dissolution of the light elements, such as oxygen or nitrogen, strongly depends on the interactions between the laser, substrate and the atmosphere. The mentioned effects are especially important in the case of the processes limited to the substrate surface. This is of great importance in biomedical applications, where the assessment of various processes such as, protein adsorption, cell adhesion or corrosion resistance is not limited to topographical parameters but includes the formation of oxide layers and microstructural changes. Therefore, this study deals with a careful cross-section microstructural analysis by combining complementary methods such as FIB, SEM, EDS and STEM on different scales to elucidate the microstcuture and surface chemistry after laser- patterning and the correlation with phase composition. The gained results are important with regard to the evaluation of laser patterned surfaces in biomedical applications. The description of the microstructure and chemical composition of the DLIL modified titanium samples, can be useful when understanding and characterizing the processes on the bone/implant interface.

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11

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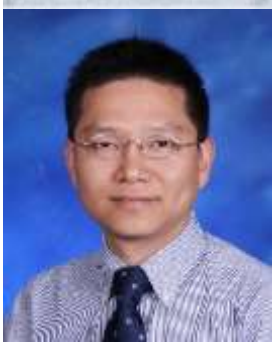

YSF Invited Oral Presentation

Silk Nanofibrils Based Flexible Tranparant Film

Qianqian Niu, Yaopeng Zhang
State Key Laboratory for Modification of Chemical Fibers and Polymer Materials, College of Material Science and Engineering, Donghua University, Shanghai, 201620, China

Silkworm silk and spider silk with outstanding properties have unique hierarchical structures at mesoscale. As the basic building block of the hierarchical structure, silk nanofibrils (SNF) is the key unit for the formation of high performance silk based materials. Conventional methods to prepare SNFs have some limitations, such as nanofiber aggregation/inadequate dissociation, low yield, toxic solvent, imperfect building model of silk hierarchical structure etc. To fabricate stable SNFs suspension efficiently, a novel solution system were used to prepare SNFs. Transmission electron microscope, atomic force microscope, and synchrotron radiation small angle X-ray scattering were applied to confirm the size of SNFs accurately. Moreover, a SNF ultra thin film with good flexibility, high transmittance, biocompatibility and biodegradability were fabricated via vacuum filtration from the SNFs suspension. The film may have potential application for biosensing devices, optics, photonics or tissue engineering.

YSF Invited Poster Presentation

The Fabrication of Silk Nanofibrils

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Silk is a kind of natural macromolecule material with good mechanical properties, and good biocompatibility. The mechanical properties of silk based materials are influenced by hierarchical structure, such as molecular-crystalline, and nanofiber structure. Moreover, fibrillar structure, especially at nanoscale, has a crucial effect on the excellent performance of native silk. The properties of silk-based materials are originated from the special arrangement at the mesoscale of hierarchical structures. Conventional ways of preparing silk nanofibrils have many disadvantages, such as, toxic solvent, unstable silk nanofibrils, and low productive rate. And the research of silk nanofibrils is not detailed. To fabricate stable SNFs suspension efficiently, novel solution systems were used. Transmission electron microscope, atomic force microscope, and synchrotron radiation small angle X-ray scattering were applied to confirm the size of SNFs accurately. Molecular dynamics simulations of silk models demonstrated that the potential of mean force required to break the HBs between silk fibroin chains or the Van der Waals? interactions between ?-sheet layers in a particular solvent system. Mesoscale research has an important value on the forming and application of materials and the study of silk nanofibrils has guiding significance to form silk-based materials and construct the hierarchical structure model.

12

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YSF Invited Poster Presentation

M13 Bacteriophage Textured Anti-reflection Film for Photovoltaic Enhancement of Organic Solar Cells

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Since discovery, organic solar cells (OSCs) have attracted immense research interests because of their unique features such as device structure tunability, lightweight, highly flexible nature, environmental-friendliness. To improve the light harvesting efficiency and photovoltaic performance of OSCs, it is crucial to reduce optical losses including reflections and scatterings. To address this issue, surface texturing, anti-reflection coating and plasmonic nanomaterials have been applied. In this study, we laminated an external M13 bacteriophage textured PDMS film onto OSC device and investigated its efficacy as anti-reflection medium. The OSCs based on PTB7-Th:$PC_{71}BM$ were fabricated on ITO glass substrate. The as-fabricated M13 bacteriophage textured film exhibited high haze and simultaneously, the reflectance of M13 film incorporated OSCs (M13-OSCs) device was lower than that of pristine OSCs. The optical absorption and power conversion efficiency of M13-OSCs was improved. M13 bacteriophage template film could potentially be an excellent metamaterial for future optoelectronics application.

PhD **Jong Hyun Lee** is a postdoctoral scholar in Technical University of Denmark. He works on multi-functional nano-carriers for atherosclerosis, cancer, and diabetic imaging and therapy, efficient delivery of protein drugs, transdermal delivery of hydrophilic drugs, multimodal imaging using MRI, PET, ultrasound and optical imaging. He has published more than 10 papers in international journals including 'Biomaterials', 'Journal of Controlled Release', 'Nanosacle'.

YSF Invited Poster Presentation

Anti-atherosclerotic polymeric nanobiocatalysts for the dissolution of cholesterol crystals in atherosclerosis

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Atherosclerosis is a systemic and chronic inflammatory condition in which plaques build up inside the arteries. Accumulation of cholesterol in early lesions leads to the formation of macrophage foam cells that ingest free cholesterol, eventually resulting in the presence of intra- and extracellular cholesterol crystal (CC) in advanced atherosclerotic plaques. Over time, growth of the necrotic core leads to plaque destabilization and vessel narrowing, which in turn increases the risk of rupture and thrombosis, leading to heart attacks and strokes. In this work we have developed novel catalytic and anti-inflammatory polymeric nanomedicines that are capable of directly diminishing a major detrimental effect of atherosclerosis; the formation of CCs within plaques. We present the development and characterization of targeted polymeric nanobiocatalysts capable of selectively targeting atherosclerotic plaques and 'dissolving' CCs via a bioinspired catalytic approach based on innate cholesterol catabolic pathways.

14

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YSF Invited Poster Presentation

Theoretical investigation of diamond coated SiO_2/ST-quartz and SiO_2/36°YX $LiNbO_3$ structures for biosensing applications

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Nowadays the detection of pathogens is an inherent part of environmental or food industry safety. In spite of good selectivity of conventional methods, they are time consuming and labor intensive. Biosensors are good candidates for real-time monitoring and fast detection of pathogenic agents [1]. Acoustic devices are in the focus of researchers for bio-sensing applications using appropriate surface functionalization [2]. Love wave surface acoustic wave (LW-SAW) sensors possess high sensitivity in liquid [3]. Acoustic energy is confined in the guiding layer close to the sensitive surface, and the energy is not radiated in the liquid due to using pure shear wave with displacement parallel to the surface [4]. Integration of diamond layer brings many favorable properties such as biocompatibility, various biomolecules attachment and prolonged stability of attached biomolecules [5][6][7]. For these reasons, we theoretically investigated properties of layered structures Diamond/SiO_2/36°YX $LiNbO_3$ and Diamond/SiO_2/ST-cut quartz for potential biosensor applications.

Theoretical calculations were carried out with normalized thickness h_{SiO2}/λ in the range of (0.01 – 1) and different thicknesses of the diamond coating. Legendre and Laguerre polynomial approach of wave propagation in layered structures [8] was used for determination of the phase velocity v_p and electromechanical coupling coefficient K^2 dispersion curves. We also investigated the sensitivity of Diamond/SiO_2/ST-cut quartz and Diamond/SiO_2/36°YX $LiNbO_3$ structures by using 100 nm thick PMMA film surface loading. The optimal sensitivity of the Diamond/ SiO_2/36°YX $LiNbO_3$ is obtained for silicon dioxide normalized thickness h_{SiO2}/λ between 0.3 and 0.6 for all tested diamond thicknesses. In this range of normalized thicknesses h_{SiO2}/λ, the electromechanical coupling coefficient is steeply decreasing from 15 % to 5 %. The diamond/SiO_2/ST-cut quartz structure simulation results show similar behavior. The highest

sensitivity and K^2 of this structure are obtained for normalized thickness h_{SiO2}/λ between 0.2 and 0.6. Results of this theoretical study show it is possible to fabricate LW-SAW devices with a very thin diamond coating without significant loss of the sensitivity. Properties of LW-SAW devices fabricated on 36° YX $LiNbO_3$ substrate will be presented and compared with theoretical results and previous studies on LW-SAW devices fabricated on ST-cut quartz substrate [9].

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15

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YSF Invited Poster Presentation

Towards Atherosclerosis-on-a-Chip; A Microfluidic Platform for Anti-Atherosclerotic Drug Screening

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Atherosclerosis is an inflammation-driven chronic disease of the arteries and the leading cause of death worldwide. Therefore, there is a growing need for efficient drug-testing and drug-screening systems. Commonly used drug-testing technologies are based on two-dimensional cell culture systems, which cannot recapitulate in vivo conditions. On the other hand, animal models are not only lengthy and costly, but also poor predictors of human responses. To overcome these shortcomings, we have proposed to use organ-on-a-chip technology for atherosclerotic nanomedicine studies.

We have developed a microfluidic chip consisting of two PDMS layers, separated by a polyester membrane. Each layer has a microfluidic channel, which is capable of simulating the shear condition of a vessel. In addition, endothelial cells were cultured on the membrane and then inflamed to mimic an atherosclerotic vessel. Calcein AM assay was used to investigate cell-viability and morphology of the cells. Moreover, Immunohistochemistry studies and permeation studies were performed. The results of these studies successfully showed tight junctions between cells before inflammation procedure, as well as compromised and leaky junctions after this procedure, which is the main indicator of inflamed vessels. Consequently, the proposed microfluidic chip, which mimics shear condition of a vessel and inflammatory condition of atherosclerosis, is a suitable alternative for typical atherosclerotic drug-screening systems.

Catarina L. Delfino received her master degree in Bioengineering and Nanosystems in 2017 at Instituto Superior Técnico, University of Lisbon, Portugal. Over the course of her master studies she received two fellowships from Erasmus + program and from the University of Twente to develop improved thin film electrode materials for lithium-ion batteries through surface modification and fabrication of 2D nanomaterials at the Institute for Nanotechnology, University of Twente. She is currently working as a master researcher at Instituto de Telecomunicações, Lisbon (Portugal) to develop conductive selfassembled monolayers by scanning tunnelling microscopy (STM). She is interested in the fabrication of supramolecular structures by STM.
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Self-assembled ordered phthalocyanines on graphite with applications in organic electronics

Catarina Delfino[1], Ángela Sastre[2], Jorge Follana-Berná[2], Luís Alcácer[1], Jorge Morgado[1,3], Quirina Ferreira[1]

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17

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YSF Invited Poster Presentation

Bioinspired anti-oxidising and anti-atherogenic matrix-metalloproteinase responsive polymeric nanogels

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Background: Cardiovascular disease (CVD) is the leading cause of death worldwide – causing 40% of all mortality in Western societies. New therapeutics that can deliver anti-inflammatory biologics in a controlled manner are currently of interest for the treatment of atherosclerosis. As such in this work we have developed matrix metalloproteinase (MMP) sensitive nanogels (NGs) that can release an antioxidant capable of dampening inflammation. MMPs are highly upregulated in atherosclerotic plaques.
Results & discussions: For this work a MMP cleavable cross-linker was synthesized by solid phase peptide synthesis methods and characterized by mass spectroscopy, NMR and HPLC. NG polymerization was performed at room temperature using aqueous polymerization techniques. The spherical morphology of the protein loaded NGs was determined using TEM analysis. DLS results were comparable with the TEM size of the protein loaded NGs. Using our methodology high loading and encapsulation efficiencies were obtained due to inclusion of cationic charge of specific acrylate monomers used in the formulations.
Conclusions: we have successfully designed and synthesized MMP enzyme cleavable protein loaded NGs systems and optimized the NG synthesis method by changing different parameters.

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PhD **Matteo Di Giosia** is a postdoctoral research fellow at the University of Bologna. In his work, he investigates the interaction between proteins and carbon nanomaterials (fullerenes, nanotubes, graphene and nanodiamonds) for applications in nanomedicine, including photodynamic and photothermal therapies.
He received his PhD, with honors, in chemistry (nanoscience and nanotechnology) in 2017, under the supervision of Prof. Marco Montalti. His thesis dealt with the synthesis and characterization of carbon based nanohybrids. During his PhD, he spent 6 months as visiting fellow at Centre For BioNano Interactions in UCD (Ireland) and at Technion - Israel Institute of Technology (Israel).
Dr. **Di Giosia** is the co-author of 15 papers published in peer-reviewed journals (first author on Adv. Funct. Mater. and Nanoscale; corresponding author on J. Cryst. Growth and Materials; Nat. Commun. as author). He participated to national and international congresses giving 4 oral presentations and 2 flash communications. In 2015, he was member of the organization committee of a European Conference (ECCG5) and a European School (ESCG). During the PhD and the post-doc he co-supervised bachelor and master students and was involved in scientific dissemination programs.

YSF Keynote Presentation

Proteins as supramolecular hosts for fullerenes

Matteo Di Giosia, Andrea Cantelli, Matteo Calvaresi

The high hydrophobicity of fullerenes and the resulting formation of aggregates in aqueous solutions hamper the possibility of their exploitation in many technological applications. Noncovalent bioconjugation of C_{60} with proteins is an emerging approach for their dispersion in water. Using lysozyme and C_{60} as model systems and NMR chemical shift perturbation analysis, a protein-C_{60} binding pocket was identified unambiguously in aqueous solution [1]. Lysozyme forms a stoichiometric 1:1 adduct with C_{60} and conserves its tridimensional structure upon binding. Only few residues, localized in a well-defined protein binding pocket, are perturbed.

AFM, cryo-TEM and high resolution X-ray powder diffraction show that the C_{60} dispersion is monomolecular. The adduct is biocompatible, stable in physiological and technologically-relevant environments, and easy to store. Hybridization with lysozyme preserves the photophysical and electrochemical properties of C_{60}. Near infrared fluorimetry and EPR spin-trapping experiments show that the C60@proteins hybrids produce reactive oxygen species (ROS) following both the type I and type II mechanisms [2]. C60 shows a significant visible light-induced generation of ROS, that can be exploited in photocatalysis or photodynamic therapy.

The non-covalent bioconjugation of C60 with different proteins offers a palette of carriers for fullerenes for all pH ranges.

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YSF Invited Poster Presentation

Monodispersion of C_{60} in water by peptidic nanotweezers

Matteo Di Giosia, Andrea Cantelli, Matteo Calvaresi

The unique physicochemical properties of C_{60}, make it a promising candidate for numerous applications in biomedical, photovoltaic and material science fields. However aggregation phenomena in organic solvents and the lack of solubility in biological environments hamper the exploitation of C_{60} properties. In this work, different peptidic nanotweezers were designed and synthesized with the aim of dispersing monomolecularly C_{60} in water. Phenylalanines were used as recognizing moieties, able to interact with C_{60} through π–π stacking, while a varying number of glycines were used as spacers, to connect the two terminal phenylalanines. The peptidic nanotweezers disperse C_{60} in water with high efficiency, and the solutions are stable both in pure water and in physiological environments. NMR measurements demonstrated the ability of the peptidic nanotweezers to interact with C_{60}. AFM measurements showed that C_{60} is monodispersed. Electrospray ionization mass spectrometry determined a stoichiometry of 1C_{60}:4FGGGF. Molecular dynamics simulations, showed that the peptidic nanotweezers assemble around the C_{60} cage, creating a supramolecular host able to accept C_{60} in the cavity. Electrochemical and spectroscopic analysis demonstrated that, also upon binding with the oligopeptides, the peculiar properties of C_{60} were still preserved. The supramolecular complex shows visible light-induced generation of ROS, which make it a suitable sensitizer in photocatalysis or photodynamic therapy.

19

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PhD **Stefania Vitale** is a material chemist, currently working as post-doctoral researcher at the Unviversity Colleage Dubin, Ireland. She received PhD degree in Chemistry from the University of Catania (2017) for her thesis entitled "Surface engineering of oxide systems for energy and molecular electronics applications". She previously held a two-years research fellowship at the Bern University Applied Sciences, where she was involved in multi-layered materialas characterisation by GDOES. Her research activities are focused on surface engineering and characterisation of technologically – interesting materials, such as trasparent conductive oxides and nanoparticles.

YSF Keynote Presentation

Fluorescent silica nanoparticles for the biofilm EPS matrix analysis

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Engineered nanoparticles (NPs) have been shown to be a promising tool for biofilm prevention and disruption.[1, 2] Although many studies indicate that the most likely mechanism for this action is the interference with the bacterial metabolism and cellular membranes, the role of the biofilm extracellular polymeric matrix (EPS) in the framework of the NPs-biofilm interaction is not yet fully understood, and quantitative relationships between NPs properties and EPS composition are still lacking.[3]

This contribution deals with the use of engineered fluorescent silica NPs to elucidate the role of the EPS matrix in NPs-biofilm interactions, especially how the EPS composition, density and structure affect phenomena such as NP diffusion, uptake and accumulation within the biofilm. Epoxide-engineered fluorescent silica NPs were prepared, and the epoxide moieties were used as anchoring platform for further functionalisation (modification with amine groups, PEG, aromatic or alkyl groups). These NPs were injected in biofilms grown from Pseudomonas strains and the interaction with the EPS studied through confocal microscopy, UV-vis, IR and fluorescent spectroscopy, DLS and Z-potential analysis. The results show that selective interactions with the EPS take place according to specific surface functionalisation. The outcome of this study will be useful in applications where antibiofouling technology is needed, such as the water, biomedical and food industries.

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20

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YSF Invited Oral/Poster Presentations

Controlled-release multilayered drug delivery films with applications in ocular diseases treatment

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The development of new drug delivery (DD) systems able to release the drugs during prolonged periods has been receiving greater attention in recent years due to the ability to use these systems to treat diseases without human intervention. Mainly in ocular diseases with most of treatments consisting in applying eye drops which has a poor patient compliance.

We are developing DD multilayers films able to release an ocular drug used in glaucoma treatment which can release the drug during a month and at specific periods of time. Biocompatible films composed of brimonidine encapsulated in β-cyclodextrin alternated with monolayers of a hydrossoluble polymer (poly (β-amino ester)) and/or graphene oxide are able to release a precise amount of drug for a month. The films growth and the pharmacokinetics were monitored by ultraviolet-visible spectroscopy, quartz crystal microbalance and atomic force microscopy. The obtained results showed that the films are stable and drug release can be controlled by the presence of the hydrossoluble polymer and the graphene oxide. In particular, it was observed that graphene oxide delays significantly the brimonidine release enabling precisely control the amount of drug delivered. This work contributed for new developments in DD films that can be used in glaucoma treatment or adapted to other DD systems with other types of drugs.

Dr. **Quirina Ferreira** received her PhD in Nanoengineering from Universidade Nova de Lisboa, Portugal in 2008 and then she started a research position at Instituto de Telecomunicações of Lisbon. She does research in self-assembled monolayers with applications on biomedical devices and molecular electronics using scanning tunneling microscopy (STM) at liquid interface to prepare and manipulate materials at molecular scale. Recent activities are related with the preparation of supramolecular structures (molecular wires and molecular switches) by a bottom-up approach using the STM to control each step at molecular level.
Another research line is the development of functional monolayers with drug delivery function for applications in ocular diseases treatment. She also collaborates with computer science researchers to develop software based in machine learning algorithms to improve STM deliverables. She has more than 10 years of experience working with nanomaterials and at moment she coordinates research projects in this area.

YSF Keynote Presentation

STM as a tool to control the fabrication of nanosystems

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22

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YSF Invited Poster Presentation

Direct laser interference patterning of diamond-like carbon silver nanocomposite thin films

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The demand for new functional materials dedicated for sensors and various optical devices is increasing and consequently novel and compatible high throughput micro lithography techniques are emerging. Direct laser interference patterning (DLIP) is an example of fast fabrication method, capable to impose periodic patterns in practically any material upon selection of proper ablation parameters. Ultrashort pulse irradiation can melt and therefore change structure and linear dimensions of nanoparticles. Silver nanoparticles have attracted considerable amount of interest due to their plasmonic properties and wide range of applications, among which are antibacterial coatings and various sensors. However, silver is a fast oxidising metal and thus requires passivation. One of the possible ways to achieve passivation is embedding silver nanoparticles in passivating matrix, for example diamond-like carbon.

In this work, we present Yb:KGW femtosecond laser two second harmonic beams interference ablation of diamond like carbon thin films doped with silver nanoparticles. We investigate the influence on nanoparticle size distributions and one-dimensional periodic structures based on applied number of laser pulses and laser fluence. The DLIP effects are compared for nanocomposites with two different silver contents as well as pure silver and pure diamond-like carbon thin films. It was obtained that existence of silver nanoparticles in thin films lowers the ablation threshold, due to presence of localised surface plasmon absorption.

23

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YSF Invited Oral Presentation

Investigation cancer biomarkers using Gold nanoparticles by lab-on-phone

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Cancer is the second leading cause of death in the world. So its early detection and therapy is very important. There are many different ways such as blood tests, X-rays, (contrast) CT scans and endoscopy to diagnose cancer that are so expensive and time-consuming. The effective and rapid detection of cancer cells at various stages are the challenges of diagnosis of cancer. Herein, we introduce a lab-on-phone device that has the ability to detect vascular endothelial growth factor (VEGF) angiogenesis on the surface of the cancerous cells. The benefits of this approach are being easy to operate, portable, low cost, reliable and fast. This method is based on the localized surface plasmon resonance (LSPR) property of gold nanoparticles (GNPs) which play the key role in this measurement [1]. In this work, a reference solution was made that acts as a probe for detection of VEGF. Gold nanoparticles were linked to Bevacizumab (Avastin) antibody (BAB) using linkers [2]. Then, GNPs were agglomerated due to BAB connection to VEGF on the surface of cancerous cell. The color of solution changed from red to purple due to GNPs agglomerations. This color change was analyzed by taking a photo by the phone's camera using a generated software application which can process the photos and convert this change to the analyte concentration [3].

[1] Li, Ming, Scott K. Cushing, and Nianqiang Wu. "Plasmon-enhanced optical sensors: a review." *Analyst* 140.2 (2015): 386-406. [2] Jazayeri, Mir Hadi, et al. "Various methods of gold nanoparticles (GNPs) conjugation to antibodies." *Sensing and bio-sensing research* 9 (2016): 17-22. [3] Wei, Qingshan, et al. "Detection and spatial mapping of mercury contamination in water samples using a smart-phone." *ACS nano* 8.2 (2014): 1121-1129.

YSF Invited Poster Presentation

Lab-on-phone Colorimetric Assay using Gold Nanoparticles

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Colorimetric detection is a widly used method for detection of analytes in different solutions. There are many instruments performing similar procedures but that are expensive and complex. Herein, we introduce a lab-on-phone device that can detect and analyze even slight color changes that are not visible for the naked eyes. The benefits of this device are being easy to oprate, portable, user friendly, low cost and fast. In our work, gold nanoparticles are playing the key role in detection of the analytes. They simly convert the analyte's concentration to a measurable color change. This lab-on-phone device consists of lightweight opto-mechanical attachments which are wirelessly connected to a smart phone. The main active part of the opto- mechanical of device has been formed from four LEDs in blue, red, green and UV which can be used to assay different types of analytes with different absorbtions. The light absorbtion of an analyte causes a color change. This color change was analyzed by taking a photo by the phone's camera using a generated software application which can process this photo and convert its color change to the analyte concentration.

24

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YSF Invited Poster Presentation

Incorporation of nitro-sensitive bacteria and nitro-capturing bacteriophages into microbeads as field-deployable biosensor

Kangseok Lee, Hyun Ji Roh, Sung Kuk Lee, Chaenyung Cha

Bacterial species capable of expressing fluorophores in response to external stimuli are actively being utilized as light-activated sensors for various applications. These stimuli-responsive bacteria encapsulated in miniaturized spherical hydrogels (‘microbeads’) are especially useful as a field deployable form of sensors for detecting environmental chemicals, due to the capability of mass production as well as long-range light detection. Herein, genetically engineered bacteria capable of expressing enhanced green fluorescent protein ($eGFP^{+}$) in response to nitro compounds were encapsulated into alginate-cellulose beads to develop microbead biosensor. Mechanical strength of the conventional alginate microbeads was improved by incorporating anionic cellulose. The encapsulated bacteria proliferated within the microbeads, and eGFP+ expression was proportional to the amount of nitro compounds (e.g. DNT and TNT). Furthermore, the M13 bacteriophage having high binding affinity towards DNT and TNT were also encapsulated into the same microbeads, resulting in increased sensitivity of nitro detection. In addition, the fluorescence emitted from the microbead biosensor deployed on a soil sample was detected at long range (e.g. 20 meters and beyond) using a laser fluorescent scanning system to validate the feasibility as field application and safe long-range detection of explosives.

25

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Mousumi Beto is currently a PhD scholar in the department of Materials Engineering, IISc Bangalore.She has obtained her Master of Science in Chemistry and Master of Technology in Solid State Technology (Physics). Her research work mainly focuses on synthesis of novel nano-biomaterials and its application towards the targeted delivery of drugs and nucleic acids to different organs depending on the type of viral infections specifically for HIV and HCV.

YSF Invited Poster Presentation

Galactose functionalized mesoporous silica nanoparticles as a delivery vehicle in the treatment of Hepatitis C infection

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In the last decade, silica nanoparticles have drawn massive interest by researchers as an excellent carrier numerous viral diseases due its distinguished physical and morphological properties. Higher biocompatibility, large surface to volume ratio, easy surface modifications,high stability and tunable pore sizes along with low cost and easy preparation methods make it more promising towards drug/nucleic acid delivery subsequently followed by larger encapsulation of drug molecules for real-life applications. Gene therapy has become a potential tool in the medical cooperation of genetically caused diseases. DNA or RNA based antiviral strategy showed better potential application over the viral media due to the less chances of gene recombination and immunogenicity. Hence, in this work mesoporous silica nanoparticle (MSN) based carrier system has been synthesized by simple chemical route, for the targeted delivery of DNA molecule against the conserved 5'-untranslated region of a viral RNA molecule to inhibit viral replications as The as-synthesized MSNs have been characterised by Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM), Brunauer–Emmet–Teller (BET) model and Fourier Transform Infrared Spectroscopy (FTIR) studies. The as synthesized MSNs have a diameter in range of 200-300 nm with an average pore size of 8-10 nm and possess very high specific surface area of ~2206 m^2/gm. Additionally the synthesized refined MSNs have been conjugated with suitable functional groups to make it a controlled drug delivery system. In vitro cytotoxicity assay in human hepatocyte carcinoma (Huh7) cells exhibits excellent cell viability in presence of these MSNs carriers. Noticeable reducing of viral RNA levels has been achieved in HCV JFH1 infectious cell culture indicating that this nanoparticle based complex molecule can be used as an efficient candidate for the effective delivery of DNA molecule for gene silencing.

This work has been financially supported by Department of Biotechnology (DBT) India and Ministry of Human Resource Development (MHRD) India.

26

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YSF Invited Oral Presentation

Investigation of algae mediated Microbial Fuel Cell for its integrated applications in Wastewater Treatment and Biofuel production

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Microbial Fuel Cell (MFC) is a sustainable energy transducer, that directly coverts organic matter into electrical energy. It shows promise in both wastewater treatment and bio-energy production. A bio film of photosynthetic green alga Chlamydomonas sp. TRC-1 deposited on fluorine tin oxide (FTO) electrodes was investigated for its ability to generate power. Cyclic voltammetry (CV) scans recorded a sharp anodic and cathodic peak with a potential difference ΔV= 0.239 V. A peak power output of 10.02 mW/m2 was observed with a current density of 27A/m2. The algal biofilm applied in MFC improved the physicochemical parameters of the wastewater, significantly reducing the chemical oxygen demand (COD: 77.1%), total dissolved solids (TDS: 82.1%) and total suspended solids (TSS: 87.4%). The study not only offers an economically and eco-friendly solution to successful power generation but also contributes towards waste water treatment and biofuel production.

27

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Marco Rizzoni is currently a PhD scholar in the Department of Information Engineering of the University of Brescia, Italy, since November 2016. He has obtained his Bachelor Degree in Physics in 2013 and Master Degree in Theoretical Physics in 2016 at the University of Padova. His research work manly focuses on the study and characterization of metal-oxide nanowires and their biocompatibility, more specially their immunogenic properties.

YSF Invited Poster Presentation

Synthesis and characterization of nanowires hybrid: potential application in a biomedical setting

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In this report we present results of investigations of the mechanical and immunogenic properties of the oxide nanowires hybrid and similar hybrids, and to see if in the future they could be used as coatings for medical prosthesis. The first group of samples consisted in nanowires of zinc oxide grown on a thin film of platinum, the second group was characterized by the added deposition of carbon oxide on the nanowires. The metal film was deposited on glass by RF Magnetron sputtering technique. A tube furnace has been used to grow nanowires of ZnO on the top of the samples by vapour-liquid-solid (VLS) technique. The samples have been investigated by Scanning Electron Microscope (SEM) to verify the morphology of the nanostructures, confirming the correct growth of the zinc oxide nanowires, then have been tested for immunogenicity. Blood samples from 5 healthy controls were obtained, and then Peripheral blood mononuclear cells (PBMCs) were extracted from these blood samples. Some of obtained peripheral blood mononuclear cells were cultured for five hours and stimulated as positive control. Two parts of PBMCs were cultured for five hours without stimuli (negative control) and with the samples of zinc oxide nanowires, respectively. In addition, PBMCs with zinc oxide nanowires were cultured for 5 days. No significative sign of lymphocyte activation was detected, either after 5 hour and after 5 days.

28

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YSF Invited Poster Presentation

Stepwise Assembly of Iron-Tannin Complexes for Liquid-Interface Engineering

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Fe-tannin species have widely been used in our daily life, from food to anti-corrosive products, and recently applied to the interfacial coating with characteristics of non-specific adhesion. Inspired by iron gall ink, a facile strategy was developed for fabricating freestanding films and surfactant-free oil-in-water emulsions through stepwise assembly of Fe(II)-tannin complexes. Fe(II) cations make soluble mono-catecholate complexes with tannins in aqueous solution, and are subsequently oxidized and self-assemble to Fe(III)-tannin complexes for liquidinterface coating. The difference in binding constants of Fe(II)-tannin and Fe(III)-tannin facilitates the oxidation step by lowering the reduction potential of Fe(II). This work provides an insight into the stepwise control of metal-organic complexes for nanobiomedical and nanobiotechnological applications.

29

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Caio H. N. Barros currently works as a PhD student at the School of Chemical and Bioprocess Engineering, University College Dublin. He obtained his Bachelor's degree (2015) and Master's degree (2017) at the State University of Campinas – Brazil, where he worked with biogenically synthesized nanoparticles with antimicrobial properties. His current studies focus on the synthesis and functionalization of silica nanoparticles especially designed for biofilm interactions, with a focus on the Extracellular Polymeric Matrix (EPS).

YSF Invited Presentation

Bacterial biofilms – silica nanoparticles interactions

Caio H. N. Barros, Henry Devlin, Stephanie Fulaz Silva, Dishon W. Hiebner,
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Unwanted biofilm formation is currently one of the most problematic areas in the biomedical and water treatment fields. In the biofilm phenotype, a self-produced matrix of biological components (EPS – Extracellular Polymeric Substances) acts as a chemical and physical barrier for the use of conventional biocides.1 Despite the extensive research of antimicrobial nanoparticles (NPs) against planktonic bacteria, information on how NPs interact and diffuse into the matrix is still a relatively unknown field, and the full potential of nanotechnology against resistant biofilms is yet to be explored.

In this study, silica nanoparticles of different sizes and functionalizations (amine, carboxylic acid) were synthesized using the classic Stober and the microemulsion methods while also being labelled with fluorescent tags. EPS-NP interactions using Pseudomonas biofilms were assessed via studies using Confocal Laser Scanning Microscopy (CLSM), Dynamic Light Scattering (DLS) and Zeta potential measurements. Attachment and penetration of nanoparticles into the biofilm as well as in vitro interactions using extracted EPS were shown to be dependent on the NPs' charge and size. The preliminary results obtained on these systems introduce basic knowledge on biofilm interactions with designed nanoparticles and begin to pave the way towards the development of antimicrobial nanoparticles with activity against bacterial biofilms.

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30

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YSF Invited Poster Presentation

Nanofiber-infused hybrid hydrogels for enhanced mechanical properties and electrical conductivity for biomedical applications

Suntae Kim, Chaenyung Cha

Hydrogels are widely used as cell-culture platforms for various biomedical applications. With the biocompatible polymers as building blocks for hydrogels, it is often difficult to provide various physical properties to tailor to specific needs. In this study, bioactive and electrically conductive nanofibers consisting of conductive polymer (PEDOT:PSS) and biopolymer (photocrosslinkable gelatin) are prepared via electrospinning and further processed to generate short, diffusible nanofibers (< 10 um). These short nanofibers are incorporated into gelatin-based hydrogels to improve their mechanical properties as well as electrical conductivity which is otherwise generally non-existent in polymer-based materials. Their properties could be tuned in a wide range by controlling their physical parameters (e.g. concentrations, molar ratio, size, etc.). The nanofiberinfused hydrogel was used as a scaffold for cardiomyocytes to not only improve their viability, but also their electrophysiological functions, which was aided by the presence of conductive nanofibers. Overall, the nanofiber-based composite hydrogel systems presented in this study could provide unique and yet practical 3D cell culture platforms for biomedical applications.

31

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YSF Invited Oral/Poster Presentations

Bio-inspired Polymer Nano-Hair Structures for Cellular Behavior Control

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A cicada wing has a biocidal feature of rupturing the membrane of cells, while the cactus spine can transmit a water drop to the stem of the plant. Both of these properties have evolved from their respective unique structures in nature. Here, we endeavor to develop geometry-controllable polymer nanohairs that mimic the cicada‘s wing-like vertical hairs and the cactus spine-like stooped hairs, and to quantitatively characterize the cell migration behavior of the hairy structures. It was found that the neuroblastoma cells are highly sensitive to the variation of surfaces: flat, vertical, and stooped nanohairs (100 nm diameter and 900 nm height). The cells on the flat structures showed random movement while the cells on the vertical hairs showed significantly decreased proliferation. It was also found that the behavior of cells cultured on stooped nanohairs is strongly influenced by the direction of the stooped pattern of hairs when we quantitatively measured the migration of cells on flat, vertical, and stooped structures. Cells on the stooped structure showed higher forward migration preference compared to that of the other structures. Furthermore, we found that these cellular behaviors on the different patterns of nanohairs were affected by intracellular actin flament change. Consistent with these results, the vertical and stooped structures can facilitate the control of cell viability and guide directional migration for biomedical applications such as organogenesis.

32

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YSF Invited Oral Presentation

Spider's Sensory Organ Inspired Highly Durable, Ultrasensitive Nanoscale Crack Based Sensor

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With increasing demand for the detection of delicate bio-signals for medical electronics, the Internet of Things (IoT), E-skin and flexible integrated circuit (IC) devices, an enhancement in sensitivity has become a major issue in flexible mechanosensors, however, overcoming the limited sensitivity remains problematic. Here, we introduce mechanosensors inspired by spiders having an ulltrasensitivity, durability. For ultrasensitivity and durability, we considered the geometrical effects in cracks and self-healable polymers. By controlling crack depth by simple propagating process, the sensitivity of our sensor shows ~15,000 in 2% strain, which is the world best sensitivity value. Due to the high sensitivity, the signal-to-noise-ratio is 6 times higher than before, up to ~35 so that it can be used in sensing human voice clearly. Also, self-healable polymer helps to recover the crack gaps after 25,000 cycles. We introduce the possibility of semi-permanent uses over 1,000,000 cycles in our sensors. The spider inspired sensory system with high sensitivity and durability would provide versatile novel applications such as E-skins, devices for medical applications, and IoT applications etc.

YSF Invited Poster Presentation

Remarkable Persistence in Nanoscale Crack based Sensor via On-Demand Healing

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The characteristics of a mechanosensor are one of the crucial issues to detect delicate bio-signals for medical applications and fine stress on flexible integrated circuit (IC) electronics. Especially, sensitivity is major issues for the sensor, determining directly the performance of the sensor. Recently, nanocrack based mechanosensor inspired by spider's vibration receptor has been a breakthrough with its high sensitivity, up to 2,000 in 2% strain, and simple fabrication process. The sensitivity is dramatically enhanced by nano-crack pattern, however, due to nano-cracks, fatigue by repeated stress is concentrated and accumulated on the spot of the crack vertex. Degradation is inevitably compromised even after 1,000 cycle in 2% strain. Thus, to overcome this drawback, we suggest a simple yet robust strategy for remarkable persistence and durability in nanoscale crack based sensor with a self-healable polymer. The self-healable polymer help it make a return to have original shape and performance. Due to the healable property, the sensitivity is stable until 10,000 cycles of 2% strain, and with additional healing at 50 ℃ for 10 minutes, the sensor over 100,000 cycles can be used. External IR LED heating is useful to locally accelerate the healing, not affecting in another component. The proposed strategy can provide high mechanosensitiy as well as highly enhanced durability.

33

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YSF Invited Oral/Poster Presentations

Molecularly Imprinted Polymer Nanoparticles as Synthetic Antibody Mimics for Cell Targeting and Imaging

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Advanced affinity tools for cell imaging are of particular interest as they can detect, localize and quantify molecular targets. Aberrant glycosylation sites and deregulated expression of growth factor receptors are promising biomarkers of many human diseases, most notably cancer. However, targeting these biomarkers is often challenging due to a lack of receptor molecules. Molecularly imprinted polymers (MIPs) are tailor-made synthetic receptors (antibody mimics), able to specifically recognize target molecules. They are synthesized by co-polymerizing functional and cross-linking monomers in the presence of a molecular template, resulting in the formation of binding sites with affinities and specificities comparable to those of natural antibodies [1]. Herein, we demonstrate biotargeting and bioimaging with fluorescently labeled MIPs on two different cancer biomarkers: hyaluronan and a growth factor receptor protein. MIPs were synthesized using a solid-phase synthesis approach in which an epitope of the biomarkers was immobilized on glass beads (as solid support) via click chemistry. This configuration allows an oriented immobilization of the template upon which thermoresponsive MIP nanoparticles were synthesized. The binding sites of the resulting MIPs all have the same orientation, thus MIPs synthesized by the solid-phase approach can be considered analogous to monoclonal antibodies [2-3].

Hyaluronan imaging was achieved by applying rhodamine-doped MIPs specific for glucuronic acid (an epitope of hyaluronan) on fixed human keratinocytes [4]. Hyaluronan is composed of alternating units of D-glucuronic acid (GlcA) and N-acetyl-D-glucosamine. Thus, azide functionalized-glucuronic acid was immobilized on glass beads bearing alkyne groups. MIPGlcA (70 nm) as water soluble particles were found to bind selectively extracellular, intracellular and nuclear hyaluronan, as imaged by epifluorescence and confocal microscopies. The specificity of binding was verified with a non-imprinted control polymer and by comparing the staining with a hyaluronan binding protein. For bioimaging the growth factor receptor membrane protein, a short peptide (terminal alkyne functionalized) was selected as epitope for immobilization on azide-modified glass beads. The MIP nanoparticles (50 nm) specifically recognized both the

template peptide and the whole protein. Cell imaging studies with fluorescent dye-doped MIPs were performed.

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34

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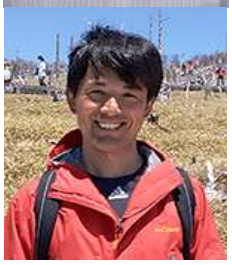

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Naoto Asai is a second year PhD student in Graduated school of Science and Engineering, Kansai University, Japan. He received B.D. in 2015, and M.D. in 2017. He has studying high-sensitive detection platforms with nanostructure and their application for biosensing.

Takeshi Ito recieved B.D. from Osaka University in Earth and Space Sicence in 1995, and received M.D. from University of Tokyo in Earth and Planetary Sicence in 1997. Then, he recieved Dr. Eng. From Keio University in 2007. His scientific interests are boundary face between living substances and inorganic materials including nanostructures, and its application for biosensing.

YSF Invited Poster Presentation

Fabrication of highly sensitive QCM sensor with a nano-honeycomb structure and the demonstration for biosensing

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Quartz crystal microbalance (QCM) methods are powerful tool to monitor some phenomena about bio-recognition with real time, which is assembled with flow injection method. QCM-based sensor are simple, convenience, and low cost. In addition, the method can be downsized easily using conventional microfabrication technologies. However, QCM-based sensor has poor sensitivity for low-molecular-weight materials since magnitude of the frequency shift is proportional linearly to the mass change, as a principle of Saurbrey equation [1].

The motivation of the research is improvement of the sensitivity of QCM-based sensor using large surface area due to 3D nanostructures. In this report, an anodic alminum oxide (AAO) was coated on the quartz crystal. The AAO nanostructure was obtained easily by anodizing only aluminum thin film [2]. Then, a self-organized nanohole array having a triangle lattice was formed in the downward direction with a high aspect ratio. The fabricated nanostructure was just like a honeycomb shape. We measured the frequency shift on antigen-antibody interraction of Mouse IgG. The frequency shift on the nano-honeycomb electrode was 2-3 times larger than that on flat Au surface electrode. The limit of detection (LOD) also improved from 0.48 to 0.20 μg/ml.

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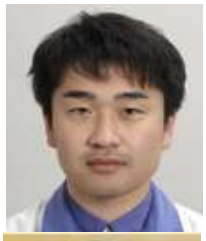
35



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Recent pubrications about the intermediate water concept for high-throughput screening of biocompatible materials: *ACS Biomater. Sci. Eng.*, 4, 1591-1597 (2018). *Biomacromolecules*, 18, 1609-1616 (2017). *Biomacromolecules*, 18, 3834-3843 (2017). *Biomacromolecules*, 18, 4214-4223 (2017). *Macromolecules*, 49, 8154-8161 (2016). *ACS Biomater. Sci. Eng.*, 2, 2122–2126 (2016). *Biomacromolecules*, 17, 3808-3815 (2016). *Macromolecules*, 49, 2493-2501 (2016). *ACS Appl. Mater. Interfaces*, 7, 18096-18103 (2015). *Langmuir*, 31, 7100-7105 (2015). *Langmuir*, 30,10698-10703 (2014). *Adv. Healthcare Mater.*, 3, 775-784 (2014). etc.

YSF Invited Oral/Poster Presentations

Protein adsorption and hydration structure of fluorine-containing synthetic polymers

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Poly(2-methoxyethyl acrylate) (PMEA) shows excellent blood compatibility due to the existence of intermediate water (1). Small amount of amino groups was found to change the hydration structure of 2-hydroxyethyl methacrylate when combining in a copolymer structure, which additionally decreased the interactions with lymphocytes (2).

Here we exploit another possibility to manipulate the surface hydration structure of PMEA by incorporation of small amount of other than nitrogen - the hydrophobic fluorine groups in MEA polymers using Atom Transfer Radical Polymerization and the (macro) initiator concept (3).

Focusing on the difference in mobility, two kind of fluorinated MEA polymers were synthesized using 2,2,3,3,4,4,5,5,6,6,7,7,8,8-pentadecafluoro-1-octanol (F15) and poly(2,2,2-trifluoroethyl methacrylate) (P3FM) (macro) initiators appearing liquid and solid at room temperature, respectively. The fibrinogen adsorption of the two varieties of fluorinated MEA polymers was different, that could not been explained only by the bulk hydration structure. Contact angle and AFM measurements reveal that the F15-PMEA reorients in water easily to the surface as compared to the P3FM-b-PMEA which reorientation was suppressed by the small solid fluorinated P3FM block.

These findings illustrate, that in order to make a better bio-inert material, the chains containing sufficient intermediate water need to be efficiently oriented to the water surface.

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36.

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Dr. **Vidya N** completed her Masters' degree majoring in Medical Nanotechnology from SASTRA University, India in 2013. She pursued her PhD in Singapore from MSE-NTU and received her degree in April 2018. Her doctoral thesis dealt with developing 3-dimensional and bi-layered scaffolds for musculoskeletal tissue regeneration applications. Currently, she is a postdoctoral research fellow at Nanyang Technological University and works on developing medical devices and on drug delivery technologies. To date, Vidya is a (co-) author of 5 papers published in peer reviewed international journals and has interned at reputed universities such as MIT-Harvard and National Chemical Laboratory, Pune India. Over and above her academic activities, Vidya has developed her interpersonal and leadership skills. She was the recipient of the Women in Engineering, Science and Technology Travel Grant in 2018. She was also the winner of the Young Persons' World Lecture Competition 2017 hosted by the Institute of Materials, Minerals and Mining (IOM3). She held the portfolio of the President of the Materials Science and Engineering Graduate Students' Club from 2015-16. Apart from playing a vital role as organizing committee for various successful academic events hosted by MSE-NTU and interacting with eminent researchers, she has contributed to student/staff welfare through fundraising, mentoring and clean campus initiatives. In addition to her long-term goal to contribute significantly towards mimicking the principles of biological systems, Vidya is fond of travelling and classical music.

YSF Invited Oral Presentation

Dual structured biodegradable scaffolds for bone and cartilage tissue regeneration

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Electrospinning has emerged as a versatile, cost effective and reliable technique for fabrication of micro/nano fibers and particles with a strict regulation of solution parameters. However, there is minimal evidence till date of any successful dual structured particle on fiber ?Sandwich?drug delivery system obtained from electrospinning that could provide controlled release of two or more different drugs. In this study we have successfully fabricated a dual structured electrospun fibrous - micro particle system through electrospinning for delivery of a hydrophilic and a hydrophobic drug simultaneously. A blend of two FDA approved biodegradable polymers was used as the electrospinning solution. Preliminary work focused on optimization of the processing parameters to arrive at 5-8?m porous particles that were electro-sprayed on a fibrous mesh network of PLGA-PCL fibres. The particles were further protected by another fibrous mesh on the top to prevent its loss during post fabrication, thereby the entire system resembling a sandwich. Characterization of the scaffold was carried out using Scanning Electron Microscopy, Rheometer and Fourier transform Infrared Spectroscopy. The hydrophobic Dexamethasone (Dex) was loaded into the fibers while Ascorbic acid (AA) was the hydrophilic biomolecule loaded into the particles. The release profiles of these drugs were quantified with the help of High Performance Liquid Chromatography (HPLC) which enabled the detection of Dex at 246nm and AA at 262 nm respectively. These scaffolds were used to study the differentiation capabilities of mesenchymal stem cells (MSCs) into osteo and chondro lineage. Future studies are directed towards understanding the influence of the carrier morphology and the synergistic effect of multiple biomolecules will be explored in depth for musculo-skeletal tissue engineering.

The Symposium E Scientific Committee:
Invited Presentation 17 Sept Keynote Forum;
Invited Poster Presentation General Poster Session with Evening Party

Multidrug-eluting bi-layered microparticle-mesh scaffolds for musculoskeletal tissue regeneration

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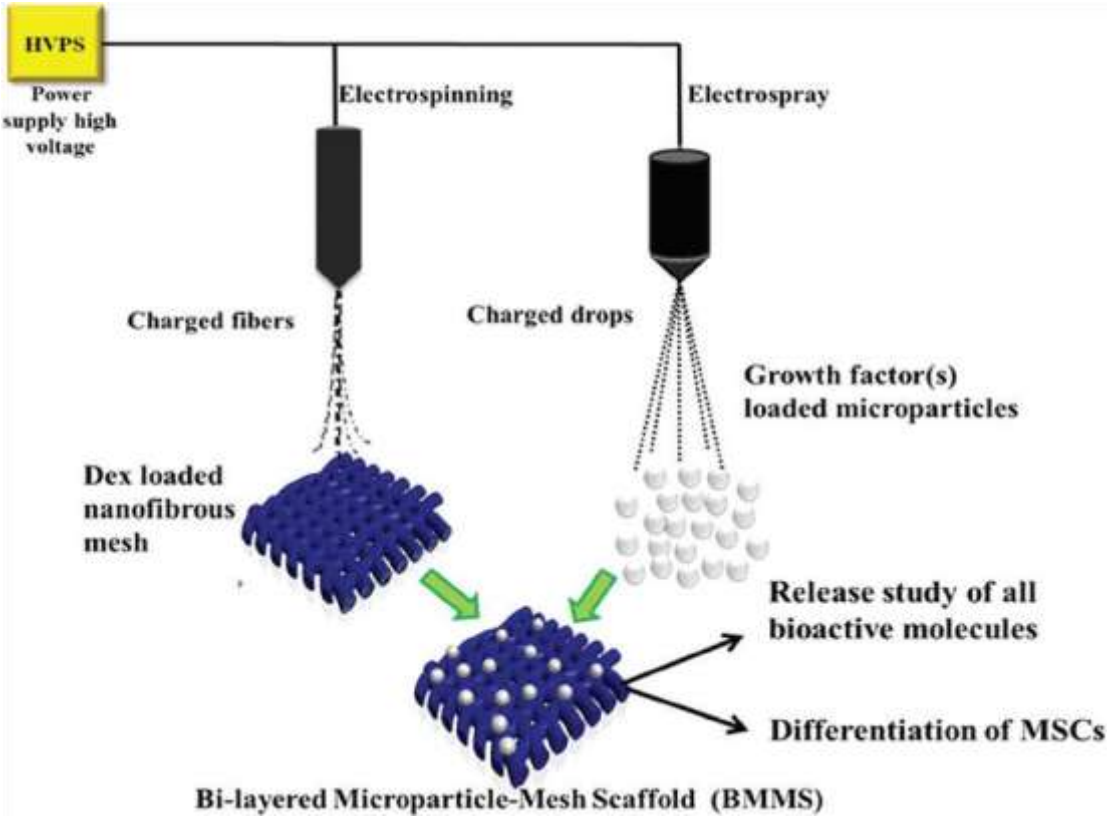
Stem cell-based tissue engineering necessitates the development of a biocompatible scaffold, as a structural support, that provides a continuous supply of bioactive molecules for specific lineage differentiation. While incorporating bioactive molecules within a scaffold to improve stem cell differentiation has been reported in the literature, there is minimal evidence of any scaffold that can deliver a customized concoction of both hydrophobic and hydrophilic bioactive molecules to induce in situ lineage differentiation without any external supplements. In this study, we established a bioactive, drug-eluting bi-layered microparticle-mesh scaffold (BMMS) using the electrospinning technique. This BMMS was co-encapsulated with hydrophobic dexamethasone (in the mesh), hydrophilic ascorbic acid and β-glycerophosphate or proline (in the microparticles). We hypothesized that a sustained-releasing BMMS can direct in situ specific lineage differentiation of MSCs (e.g. osteogenic and chondrogenic) in a minimally supplemented culture environment into musculoskeletal tissues. The characterization of this BMMS revealed good encapsulation efficiencies of the bioactive molecules with sustained-releasing capabilities. The release kinetics of each drug was further analyzed using mathematical drug-releasing models. These scaffolds were subsequently shown to have potential for osteogenic or chondrogenic lineage differentiation from mesenchymal stem cells (MSCs) in a minimally supplemented culture medium.



37.

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YSF Invited Oral/Poster Presentations

Development of Wearable Organic Solar Cells and Supercapacitor Integrated Devices for Smart Textile Applications

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Textile based, wearable optoelectronic devices have been widely investigated because of its wearability, lightweight, ease of processing, and low-cost production. Particularly, textile based organic photovoltaics (OPVs) have shown promising results in the past. However, the photovoltaic performance of textile OPV is usually hindered by the non-uniform coating of conductive fibers and high sheet resistance of electrode. In this work, highly flexible, transparent hybrid conducting electrodes (TCE) were fabricated via embedding silver sub-electrodes/conductive polymers into an UV-curable polymer. The photovoltaic performance with active layer consisting of PTB7-Th:$PC_{71}BM$ shows a relatively high power conversion efficiency (PCE) of ~ 5% with an active area of 0.3 cm^2. To prepare functional textile OPVs, multiple devices were weaved and integrated into the fiber thread with various aperture area. An output voltage of > 7 V was achieved by connecting seven devices in series. Additionally, flexible supercapacitor (SCs) were integrated with solar cells as textile based power pack. The SCs were fabricated based on PEDOT:PSS electrodes sandwiched between gel electrolyte in symmetrical device structure. An areal capacitance of >3.8 mF/cm^2 was successfully achieved for the SC device. The multifunctional textile OPVs and SCs fabricated herein exhibits underlying potential for next-generation optoelectronics application.

38

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MSc Aleksandra Jastrzębska - a fourth year PhD student at the Mechanical Faculty at Lodz University of Technology. She received the BSc degree in the field of Biomedical Engineering in 2013 and the Master degree in the field of Biomaterials Engineering in 2014. Her research aims on the surface engineering of biomaterials and the interactions of surfaces with microorganisms and tissues.

Prof. **Bogdan Walkowiak** – an expert in the field of biological evaluation of nanomaterials and other products of innovative technologies. He graduated physics at the University of Lodz, Poland. In 1985 he received his PhD from the Medical University of Lodz. In years 1989-90 he was a Post Doc at the State University of New York, Health Science Center at Brooklyn, New York, USA. At present he is the head of the Department of Biophysics at the Technical University of Lodz, Poland, and he is also the scientific leader of laboratories of Bionanopark Ltd, Lodz, Poland, and he is a member of Nanomaterials Expert Group in European Chemicals Agency in Helsinki, Finland.

YSF 18 Sept Invited Oral Presentation E.YSF.27
The Symposium E SciComm Invited Poster Presentation
17 Sept Special Poster Session E. P1.8

Impact of structuring and doping of Ti6Al4V alloy surface by anodizing method on properties expected in medical applications

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Despite strict compliance with the standards of ISO 10993 with respect to medical implants, their widespread use proves a certain level of risk of implant failure. Among the main problems regarding the use of implants in clinical practice microbial biofilm-related infections and an insufficient integration of implant with tissues are serious obstacles. Currently available biomaterials are relatively well-suited to strength requirements, therefore, the methods of surface modification of implants are used to improve their properties and minimize possible negative outcomes of the use of biomaterials. Moreover, changes and proper control of process parameters allow to get surfaces better adapted to the needs and expectations of personalized medicine. Parameters of anodization process can be easily altered and well controlled, thus leading to the tailoring of properties of the resulting oxides. In the performed research, the anodic oxidation was used for creation of titanium dioxide films (TiO_2) on surfaces of titanium alloy Ti6Al4V samples. The coatings differed from each other in the surface structure. Four different types of surface textures were obtained (smooth, porous, nanotubular and nanorough). Additionally, each type of the coating was doped with antimicrobial agents – copper and zinc. Presence of dopants decreased the number of *E. coli* cells which adhered to the examined surfaces. Biological evaluation concerning the live/dead test for osteoblasts indicated that the created layers were not cytotoxic. The presented results prove a real possibility of the use of titanium dioxide films doped with copper and zinc for medical applications.

39

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Jinho Hyun recieved B.D. from Seoul National Univerity in Natural Fiber Sicence in 1993, and received M.D. from Seoul National Univerity in Natural Fiber Sicence in 1995. Then, he recieved Ph.D. From North Carolina State University in 1999. His scientific interests are nanobiomaterials including cellulose nanofibers, silk proteins and hybrid composite hydrogels

YSF Invited Oral/Poster Presentations

Stereolithography 3D printing of silk-PEG hydrogel for the construction of epidermal equivalents

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The epidermal equivalents are used as an alternative animal test of permeation and toxicity screening of chemicals. In this study, we demonstrate stereolithography three dimensional (3D) printing for the mimicry of the epidermal equivalents. In comparison with traditional methods for constructing epidermal equivalents, it offers advantages in terms of cell laden retention, reproducibility and high culture throughput. Human keratinocytes are incubated on a silk fibroin-PEG hydrogel scaffold containing fibroblasts and also grown at the air-liquid interface, which allows the enhanced maturation and stratification. In the presentation, the detailed process of purification of silk fibroin from the cocoon, the synthesis of acrylated-PEG, 3D printing of bioinks, and the critical parameters of the cell culture will be discussed.

40

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YSF Invited Poster Presentation

In situ detachment of subcellular regions using a cell-friendly photoresist and spatial light modulator

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Dynamic adhesion and detachment of subcellular regions occurs during cell migration. Migrating cells exhibit highly polarized morphology with non-uniform distribution of adhesions across the cells. To systematically investigate roles of adhesions in each region of cells, we devised a new method enabling us to detach defined sub-cellular regions of cells and observe cell responses in real time using a cell-friendly photoresist poly(2,2-dimethoxy nitrobenzyl methacrylate-r-methyl methacrylate-r-poly(ethylene glycol) methacrylate) (PDMP).[1] Unlike conventional photoresist polymers, PDMP dissolves in cell culture medium with near neutral pH conditions after brief UV exposure without harming cells [2], thus in situ micropatterning can be performed in the presence of cells. First, PDMP polymer thin films formed by spincoating on glass coverslips were briefly treated with air plasma and coated with fibronectin. Then, cells were attached on fibronectin-coated PDMP thin films. By using a spatial light modulator, we illuminated UV to specific sub-cellular regions to selectively dissolve PDMP thin films underneath the cells, resulting in detachment of cell adhesions on UV-illuminated regions. Using this new method, we systematically investigated how cells respond when specific sub-cellular regions of the cells were detached.

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41

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Feby Pratiwi is a PhD candidate in (Nanoscience and Nanotechnology) Chemistry at joined program between Taiwan International Graduate Program (TIGP), Academia Sinica and National Taiwan University (NTU), Taiwan. Her research interest is on developing a new design of ratiometric intracellular pH (pHi) sensing probes using Quantum dots and Mesoporous Silica Nanoparticles and their monitoring techniques using Optical microscopy.

Peilin Chen received his Bachelor degree in Chemistry from National Taiwan University in 1990 and obtained his Ph.D. degree in Chemistry from University of California, Irvine in 1998. He worked as a postdoctoral fellow in the Chemistry department of University of California, Berkeley between 1999 and 2001. Prof. Chen joined Research Center for Applied Sciences, Academia Sinica, Taiwan as an Assistant Research Fellow in 2001. He was promoted to Associate Research Fellow and Research Fellow in 2005 and 2010, respectively. He served as the deputy director of the Research Center for Applied Sciences between 2010 and 2012 and the Chief Executive Officer of the thematic center of Optoelectronic in 2012. Prof. Chen was a visiting Professor in RIKEN and Kyoto University. Prof. Chen received several prestigious awards in Taiwan including Research Award for Junior Research Investigators in Academia Sinica, Ta-You Wu Memorial Award of National Research Council and Career Development Award in Academia Sinica. Prof. Chen has authored or co-authored more than 120 papers in refereed journals and conference proceedings, he has delivered more than 60 invited talks in international meetings and conferences. He organized more than 10 international symposia.

YSF Invited ORAL Presentation
The Symposium E Scientific Committee's Special Invited Poster Presentation for 17 Sept Special Poster Session "Face-to-Face" Keynote/Invited Presenter- Participants

Local pH tracking for lysosome targeting using triple labeled Mesoporous Silica Nanoparticles

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We will report the synthesis of triple labeled Mesoporous Silica Nanoparticles (FORMSN) by encapsulates 3 kind of dyes: Fluorescein isothiocyanate(FITC, pKa=6.7) and oregon green succinimidyl ester (OG, pKa=4.8) as pH sensitive dyes and rhodamine isothiocyanate (RITC) as a reference dye, which have broad range pH detection. FORMSN have also been decorated with lysosomal sorting peptide (YXXϕ) for targeting lysosome. The 3D single particle movement based on pH detection were demonstrated by using this FORMSN. We too found out that with the peptide conjugation increased the number accumulation of particle in lysosomal compartment. Moreover, we noticed 3 different patterns of the pH changing to the time of FORMSN-peptide during traffic routes: acidification, basification, and stabilization.

42

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YSF Invited Oral Presentation
The Symposium E Scientific Committee Poster Presentation 17 Sept Special Poster Session

Molecularly Imprinted Polymers for Determination of Chosen Food Toxins

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High temperature frying, broiling, grilling and, especially, smoking of protein providing food products, such as meat, fish, poultry, eggs, and cheese, generates in these products toxins, namely heteroaromatic compounds, amines, nitrosamines, etc. Continuous exposure to low doses of these toxins causes several chronic diseases, serious hormonal dysfunctions, and cancer. One of the trace amines, tyramine, may also cause unwanted interactions with antidepressant monoamine oxidase (MAO) inhibitors causing so called “Cheese reaction”. Currently used procedures for determination of these toxins in food matrices are either expensive or tedious and time-consuming.

Therefore, fast, inexpensive, simple, and reliable determination procedures, without need of separation of these toxins, in the protein food matrices are in demand. Molecularly imprinted polymers (MIPs) are excellent example of bio-mimicking recognition materials. Therefore, they have found numerous applications in selective chemosensing. Within the present project, we have applied tyramine imprinted polythiophene films as a selective recognition units for devising electrochemical MIP sensors. Both sensitivity to tyramine and selectivity with respect to common interfering compounds of the MIP-tyramine film coated electrodes were high. The linear dynamic concentration range of the devised MIP chemosensor was 260 μM to 2.6 mM tyramine and the imprinting factor was IF = 3.