Keynote session Young Investigators Forum.

The theme ***Grown The BioFuture***

Tuesday, May 30 10:00

Keynote Introduction Founder of the E-MRS, General Secretary of the E-MRS Professor Dr. Paul Siffert

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10:10 HONORARY LECTURE Nobel Laureate in Chemistry 2021

Professor Dr. Benjamin List

Frontiers in molecular green engineering: asymmetric organocatalysis

Revolutionary molecular construction by asymmetric organocatalysis with enzymes organocatalyst. New organocatalysts for asymmetric organocatalysis can complete with enzymes. This is an ingenious tool for building molecules.

Benjamin List and **David MacMillan** are awarded the Nobel Prize in Chemistry 2021 ”for development of asymmetric organocatalysis”. This is a precise new fool for molecular construction. This has had a great impact on pharmaceutical research and has made chemistry greener. www.nobelprize.org/prizes/chemistry/2021

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Université de Technologie de Compiègne

11:00 Tutorial Lecture Molecularly imprinted polymer nanogels as synthetic antibody mimics for diagnostics and therapy

Dr. Full Professor
Karsten Haupt
Université de Technologie de Compiègne, Alliance Sorbonne Universities, CNRS Institute for Enzyme and Cell Engineering, Compiègne, France
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Tutorial Lecture

Molecularly imprinted polymer nanogels as synthetic antibody mimics for diagnostics and therapy

Karsten Haupt

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Molecularly imprinted polymers (MIPs) are synthetic antibody mimics that specifically recognize molecular targets. They are highly cross-linked polymers synthesized in the presence of the target molecule or an 'epitope' thereof, acting as a molecular template. This templating induces three-dimensional binding sites in the polymer that are complementary to the template in size, shape and chemical functionality (Figure 1). The synthetic antibody can recognize and bind its target with an affinity and selectivity similar to a biological antibody.

Herein, we demonstrate the potential of MIP nanogels (size below 100 nm) as antibody mimics directed against peptide epitopes of target proteins, for diagnostics, bioimaging and therapy, on the example of cell surface targets (cadherins - cell-cell adhesion proteins) as well as a soluble biomarker for kidney injury (KIM1) and soluble cytokines. The MIP is obtained through a rational approach using in silico epitope identification followed by solid-phase synthesis of polymer nanogels around the immobilized template peptide. Affinity and specificity are assessed through equilibrium binding assays and solution STD and WaterLOGSY NMR spectroscopies, before the MIPs are tested in bioassays.

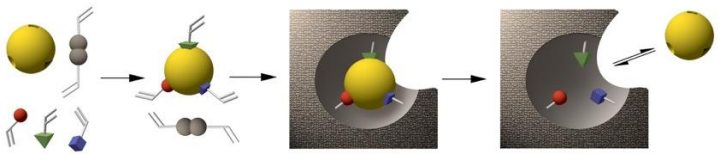
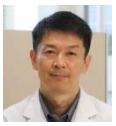


Figure 1: General principle of molecular imprinting : Functional monomers interact with the target antigen (molecular template), followed by cross-linking polymerization, resulting in the formation of specific binding cavities in the 3D polymer network.

The E-MRS Invited Scientific Organizer of Young Investigators Forum
Prof. M. Tanaka*, Kyushu University, Japan,* masaru_tanaka@ms.ifoc.kyushu-u.ac.jp



The E-MRS Invited Scientific Organizer of Young Investigators Forum
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E-MRS invited Leader of Work Group for organization and to held of Young Investigators Forum Ph.D. student Nozawa Koki, *University of Tsukuba, Japan*
noza.ez@gmail.com

E-MRS invited memberg of Work Group for organization and to held of Young Investigators Forum PhD Candidate A. Alp Yetisgin*, Sabanci University*
yalp@sabanciuniv.edu

The E-MRS INVITED PRESENTERS

11:30 00578 A. Alp Yetisgin PhD Candidate

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Alp Yetişgin finished the Department of Bioengineering, Yildiz Technical University with BSc degree. Dropped the NanoScience and Nano Engineering graduate program of the ITU after the first year. However, he worked at ITUnano and ITU-MEMS labs and gained experience on polymer/cnt composite, PVD, XRD, soft lithography, also worked on microbial fuel cells. Currently he is studying at Sabanci University Material Science and Nano Engineering graduate program as PhD student, and working at SU-NUM.

Supervisors of the PhD candidate A.Alp Yestigin

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-2003-2008 : ResearchAssistant, KumamotoUniversity, Department of Materialand Life Science, JAPAN
-2002-2003: VisitingScientist, IstanbulUniversity, Department of Genetics, InstituteforExperimentalMedicine (DETAE), Istanbul, TURKEY.

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Reseach
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Visiting Graduate Student 2006-2009 Materials Science and Engineering Department, Genetically Engineered Materials Science and Engineering Center (GEMSEC), University of Washington, USA

Development of Topical Drug Formulations for the Treatment of Ocular Neovascularization

A.A. Yetisgin, O. Kutlu, S. Cetinel.
Nanotechnology Research And Application Center (sunum), Sabanci University - Istanbul (Turkey).

The growth of new blood vessels from already existing vessels is known as angiogenesis. Uncontrolled angiogenesis in ocular compartments such as iris, retina, and choroid may result in formation of leaky vessels, hemorrhage, or edema in the surrounding tissue, which could potentially lead to vision loss. Several ocular diseases such as age-related macular degeneration (AMD), diabetic retinopathy (DR), retinal vein occlusion, and myopic choroidal neovascularization are associated with abnormal ocular neovascularization (NV) of posterior segment tissues of the eye. These add up to the posterior segment diseases constituting the major cause of visual impairments worldwide, according to World Health Organization (WHO).

There are US Food and Drug Agency (FDA) approved anti-VEGF agents such as Ranibizumab (Lucentis), Bevacizumab (Avastin), Pegaptanib sodium (Macugen), and Aflibercept (Eylea) for ocular NV treatment. Despite the efficiency of these agents, intravitreal injections need to be done frequently to withstand the high clearance rate. Consequently, frequent injections lead to complications such as increased intraocular pressure, macular edema, retinal detachment, and risk of infections. Considering these drawbacks of current anti-VEGF treatments, optimal therapeutics for ocular NV providing a long duration of action and high bioavailability with a non-invasive administration route such as topical, is in need.

Here, we attempt to generate a topical anti-VEGF formulation. As the drug carrier polymersomes are formed by amphiphilic hyaluronic acid (HA) polymers synthesized with conjugation of HA (<10kDa) with lipid molecules. Degree of substitutions (DS%) were obtained as 14,09%, 20,02%, and 24,21% for three different amphiphilic HA polymers. Critical micelle concentrations (CMC) measured using pyrene peak ratios demonstrated that increased DS% result in decreased CMC. Excimer peak formation of pyrene in polymer concentrations higher than CMC indicated vesicle formation. Self-assembled polymersomes had hydrodynamic sizes below 200nm with PDI values below or around 0,3. Blank polymersomes were highly negatively charged with zeta potential lower than -20mV. Moreover, polymersomes were stable in an aqueous solution up to 90oC.

Since both hydrophobic and hydrophilic drugs can be loaded into these nanovesicles, they have been considered as a potential drug delivery system. Preliminary results showed that polymersomes had encapsulation efficiencies more than 65%, when polymer to anti-VEGF peptide ratio of 10:2 (w/w) is used. Results obtained in the study show the potential of amphiphilic HA polymersomes as drug delivery vehicles. For the continuation of the study, we will demonstrate the in vitro cytotoxicity and the in vitro activity of the anti-VEGF peptide-loaded polymersomes on various cell lines including HUVEC (Human Umbilical Vein Endothelial Cells), ARPE-19 (Human Retinal Pigment Epithelial Cells) and HCEC (Human Corneal Epithelial Cells).

Lunch ***12:00 a.m. - 13:00***

13:00 00775 Koki Nozawa Ph.D. student

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University of Tsukuba, Japan
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Koki Nozawa is a Ph.D. student at the University of Tsukuba supervised by Assoc. Prof. Dr. Kaoru Toko. His research interests are a low-temperature synthesis of polycrystalline Ge thin films on insulators and its applications to thin-film transistors and solar cells. In particular, he developed advanced solid-phase crystallization (SPC) technique, which enables us to form the high-quality polycrystalline Ge thin film on glass and plastic substrates. Using this technique, he has continuously updated the highest carrier mobility among the semiconductor thin films directly formed on insulators at low temperatures. He has 5 papers, 3 of which are the first authors. Recently, his paper was selected for the Front Cover of ACS Applied Electronic Materials

Supervisors of the PhD student Koki Nozawa

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Reseach
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High carrier mobilities in polycrystalline germanium layers for flexible electronics

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

K. Nozawa 1, T. Suemasu 1, K. Toko 1.
1University Of Tsukuba - Tsukuba (Japan)

With the development of the ubiquitous society, there is a desire to develop wearable devices that allow us to exchange information anytime, anywhere. Especially flexible devices with better computing performance than Si integrated circuits will be innovative devices such as multifunctional displays. In this situation, Ge, a group IV semiconductor, has higher mobility for both holes and electrons than Si and is expected to be applied to high-speed devices. It also has a low crystallization temperature and can be synthesized directly into flexible plastics under heat-resistant temperatures.

Based on this background, intensive research has been conducted on the low-temperature synthesis of polycrystalline Ge (poly-Ge) thin films on insulators. However, although various methods have been investigated, the film quality was too poor for practical use. In that context, we focus on solid phase crystallization (SPC), a simple method to directly form poly-Ge thin films on insulating substrates at low temperatures. Recently, we have successfully fabricated p-type polycrystalline Ge layers with high hole mobility (690 $cm^2\ V^{-1}\ s^{-1}$) at low temperatures (< 500 °C) using an advanced solid-phase growth method [1,2]. In addition, we fabricated n-type polycrystalline Ge layers by doping n-type impurities (P, As, and Sb) [3]. In this study, we investigate the effects of Sn addition and underlayer insertion on P-doped Ge to improve electron

mobility, which has been effective for p-type Ge [2,4], and apply this method to a plastic substrate. As a result, by adding Sn and employing Al_2O_3 underlayer to P-doped Ge, the electron mobility of 450 $cm^2 V^{-1} s^{-1}$ on glass and 300 $cm^2 V^{-1} s^{-1}$ on plastic was achieved at a process temperature of 375 °C. These are the highest value among n-type polycrystalline Ge-based layers directly grown on glass and plastics at low temperatures.
[1] K. Toko *et al.*, Sci. Rep. **7**, 16981 (2017). [2] T. Imajo *et al.*, ACS Appl. Electron. Mater. **4**, 269 (2022). [3] K. Nozawa *et al.*, ACS Appl. Electron. Mater. *in press*. [4] A. Choroneos *et al.*, J. Appl. Phys. **110**, 093507 (2011).

13:30 02471 L. Calì , V. Sanfilippo , A. Foti PhD students

Supervisor of the PhD students L. Calì , V. Sanfilippo , A. Foti

Cristina SATRIANO
Associate Professor of Physical chemistry
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2D hybrids of palladium nanozymes and graphene oxide as a new multimodal theranostic platform

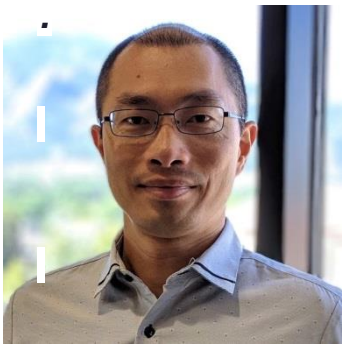
L. Calì 1, V. Sanfilippo 1, A. Foti 1, S. Petralia 2, G. Forte 2, R. Fiorenza 3, S. Scirè 3, L. D' Urso 3, C. Satriano 1.
1Nanohybrid Biointerfaces Lab, Department Of Chemical Sciences, University Of Catania - Catania (Italy), 2Department Of Drug Science And Health, University Of Catania - Catania (Italy), 3Department Of Chemical Sciences, University Of Catania - Catania (Italy).

Multifunctional nanoparticles with enzyme-like behavior represent an emerging paradigm in theranostics. Concerning cancer nanomedicine, recent studies have shown the great potential of palladium (Pd) nanozyme for chemodynamic therapy, by the generation of endogenous chemicals such as reactive oxygen species (ROS) through their oxidase and peroxidase activities or by relieving the hypoxia of a tumor microenvironment through their catalase or superoxide dismutase (SOD) activity, with a potent antitumor effect that directly induces tumor cell death.
In this work, hybrid nanoplatforms made of Pd nanospheres and graphene oxide (GO) nanosheets were prepared by the green reduction of PdCl2 in the presence of polyvinylpyrrolidone as a stabilizing agent. The physicochemical properties were scrutinized by using UV-visible and Raman spectroscopies, atomic force microscopy, zeta-potential and hydrodynamic light scattering. Theoretical DFT calculations paralleled the experimental studies. On the catalytic side, Pd-GO hybrids were tested in terms of photocatalysis experiments of H2 evolution. The assessment of nanozyme features for the Pd-GO unveiled a strong enhancement of hydrogen evolution and broad antioxidant activities, as scrutinized respectively by photocatalysis experiments and MitoSOX and SOD-like activity, respectively.Proof-of-work in vitro cell experiments on human prostate cancer cells (PC-3 line) and

mouse embryonic fibroblast cells (3T3 line) cells were carried out in terms of cytotoxicity (MTT assay), inhibition of cell migration (wound scratch test) and organelle perturbation (colocalization studies by confocal microscopy). The results pointed to a significant reduction of tumor growth and thus the promising potential of the developed Pd-GO hybrid nanozymes in cancer therapy.
This work has been partially funded by the European Union (NextGeneration EU), through the MUR-PNRR project SAMOTHRACE (ECS00000022) and by the University of Catania (PIAno di inCEntivi per la RIcerca di Ateneo 2020/2022 GRABIO_Linea di intervento 2).

Keynote presentation

13:45 02515 Sheng-Ting Hung Ph.D



Postdoctoral Research Associate
National Tsing Hua University
Bachelor of Science, Physics, Fu Jen Catholic University, Taiwan
Master of Science, Physics, National Sun-Yat-Sen UniversityTaiwan. Ph.D., Chemistry, Catholic University of Leuven, Belgium
Ph. D. in Physics, Washington State University, USA

Scientific interests and opportunities for collaboration
My interests lie in the development of microfluidic platforms combining (bio)photonics, optical spectroscopy, and artificial intelligence to improve human health and society.

Development and characterization of FusionRed variants

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

S.T. Hung 1, S. Mukherjee 2, P. Manna 3, A. Palmer 4, R. Jimenez 5.
1Department Of Physics, National Sun Yat-Sen University - Kaohsiung (Taiwan, republic of china), 2Department Of Chemistry, Stanford University - Stanford, California (United states), 3Department Of Chemistry, Massachusetts Institute Of Technology - Cambridge, Massachusetts (United states), 4Department Of Biochemistry, University Of Colorado Boulder - Boulder, Colorado (United states), 5Jila, University Of Colorado Boulder And National Institute Of Standards And Technology - Boulder, Colorado (United states).

Fluorescent proteins (FPs) have become an essential tool for bioimaging and biosensing applications. FusionRed, a monomeric red FP, was developed for good fusion properties in mammalian cells with low cytotoxicity. Nonetheless, the imaging application of FusionRed is largely limited by its low fluorescence brightness. We have developed multiple FusionRed variants for various imaging purposes through directed evolution with custom-built multiparameter fluorescence lifetime cell sorters. With three key mutations on FusionRed, FR-MQV eliminates the photoswitching behavior of FusionRed and shows a 3.4-fold higher molecular brightness and a 5-fold increased cellular brightness in HeLa cells. Thus FR-MQV is better suited for fluorescence microscopy than its progenitor FusionRed. Another FusionRed mutant, FR-MQ, retains the photoswitching property and exhibits a 2.6-fold higher molecular brightness and a 3.6-fold increase in cellular brightness in HeLa cells. We also developed a new method to characterize the dark state kinetics of photoswitchable FPs under bioimaging irradiances, which were previously unmeasurable experimental conditions, using single-molecule imaging and

ensemble photobleaching measurement bridged with a three-state model. Our analysis suggests FR-MQ is an improved candidate for super-resolution microscopy applications compared with FusionRed.

14:00 02522 Sintaro Maeda ph.D. student in Japan.

Institute of Applied Physics,
University of Tsukuba, Japan
Shintaro Maeda is a ph.D. student in Japan. He is studying about thermoelectrics.

Supervisors of the PhD student Sintaro Maeda

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Reseach
2018- Professor University of Tsukuba, Institute of Applied Physics, Ibaraki, Japan
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2011-2016 Assistant Prof. University of Tsukuba, Institute of Applied Physics, Ibaraki, Japan
2009- Ph. D. student at Kyushu University. Fukuoka, Japan

Thermoelectric application of Ge-based group IV semiconductor layers

S. Maeda, T. Suemasu, K. Toko.

University Of Tsukuba - Tsukuba (Japan).

Micro-energy harvesting is one of the most important technologies in the trillion-sensor society, such as for the power supply to wearable devices. The research on the thin-film thermoelectric generators (TEGs) of the group IV materials including Si have been active because they are non-toxic, abundant, and have mature thin-film processes. The high reliability of SiGe alloys, evidenced by its practical use in space applications for decades, is also attractive. These studies have demonstrated the high potential of group IV materials including flexible device applications [1,2]. In contrast, TEG applications of Ge have also attracted attention recently because Ge is suitable for energy harvesting at ambient temperature due to its narrow band gap. In fact, the high power factor *PF* has been reported in polycrystalline Ge thin films as well as single crystal [3,4]. However, single-crystal Ge has the high thermal conductivity κ (approximately 60 W K^{-1}), which is included in the dimensionless figure of merit *ZT* while the net thermoelectric performance is expressed in *ZT* considering *PF* and κ. The alloy scattering of phonons by adding a moderate amount of Si or Sn possibly could effectively reduce κ without significantly reducing *PF* [5]. In this study, we synthesized polycrystalline ternary alloy $Ge_{1-x-y}Si_xSn_y$ thin films by advanced solid phase crystallization method and investigated impurity doping and their thermoelectric properties. The

crystallinity and electrical properties of the $Ge_{1-x-y}Si_xSn_y$ films degrade with increasing x and y. However, for $x < 0.15$ and $y < 0.05$, the grain size of the $Ge_{1-x-y}Si_xSn_y$ films remain on the order of μm and exhibits high carrier mobility of approximately 200 $cm^2 V^{-1} s^{-1}$. In particular, x and y have a significant effect in increasing the alloy scattering of phonons and lowering κ. Ga and P doping with spin-on-glass solutions allowed to control the carrier concentration to the order of 10^{19} cm^{-3} for p-type and 10^{18} cm^{-3} for n-type $Ge_{1-x-y}Si_xSn_y$, respectively. For both p- and n-type $Ge_{1-x-y}Si_xSn_y$, *PF* peaks at $x = 0.06$ and $y = 0.02$, reaching 1160 μW $m^{-1} K^{-2}$ for p-type and 2040 μW $m^{-1} K^{-2}$ for n-type at room temperature, respectively. The κ value is 3.1 W K^{-1}, so the *ZT* values are calculated to be 0.12 for p-type and 0.20 for n-type, respectively. In this way, the addition of small amounts of Si and Sn to Ge lowered κ while maintaining a high *PF*, resulting in high performance as a thin-film thermoelectric material. These results can facilitate the development of high-performance, reliable, and human-friendly TEGs.

[1] K. Kusano *et al*., *ACS Appl. Energy Mater.* **1**, 5280 (2018). [2] T. Ozawa *et al*., *Materials* **15**, 608 (2022). [3] T. Taniguchi *et al*., *Appl. Phys. Lett.* **117**, 141602 (2020). [4] T. Ozawa *et al*., *Appl. Phys. Lett.* **119**, 131201 (2021). [5] H. Lai *et al*., *Appl. Phys. Lett.* **119**, 113903 (2021).

14:15 02533 Aoi Hatate PhD student

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Aoi Hatate is a graduate student of University of Tsukuba supervised by Prof. Takashi Suemasu. One of his research targets is the development of single crystal Mn4N doped with nonmagnetic elements showing magnetic structure change with respect to composition, for the next-generation memory devices. In this study, the epitaxial growth of Ga-doped Mn4N thin film was confirmed for the first time in the world. In addition, the magnetic structure of the film changes from ferrimagnet to ferromagnet depending on the composition, as confirmed by X-ray magnetic circular dichroism.

Supervisors of the PhD student Aoi Hatate

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Reseach
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Epitaxial growths of Mn4-xGaxN films and their X-ray magnetic circular dichroism spectra

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We have focused on compensated ferrimagnet $Mn_{4-x}Z_xN$ films (Z : metal element), which are candidates for future domain wall motion (DWM) device materials. For instance, $Mn_{4-x}Ni_xN$ has a magnetic (and/or angular momentum) compensation composition at RT[1], confirmed by X-ray absorption spectroscopy (XAS) and X-ray magnetic circular dichroism (XMCD) measurements. Remarkably, in $Mn_{3.85}Ni_{0.15}N$, the DWM velocity driven purely by STTs reached 3,000 m/s at RT[2] thanks to the angular momentum compensation. We expect that $Mn_{4-x}Ga_xN$ epitaxial film can be another candidate. Zhang *et al*. reported that bulk $Mn_{4-x}Ga_xN$ has a magnetic compensation composition[3]. However, there have been no reports thus far about the magnetic compensation in $Mn_{4-x}Ga_xN$ films. We grew 23-nm-thick $Mn_{4-x}Ga_xN$ (x = 0, 0.1, and 0.3) epitaxial films on $SrTiO_3$(001) substrates by molecular beam epitaxy (MBE). According to the ω–2θ XRD profiles of $Mn_{4-x}Ga_xN$ (x = 0, 0.1, and 0.3) films, $Mn_{4-x}Ga_xN$ 002 and 004 peeks were confirmed. In the RHEED images of $Mn_{4-x}Ga_xN$, streaky patterns, suggesting epitaxial growth of Mn_4N films, were confirmed for all the samples. In addition, we found clear superlattice diffraction lines drived from body-centered nitrogen, implying no excess or deficiency of nitrogen atoms. From these results, we conclude that we succeeded in the epitaxial growths of $Mn_{4-x}Ga_xN$ films.We measured the XAS and XMCD spectra on Mn-$L_{2,3}$ absorption edges in the $Mn_{3.9}Ga_{0.1}N$ and $Mn_{3.7}Ga_{0.3}$ films at RT. There is not much difference in the XAS spectra between them, suggesting that the valence number of Mn atoms was almost the same. In the XMCD spectrum of $Mn_{3.9}Ga_{0.1}N$, the Mn-L_3 absorption edge contains the negative sign of peak α and the positive sign of peak β. According to Ito *et al*.[4], Mn atoms at corner and face-centered sites mainly contribute to peaks α and β, respectively, meaning that the magnetic moment of Mn atoms at the two sites are antiparallel. When x was increased to 0.3, the sign of peak β reversed to be negative. This result indicates that the magnetic moment of face-centered Mn reversed, and the magnetic moments of Mn atoms at both sites became parallel in $Mn_{4-x}Ga_xN$ films at x = 0.3. We thereby state that the ferrimagnetic-to-ferromagnetic phase transition occurred in $Mn_{4-x}Ga_xN$ between x = 0.1 and 0.3 at RT by nonmagnetic Ga doping, meaning the absence of the magnetic compensation point in $Mn_{4-x}Ga_xN$ films at RT. In conclusion, we grew $Mn_{4-x}Ga_xN$ epitaxial films on $SrTiO_3$(001) substrate with x up to 0.3 by MBE. The XMCD spectra revealed that the ferrimagnetic-to-ferromagnetic phase transition occurred between x = 0.1 and 0.3 at RT.

[1] T. Komori *et al*., J. Appl. Phys. **127**, 043903 (2020). [2] S. Ghosh *et al*., Nano Lett. **21**, 2580 (2021). [3] R. Zhang *et al*., Acta Mater. **234**, 118021 (2022). [4] K. Ito *et al*., Phys. Rev. B **101**, 104401 (2020).

14:30 00380 Sovanlal Mondal Graduate Assistant

I am a 5th year PhD student in the University of Memphis. My primary research interest is on ergodic theory. I have been trying to understand the behavior of ergodic averages along random time. Currently, I am learning ergodic Ramsey theory.
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Supervisors of the Graduate Assistant Sovanlal Mondal

Professor **Dipak Kumar Goswami**

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Organic Electronics group is working on fabrication of highly efficient organic field-effect transistors (OFETs) and different sensors based on OFETs. The group has fabricated few highly efficient devices with exceptional ambient stability. Such devices showed tremendous promises to be used for flexible and stretchable applications. Few devices have been demonstrated for highly sensitive gas sensors with fastest responses. The group is currently working on fabrication of OFETs for flexible and stretchable applications. We are also interested in bio-medical application of OFETs.

Current generation by direct electron pumping by Escherichia Coli to Au electrode

S. Mondal, D.K. Goswami, R. Sadhukhan.

Indian Institute Of Technology Kharagpur - Kharagpur (India).

It is well known that microorganisms can produce fuels, such as ethanol, methane, and hydrogen, from organic matter. It is less well-known that microorganisms can also convert organic matter into electricity in devices known as microbial fuel cells. However, interest in microbial fuel cells is increasing. Microbial fuel cells offer the possibility of harvesting electricity from organic waste and renewable biomass. Here we have used the Bacteria Escherichia Coli in our device to generate electrical energy. The important fact is that in our device without any applied voltage, we are getting a vast current(μA) concerning device current(nA). From Scanning Electron Microscopy(SEM), we can confirm that E. Coli has been trapped on the positively biased gold electrode due to the surface charge of E. Coli. And the novelty of this work is that it is not an Antigen-Antibody reaction as we haven't used any antibodies here. So we have also experimentally verified the Charge Transfer between E. Coli bacterial cell and electrode. So our device also can be used for water cleaning purposes.

14:45 00594 CHEN Shangsi PhD student

Heparin Release and Sustained Delivery of Ionic Dissolution Products for Quick Endothelialization in 3D Printed Vascular Grafts

S. Chen, M. Wang.

The University Of Hong Kong - Hongkong (Hong kong).

Cardiovascular diseases have become a major threat to human lives and therefore successfully repairing or replacing blood vessels are now highly important for millions of patients. Traditionally, autografts or allografts are used for the treatments but, donor shortage, immune rejection, etc., have posed various problems. Synthetic grafts are increasingly investigated, and tissue engineering holds the promise to provide new artificial grafts that are biocompatible and biodegradable and can assist new blood vessel formation. The endothelial cell layer in blood vessels plays a crucial role in anticoagulation, transmitting biochemical signals and keeping blood vessel unobstructed. A quick endothelialization of tissue engineered vascular grafts can prevent thrombosis and hyperplasia and promote blood vessel regeneration. In this study, to promote quick endothelialization, 3D printed vascular graft with controlled heparin release and sustained ionic dissolution products (Mg2+ and SiO32-) was fabricated. In the process, poly(D,L-lactide-co-trimethylene-carbonate) (PDLLA-co-TMC, abbreviated as PTMC), a biomedical polymer, and particulate laponite (LAP) were homogenously mixed. The mixtures were then made into composite scaffolds through extrusion-based 3D printing. The 3D printed LAP/PTMC scaffolds with different amounts of LAP exhibited good porous structures. The degradation behavior of LAP/PTMC scaffolds and release profiles of ionic dissolution products from LAP particles in LAP/PTMC scaffolds were studied, and their biological functions were investigated in vitro. It was found that when the LAP amount in scaffolds was over 2.5%, a large amount of SiO32- was released, which resulted in an alkaline environment and hence was not beneficial for bone marrow-derived stromal cell (BMSC) growth. Also, with the addition of LAP particles in composite scaffolds, the scaffold degradation rate increased and BMSCs proliferated and grew well on LAP/PTMC scaffolds. Meanwhile, polydopamine (PDA) nanoparticles with encapsulated heparin (HEP) were synthesized and characterized. The PDA@HEP nanoparticles were subsequently deposited on the strut surface of composite scaffolds. It was revealed that heparin could be controlled and sustainably released from the scaffolds. The presence of heparin on the scaffold surface could prevent the adhesion and activation of platelet and the growth of muscle cells. Furthermore, the released heparin and ionic dissolution products could promote endothelial cell attachment, growth and proliferation, thereby promoting a quick endothelialization for the scaffolds. Finally, human umbilical endothelial cells (HUVECs) and human aortic smooth muscle cells (HASMCs) were cocultured on the composite scaffolds to evaluate the competitive adhesion and proliferation of HUVECs over HASMCs.

15:00 01802 Nikolaj Kofoed Mandsberg PhD

Kalsruhe Institute of Technology
- Homepage
InterdisciplinarityWetting/Liquid
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CART: Carrier-based Actuatable and Reprogrammable Transport

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Methods for remotely manipulating micro-cargo, such as droplets, are crucial for miniaturizing, parallelizing, and automating experiments, and for obtaining rapid and resource-efficient scientific evidence. However, existing methods rely on reducing substrate-cargo friction to enable cargo mobility, which can limit the versatility of substrate and cargo choice by introducing a substrate-cargo matching requirement. We introduce the CART

(Carrier-based Actuatable and Reprogrammable Transport) system, a solution to the challenges faced by existing cargo actuation techniques. By introducing a carrier between the substrate and the cargo, CART physically separates these, eliminating the need to reduce substrate-cargo friction and the need for substrate-cargo matching. CART is easy to realize, easy to tailor, and easily post-functionalized. As an example, using a photo-polymerizable phase-separating resin, we 3D printed porous carriers in different sizes and shapes, and subsequently infused them with ferrofluid to make them magnetically-responsive, enabling non-contact actuation on both solid and liquid substrates. Using magnetic stimulation, the carriers can be remotely moved, rotated, and inverted, further facilitating interaction between two carriers for transferring, merging, and tunably splitting cargo.

15:15 02490 Immaculada Jennifer Gomez Perez PhD student

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Nitrogen-doped graphene quantum dots as versatile carriers for nanomedicine

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Graphene quantum dots (GQDs) belong to the family of zero-dimensional fluorescence carbon dots. They are quasi-spherical crystalline nanoparticles with lateral dimensions below 10 nm.
GQDs become excellent bioimaging tools when tuned to emit at larger wavelengths that exhibit minimal tissue absorbance and emission. The photoluminescence at larger wavelengths is usually reached when dopped by nitrogen. Besides, the bioactive nitrogen groups provide an excellent platform for coupling with biomolecules, photosensitizers, and drugs. In this contribution, I reveal exciting properties of nitrogen-doped GQDs (N-GQDs) prepared via a bottom-up hydrothermal approach using glucose and ethylenediamine. The as-prepared nanoparticles showed multicolor excitation-dependent fluorescence in a broad NUV-Vis-NIR spectrum. They were water-soluble and biocompatible, as concluded from a cell viability assay with human vascular smooth muscle cells. The N-GQDs were coupled with a photosensitizer (BODIPY) and a drug, proving their suitability as a prospective biocompatible delivery system with a bioimaging option.

15 :30 02356 Takamitsu Ishiyama PhD student

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Supervisors of the PhD student Takamitsu Ishiyama

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Reseach
2018- Professor University of Tsukuba, Institute of Applied Physics, Ibaraki, Japan
2016- Assoc. Prof. University of Tsukuba, Institute of Applied Physics, Ibaraki, Japan
2011-2016 Assistant Prof. University of Tsukuba, Institute of Applied Physics, Ibaraki, Japan
2009- Ph. D. student at Kyushu University. Fukuoka, Japan

Machine learning techniques for analyzing time evolution in microscope images

T. Ishiyama, T. Suemasu, K. Toko.

University Of Tsukuba - Tsukuba (Japan).

Crystal growth is a fundamental technology for various electronics with semiconductor thin films. To address the question of how to grow high-quality thin films, numerical research has been conducted to understand and control various crystal growth techniques. With the development of the information society in recent years, to realize advanced wearable devices, there is a strong need for technology to synthesize semiconductor thin films on the flexible insulators. Solid-phase crystallization (SPC) is the oldest and most representative synthesis method in which crystallization is induced by annealing an amorphous thin films [1]. Recently, SPC has been in the spotlight because it provides an extremely high carrier mobility of Ge-based materials [2,3] even with low-temperature annealing, which are leading candidates for replacing Si. To understand and discuss the SPC of a system, it is important to observe the phase transition from amorphous to crystalline, determine the lateral growth velocity and nucleation frequency of the crystalline domains, and determine the activation energies and frequency factors [1]. These physical properties have been obtained by repeating the annealing of the samples and conducting *ex-situ* observations and manual analyses (*i.e.* a calculation of the crystal domain size and nuclei density). However, this process is time-consuming, labor-intensive, and is inevitably subject to systematic errors among the measurers. Materials informatics is an interdisciplinary field of machine learning (ML) and materials engineering and is a new approach based on experiments, theory, and computation. In recent years, a significant amount of research has been conducted on the application of materials informatics to crystal engineering in the search for more

efficient materials and processes [4]. In material research using ML, the inverse problem approach is often taken. Conversely, although the need for a fast analysis and subjective removal is high, the application of ML to micrograph recognition is still limited. The main reason for this is that the collection of micrographs, which serves as training data, requires an enormous amount of effort. In this study, an automated analysis technique was developed for SPC properties using fake micrographs automatically generated within a few minutes as ML training data and an *in-situ* annealing observation system. Using the recognition of the SPC process of high-carrier-mobility Ge as an example, we demonstrated that ML can recognize crystal domains in *in-situ* micrographs through the learning of fake micrographs. The proposed technique not only reduces the time and human effort required to derive the SPC properties, it also enhances the accuracy by eliminating human subjectivity.

[1] P. Germain *et al., J. Appl. Phys.* **50** 6986–94 (1979) [2] T. Imajo *et al., ACS Appl. Electron. Mater.* **4** 269–75 (2022) [3] K. Toko *et al., J. Appl. Phys.* **122** 155305 (2017) [4] C. Liu *et al., Adv Mater.* e2102507 (2021)

15 :45 01805 NENA GARG Neha PhD student

Kuramoto-Model-Based Data Classification Using the Synchronization Dynamics of Uniform-Mode Spin Hall Nano-Oscillators

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1Indian Institute Of Technology Delhi - New Delhi (India), 2Indian Institute Of Technology Bombay - Bombay (India).

Oscillator-based data-classification schemes have been proposed recently using the Kuramoto model which predicts synchronization behaviour of coupled oscillators through a general framework neglecting underlying physics [1,2]. Here we propose hardware implementation of a Kuramoto-model-based data-classification scheme through an array of dipole-coupled uniform-mode spin Hall nano-oscillators (SHNOs) [3,4].
Using micromagnetic simulations on 'mumax3' software [5], which captures physics of SHNOs, we first study how synchronization range between two SHNOs (150 nm diameter) varies with physical distance between them. Further, we correlate the coupling constant in Kuramoto model with dipole-coupling strength between two SHNOs in 'mumax3'. Using this correlation, we generate a synchronization map for a two-input-two-output SHNO system through micromagnetics. Thus, we establish here that synchronization behaviour of SHNOs obtained from physics-based modeling (micromagnetics) is consistent with that obtained from Kuramoto model. This shows that a Kuramoto-model-based data classification scheme [2] can indeed be implemented on an array of SHNOs.
We also model the SHNO system through the macro-spin model, which is computationally much less resource-intensive to simulate compared to the micromagnetic model [3].

Next, we show through micromagnetics, classification of data from a popular data set (Fisher's Iris [6]) using an array of SHNOs. While distinguishing flowers in Iris of Setosa type from Virginica type, output oscillators synchronize for Setosa and desynchronize for Virginica. The obtained accuracy is 98.67%.

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Tuesday, May 30 16:00-16:30 Coffee Break

16:30 00963 Armin Ebrahimi PhD student

PhD student
Jagiellonian University in Krakow.

Quantum-effect-based Nanosensing and imaging:
Novel glass-diamond photonic approach for the next generation biodiagnostic Applications
His research interest in the interdisciplinary sciences of physics and biophysics led him to become a Ph.D. student at the Jagiellonian University, as part of the QUNNA project, working on the effects of HA on living cells using optical tweezers, microscopy techniques, and the application of NV-diamond sensing to biological systems

Supervisors of the PhD student Armin Ebrahimi

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RESEARCH

Cell migration biophysics optical microscopy mechanobiology cytoskeleton, biomaterials

The role of molecular composition of endothelial and pancreatic beta-cell extracellular vesicle in diabetic endothelial cell dysfunction - impact on the targeted cell membrane properties

Influence of culture substrate elasticity on talin recruitment to focal adhesion

Role of talin phosphorylation in cardiovascular disease

Cells' preferable uptake of microdiamonds and the role of myosin motor proteins in the particle uptake and transport

A. Ebrahimi, A. Wojciechowski, Z. Rajfur.
Jagiellonian University - Krakow (Poland).

Diamond particles emerged as a novel agent in cellular studies in recent years due to their good biocompatibility. In addition, the unique characteristics of diamond particles, e.g. the presence of fluorescent color centers, allow researchers to use them in drug delivery and sensing applications. However, the mechanism of interaction between cells and diamond particles, i.e., the process of uptaking, transporting, and final localization within cells still needs to be fully understood.

In our research, we studied the interactions between MEF 3T3 cells and microdiamonds (MDs) with sizes of 1μm which contained NV centers used as fluorescent markers. The main goal of this study was to observe the effect of cell-MDs interaction on selected cellular processes like MDs uptake and its subsequent cellular transportation. We studied how environmental conditions influence cell behavior during the interaction with MDs. Our results show a novel cell behavior, where cells actively search and preferably uptake MDs from their surroundings more than other particles like latex beads (LBs), followed by their active transport within cells.

The preferable uptake can be a consequence of various factors such as stiffness (Young's modulus) and shape that can affect the rate of particle uptake. Studies showed cells tend to uptake stiffer (MPa) particles more than softer (KPa) ones, while it is not clear that cells can feel diamonds' stiffness (TPa), therefore it needs further investigations to reveal if this factor is causing more MDs uptake. Moreover, it has been shown that the uptake rate can change for different shapes of particles, e.g. spherical gold particles are absorbed more than rod ones, while for polystyrene this dependence is reversed. In this work, we used round LBs while our MDs have irregular random shapes. Also, this phenomenon can be related to the carbon-based nature of the MDs, where cells can detect it as a biocompatible material and uptake them preferably.

Next, we investigated the possible roles of myosin family motor proteins (Myosin-II and Myo10) in the mechanism of uptake and internal transport of MDs. We demonstrate that the Myo10 is involved in particle transport within cells while inhibiting the activity of the Myosin-II, cells still continue searching and uptaking diamond particles, and there are no differences compared to normal cells in the particles' uptake and their final destination after 24 h of incubation. More, we observed cells change their morphology and create vesicles along their tails, that can contain MDs and transport them inside the cells. Our results show that there are accumulations of Myo10 around diamond particles, and also we detected the presence of this protein in the moving vesicles along the cell tails, which can point to a novel role of this protein for particle transportation within cells. These results can have significant consequences in the drug delivery context and improve diamond particles' sensing methods.

16:45 00561 L. Pin-Hui PhD student

Bio-inspired radiative cooling aerogel for sustainable cold chains in developing countries

L. Pin-Hui, C. Tai-Chi, W. Dehui.

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For intractable challenges of pandemics, vaccination is widely recognized as the most exceptional and cost-effective health intervention. However, the number of COVID-19 vaccine doses in Africa is far lower than other developed countries. The unbalanced distribution of medical resources derives from not only poverty but also shortages of electricity and reliable refrigerators in developing countries. Solutions such as refrigerators equipped with solar cells or phase change materials have been proposed, but they have limitations such as high cost, low photoelectric conversion efficiency and severe leakage.

Sahara Desert, known for its scorching sunlight, is inhabited by a kind of insect called silver ant. To fight against the intense sunlight, their triangular hair enhances the reflectance in solar spectrum (0.3~2.5 μm), which remarkably reduces solar heat gain. Moreover, it also functions as a good emitter within the atmospheric transparency window (ATW, 8~13 μm) and emit radiation to the outer space (~3 K) to offload excess heat without energy consumption. Inspired by the bio-inspired passive daytime radiative cooling (PDRC) strategy, this work aims to exploit solar-reflective, infrared-radiative and thermal-insulating bio-inspired radiative cooling silica aerogel (BCSA). Here, we offer a new paradigm for sustainable cold chain in the application scenarios with electricity and equipment shortages.

To construct a 3D interconnected Si-O-Si crosslinking network in BSCA, we use commercially available SiO_2 nanofibers and methyltrimethoxysilane as the crosslinker. After freeze drying, the freeze-cast samples become aerogels. The BCSA, with a fiber diameter range of 0.3~2.5 μm, could achieve high solar reflectance (98.1%) due to strong multiple backscattering. Thanks to the strong phonon resonances of abundant Si-O bonds and high specific surface area of nanofibers, the high emissivity (92.0%) in ATW could also be attained. Of note was that the ultrahigh porosity (99.1%) and ultralow density (0.02 g/cm_3) lead to ultralow thermal conductivity. In comparison with commercial insulation materials such as Styrofoam and melamine formaldehyde (MF) foam, BCSA demonstrates superior cooling ability, not only because of the lowest surface temperature resulting from its exceptional PDRC but also the intrinsic insulating performance. To evaluate the practical cooling ability of BCSA, a proof-of-concept experimental setup was adopted to simulate direct sunlight. Under an illumination of 1000 W/m_2, BCSA maintained an average backside temperature of 25 °C, which was about 2, 3 and 20 °C lower than that of Styrofoam, MF foam, and the frontside of BCSA, respectively. The results revealed the outstanding cooling ability of BCSA. Further demonstrations of cold-chain in the practical outdoor applications are in progress and will be reported in the conference.

17:00 00039 MIQUEL Castellote Borrell PhD student

PEG-heparin biohybrid synthetic hydrogels for tumoroid culture

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

M. Castellote-Borrell 1, J. Guasch Camell 2.
1Institute Of Materials Science Of Barcelona (icmab-Csic), Dynamic Biomimetics For Cancer Immunotherapy, Max Planck Partner Group, Icmab-Csic - Barcelona (Spain), 2Institute Of Materials Science Of Barcelona (icmab-Csic), Networking Research Center On Bioengineering, Biomaterials And Nanomedicine (ciber-Bbn), Dynamic Biomimetics For Cancer Immunotherapy, Max Planck Partner Group, Icmab-Csic - Barcelona (Spain)

Organoids are 3D in vitro models that resemble some of the key physiological characteristics of real organs, such as cellular heterogeneity or genetic expression. In cancer research, great expectations are put on the use of tumoroids, which

are organoids resembling tumours. Preclinical testing including drug discovery, the study of tumour biology or the development of personalized medicine could benefit from such a versatile model. At the moment, Matrigel is the gold-standard extracellular matrix used for the culture of tumoroids. This happens irrespective of the cancer model, and despite its disadvantages including batch-to-batch reproducibility, unknown exact composition and possible immunogenicity associated to its natural origin. In this work, we have produced a family of hybrid PEG-heparin hydrogels with tailorable physicochemical properties (i.e. stiffness, porosity, presence of biological ligands), which has been used to develop different patient-derived tumoroids of both haematological and solid tumours.

17:15 00277 SHIFAN WANG Shifan PhD student

The compression strength of carbon fibre composite increases with a nanostructured interface inspired by nacre

S. Wang.
Francois De Luca - London (United kingdom).

Structural fibre-reinforced polymer (FRP) composites have been widely used due to the high strength-to-weight ratio, however, the compressive strengths of FRP composites are usually less than 60% of their tensile strengths. The compressive and tensile mechanical properties can both be improved by the novel design of the fibre-matrix interface. Here, a nanostructured "brick-and-mortar" interface, which was inspired by natural nacre, was developed.
Francois de Luca used 90 wt % of well-aligned poly(diallyl dimethylammonium chloride)(PDDA) and 10 wt % of polysodium4-styrene sulfonate(PSS) to make the interface. The inner structure is similar to nacre but the scale is lowered by an order of magnitude. The platelets offer structural rigidity while the polymers provide ductility. The interface can absorb more energy when fibre fails and decrease local stress concentration, resulting in higher toughness. The possible reason is that the interface can mimic crack bifurcation and platelet interlocking mechanism, which occurs in natural nacre. The absolute tensile strength and strain-to-failure increase by 15% and 30% respectively.
My research focuses on the compressive properties of the carbon fibre composites with the “brick-and-mortar” interface. The interface will be developed by about 90 wt % of well-aligned hexagonal gibbsite (Al(OH)3) platelet and 10 wt % of polysodium4-styrene sulfonate(PSS). The layer-by-layer assembly method is chosen to coat a bundle of carbon fibres simultaneously because it can provide good control of thickness. The thickness control is very important because the thickness of organic layers must be about 5-10% of the inorganic platelets to induce the nacre-like properties. The characterisation and four-point bending tests will follow to observe the failure mechanism and measure the compressive strength. This experiment will finish in April. Then I will spend about two months to analyse the results and prepare for the conference.

Poster session The 3 min. flash reports

The E-MRS Invited Organizer/Chair PhD Candidate A.Alp Yetisgin,
Sabanci University, Istanbul , Turkey

17:30 00166 SANGHO CHO Sangho PhD student

Sustainable and transparent gas barrier films for food packaging

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

S. Cho 1, M. Kim 1, T. Lim 1.
1Korea Institute Of Science And Technology - Seoul (Korea, republic of)

Food packaging protects food from biochemical and mechanical damage. Among various types of food packaging such as plastic containers, carton packs, and films, transparent films are used as the outmost sealing materials with clear visibility of the contents. The food packing films require oxygen and moisture barrier properties to prevent decaying by oxidation. Currently, the most abundant packaging films consist of aluminum foil or halogenated polymers for oxygen and moisture protection. However, they are opaque or generate hazardous gas by combustion after use.
In this work, we prepared biomass-based gas barrier films. All components of the films consist of eco-friendly and biodegradable materials: 1) poly(lactic acid) (PLA) as a substrate and 2) nanocellulose and poly(vinyl alcohol) (PVA) for gas barrier coating. Significantly, the surface of nanocellulose was modified to improve the gas barrier properties by crosslinking with PVA. This presentation will discuss the gas barrier properties, biodegradability, cytotoxicity, and biomass content of the sustainable food packaging film.

00528 HERMANS Dries PhD student

Leaching mechanisms of PVP coated silver nanoparticles from anti-microbial bioplastics

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

D. Hermans 1, M. Gücyetmez 2, M. Buntinx 3, W. Marchal 2.
1Materials And Packaging Research & Services, Institute For Materials Research (imo-Imomec), Hasselt University - Diepenbeek (Belgium), 2Analytical & Circular Chemistry, Institute For Materials Research (imo-Imomec), Hasselt University - Diepenbeek (Belgium), 31materials And Packaging Research & Services, Institute For Materials Research (imo-Imomec), Hasselt University - Diepenbeek (Belgium)

Silver based nanocomposites (Ag NC) show great potential as packaging materials, given their antimicrobial performance, protecting food against microbial degradation. The incorporation of silver nanoparticles (Ag NPs) in biobased food contact materials could be considered as an extra opportunity, contributing to a circular bioeconomy with less food waste. However, the lack of knowledge regarding nanoparticle release mechanisms from (biobased) nanocomposites and the fate on the nano-silver in the end-of-life packaging scenario's (e.g. waste-disposal, recycling…), leads to restrictive legislation. In the case of silver, excessive NP exposure is undesired in terms of health, safety and environmental considerations. Therefore, this study aims to elucidate the NP migration mechanisms and influential factors such as NP size, matrix material (polyhydroxyalkanoate (PHA) vs cellulose) and external migration conditions on the leaching behaviour of Ag NPs and the antimicrobial performance of Ag NCs.

Commercially available spherical Polyvinylpyrrolidone (PVP) coated (~0.2%) Ag NPs are bulk mixed in the PHA matrices using a solvent-based masterblend approach on the one hand, and deposited on cellulose fiber surfaces on the other hand. The processing of these two models allows to differentiate between desorption and diffusion-based migration mechanisms. The internal structure is analysed using scanning electron microscopy (SEM), and the absolute silver loading is quantified via inductively coupled plasma atomic emission spectroscopy (ICP-AES). Subsequently, the NC models are exposed to food simulants (A, B, D2) via full immersion at standardized conditions (EU Regulation 10/2011). To distinguish the silver release in ionized versus nanoparticulate form, the simulant leachate is followed up longitudinally during the immersion by means of single particle inductively coupled plasma mass spectrometry (SP-ICP-MS). In addition, antimicrobial efficiency is tested on Gram-negative and Gram-positive bacteria.

The silver leaching behaviour was found to be dependent on the incorporation mode (bulk vs fiber surface) of the NPs in the NC matrix, rationalized by their different dominant migration mechanisms. In addition, the time- and size (40 vs. 65 nm) dependency of Ag NP leaching could be established and correlated to the NP mobility in two biodegradable matrix systems. A preferential leaching of the smaller NPs was observed. Ultimately, the physicochemical properties of the leaching medium such as acidity (simulant B) play an important role in the extent of silver release and its physical form (dissolved

vs. nanoparticulate) in the leachate. Hence, the diffusion, dissolution and desorption release mechanisms of silver are elucidated.
In conclusion, this methodology can be further optimized to quantify potential NP migration from other biopolymers in order to ensure the safety and application potential of bio-nanocomposites as active packaging material.

01150 RAZONADO Ivy Ann PhD student

Synthesis of chitosan-clay composite for potential packaging application

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

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1Dmmme, University Of The Philippines-Diliman - Quezon City (Philippines)

Many studies have recently focused on identifying materials with sustainable and environmentally friendly applications. As a result, various research on the use and applications of biopolymers have recently attracted attention. One of the most studied and abundant biopolymers is chitosan, a deacetylated chitin derivative from waste shells such as crab and shrimp shells. This study aimed to determine the effect of different filler loadings of nanoclay on the properties of the chitosan-clay composites for potential application in packaging. Chitosan-clay composite films at various filler loadings were fabricated by solution casting and characterized. Mechanical properties, thermal behavior, composition, morphology, and barrier properties have been studied using the ultimate tensile machine (UTM), thermogravimetric analyzer (TGA), viscometer, and scanning electron microscopy (SEM), respectively. Tensile results showed a ~6% increase in tensile strength compared to pure chitosan films. This can be attributed to the high rigidity and aspect ratio of the nanoclay and the high affinity between chitosan and nanoclay. Thermogravimetric analyzer (TGA) and viscometer results showed an increase in thermal stability and viscosity, as the addition of nanoclay increased. The addition of nanoclay provides a thermal barrier and decreases the weight loss. Barrier properties results showed that as the added nanoclay increases, there is a decrease in water sorption and an increase in hydrophobicity. This can be attributed to the diminished -OH or -O sites eager to interact with water. The enhanced properties of the chitosan-clay composite can result from reactions within the chains and molecular interactions between chitosan and nanoclay. With the results, the chitosan-clay composite films with 5wt% loading showed great potential for use in packaging.

01242 KITSOU Ioanna PhD student

Nano-zirconia dental implants via additive manufacturing

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

I. Kitsou 1, P. Angelopoulou 1, E. Roussi 1, P. Gkomoza 1, M. Papageorgiou 1, S. Koltsakidis 2, D. Tzetzis 2, A. Galiatsos 3, A. Tsetsekou 1.
1School Of Mining And Metallurgical Engineering, National Technical University Of Athens - Athens (Greece), 2Digital Manufacturing And Materials Characterization Laboratory, School Of Science And Technology, International Hellenic University - Thermi (Greece), 3Lino3d - Athens (Greece)

Dental implants are artificial devices, that are generally made of titanium and are used to replace missing natural teeth. Potential immunologic and aesthetic drawbacks associated with metallic dental implants have resulted in the development of zirconia-based dental implants. Zirconia all-ceramic teeth are expected to be used worldwide in dentistry because of their good biocompatibility, mechanical properties and aesthetic characteristics. The present study is driven by the market needs for fast production of custom made, high quality and precision dental elements and focuses on the novel approach of additive manufacturing using new zirconia materials. Water-based zirconia slurries and pastes with various amounts of solids were developed using 3mol% yttria stabilized custom-made nano-zirconia powder produced via several production routes. The effect of several additives (binders, dispersants, momomers) on their dispersion and rheological properties was investigated and critical printing parameters were examined. A thorough investigation of the post printing crucial steps of drying-debinding–sintering processes was also conducted for their optimization. The microstructure and mechanical properties of the samples after the sintering process were studied by SEM/EDX, mechanical tests and measurements of density and porosity. The specimens presented high values of density and very good mechanical properties.

01268 01336 BOUZAHER Yassine PhD student

Numerical and kinetic study of isomerization reaction of oriented polyacetylene induced by laser impact, shown by multichannel Raman

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

A. Lakhzoum 1, Y. Bouzaher 1.
1L.c.c.e - Batna 2 (Algeria)

The laser impact induces the Raman scattering from the two film-components simultaneously with the conversion of PAcis into PAtrans. The total Raman-Stokes scattering from two pertinent bands (1248 cm-1 from PAcis and 1110 cm-1 from PAtrans), was measured simultaneously taking advantage of multichannel technique. The laser beam power P(λ) is equivalent to the temperature T of isotherm i of isomerization reaction. The laser beam axis was normal to the PA- film surface and the retro- Raman scattering was collected. We elaborate a numerical model reproducing the Raman experiment within 5 % error. The rate constants, activation energy values, Arrhenius factors and linear regression coefficients are obtain with a small error. The kinetic results obtained, such as reaction orders values obtained, varying from 1/2 to 2/3, The isotherms in a time-scale of seconds were obtained for the first time and the initial rate constants k0(Pi) determined. The reaction order of 2/3 seems to be the most appropriate value in this case, since it refers to a solid state reaction propagation, where the reaction rate is controlled by a three dimensional development of active centers. The observed Raman scattering seems to obey some activated process. The temperatures of our isotherms were determined from the relationship: Ti = Eai / R/ ln (A / k0 (Pi)) , An estimate of N0 and then of fcis and ftrans was obtained.

Key words: Polyacetylene, isomerization, laser, activation energies, Raman spectroscopy

kinetic study and synthesis of new macroinitiator by ozonization of poly (vinylidene fluoride)

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

I.R. Kribaa 1, A. Lakhzoum 2, Y. Bouzaher 1.
1Lcce - Batna 1 (Algeria), 2Lcce - Batna 2 (Algeria)

We studied the synthesis of a macroinitiator containing poly (vinylidene fluoride) (PVDF) obtained by an ozonization reaction. On one hand, we optimized the reaction in order to control the rate of oxidation and on the other hand the ozonized polymer was also proportioned, which enabled us to determine the

rate of active oxygen T (0°) and the rate of hydro peroxide. We noticed an average of 5.5 *10-6 mole/g, a relatively lower rate T(0°) compared to those obtained for Polyethylene EP and the Poly(vinyl chloride) PVC, respectively of 5.6 *10-5 mole/g and 28 *10-5 mole/g. With regard to these two products, the presence of CH and C-Cl bonds sensitive to the action of powerful agents of oxidation such as ozone makes it easy to obtain compounds of oxidation of peroxides type and hydro peroxides compared to the PVDF for which the C-F bond which has proven to be stronger. In the same way, this study showed that the technique of ozonization of the powder PVDF, despite of the insufficient rates of oxidation to which it leads, remains the most adequate adapted because it leads to a reduced increase in mass of the product.

Key Words: Ozonization - PVDF

- PVC- macroinitiator - kinetics – Synthesis

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Thermally Stable and Reusable Ceramic Encapsulated CalB Enzyme Particles for Rapid Hydrolysis and Esterification

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)
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This work reports the preparation of silica encapsulated Candida antarctica lipase B (CalB) enzyme to enhance the thermal stability and reusability, and demonstrated for rapid enzymatic hydrolysis and esterification. Silica encapsulated CalB particles (Si-E-CPs) and silica cross-linked CalB particles (Si-CL-CPs) were prepared as a function of TEOS concentration. The particle size analysis, thermal stability, catalytic activity in different pHs, and reusability of Si-E-CPs and Si-CL-CPs were demonstrated. Furthermore, the determination of CalB enzyme in Si-E-CPs and Si-CL-CPs was achieved by Bradford assay and TGA analysis. Enzymatic hydrolysis was performed against the p-nitrophenyl butyrate and the catalytic parameters (Km, Vmax, and Kcat) were calculated by the Michaelis-Menten equation and a Lineweaver-Burk plot. Moreover, enzymatic synthesis for benzyl benzoate was demonstrated by esterification with an acyl donor of benzoic acid and two acyl donors of benzoic anhydride. Although the conversion efficiency of Si-CL-CPs was not much higher than that of native CalB, it has an efficiency of 91% compared to native CalB, and is expected to be very useful because it has high stability for thermal and pH and excellent reusability.

Magnetic Nanoparticles Immobilized CalB Enzyme Particles for reusable and rapid esterolysis of p-nitrophenyl alkanoates

I. Bioinspired and biointegrated materials as new frontiers nanomaterials (11th edition)

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This study reports the preparation of the nanofroctosome coated Candida antarctica lipase B (CalB) enzyme immobilization on silica-coated magnetic nanoparticles (Si-MNPs@NF@CalB) using a various cross-linkers, and demonstration of rapid esterolysis of p-nitrophenyl alkanoates. CalB and NF@CalB enzymes were coupled cross-linkers silanes (-Cl) on the Si-MNPs surface. The protein quantitation evaluation for CalB:NF@CalB and Si-MNPs@CalB:Si-MNPs@NF@CalB were 10:1 and 2:1 confirmed by Bradford assay. From Michaelis-Menten equation and Lineweaver-Burk plots, various enzyme kinetic parameters (Km, Vmax, Kcat) were calculated. The stability for pH and temperature of Si-MNPs@CalB and Si-MNPs@NF@CalB were optimized at 8 and 45 ℃.

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