BP 12: Biomaterials, Biopolymers and Bioinspired Functional Materials III (joint session CPP/BP)

Time: Tuesday 9:30–11:15 Location: H46

Invited Talk BP 12.1 Tue 9:30 H46

Hybrid materials from colloidally stable nanocellulose and nanoparticles - scattering techniques are needed for characterization — •Eva Malmström[1], Åsa Jerlhagen[1], Benedikt Sochor[2], Korneliya Gordeyeva[1], and Stephan Roth[1,2] — [1]KTH Royal Institute of Technology, Stockholm, Sweden — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

Cellulose nanofibrils (CNFs) have rendered increasing interest during the last decades as their high stiffness, strength, and aspect ratio are attractive features to further explore on the pathway to a more sustainable society.

Controlled radical polymerization procedures allow for the synthesis of well-defined, nearly monodisperse, block-copolymers. The development of the polymerization-induced phase self-assembled (PISA) technique enables the production of well-defined nanoparticles (nanolatexes), with controlled size (typically with a diameter smaller than 200 nm), charge density, chemical functionality, and glass transition temperature.

The combination of CNFs and well defined nanolatexes allows for the design of novel materials with unique properties. Scattering techniques have proven very useful to characterize the corresponding materials, for instance, a method to assess cross-section orientation.

BP 12.2 Tue 10:00 H46

In situ GISAXS investigation of different protein-templated titania nanostructures — •Linus Fidelis Huber and Peter Müller-Buschbaum — TUM School of Natural Sciences, Chair for Functional Materials, 85748 Garching, Germany

Nanostructured titania thin films have been studied for a large variety of applications. An environmentally benign and scalable synthesis route for this material class could be of interest to many state-of-the-art devices, from solar cells to battery materials. Protein-assisted sol-gel synthesis is a low-temperature, low-cost, and highly scalable technique, that can be used to achieve a nanostructured titania thin film. It has been shown that the bovine whey protein β-Lg forms differently shaped aggregates at different solution pH values. With simple changes to the solution chemistry, different domain sizes, porosities, and morphologies are possible. Therefore, it is a promising candidate to create tunable and mesoporous titania structures. In this work, we investigate the film formation with in situ small-angle/wide-angle grazing incidence X-ray scattering (GISAXS/GIWAXS) techniques. It is found that films printed at acidic pH form significantly different final bulk morphologies than films printed at neutral pH. The crystallite phase is strongly reduced in average domain size and domain-domain distance. Agglomerate size is increased for the acidic template. The in situ data is complemented by SEM, PL, UV-Vis and static GISAXS/GIWAXS measurements.

BP 12.3 Tue 10:15 H46

With digital luminescence towards minimalistic, biodegradable information storage — •Sebastian Schellhammer, Heidi Thomas, Tim Achenbach, and Sebastian Reineke — Dresden Integrated Center for Applied Physics and Photonic Materials (IAPP) and Institute for Applied Physics, Technische Universität Dresden, Dresden, Germany

Materials showing persistent luminescence, characterized by extended excited state decay times in the millisecond range and beyond, have gained much attention. Recently, we have reported a photonic device architecture based on organic functional materials called programmable luminescent tag (PLT) that is well suited for sensing, labelling, and information exchange applications. Information can be erased and rewritten repeatedly by using the design principle of digital luminescence, i.e. the control of the local oxygen concentration in a polymer:emitter blend and accordingly the emission by room temperature phosphorescence (RTP). We present the design of PLTs made from industrially compostable, ready-to-use materials (bioPLTs). As natural emitters, quinoline alkaloids show sufficient RTP when being embedded in a polymer matrix. Polylactic acid is used as matrix material and flexible substrate. RTP can be controlled adding oxygen blocking layers made from Exceval. Although organic semiconductors provide the potential of biodegradable technologies, prototypes do only rarely exist. With this work, a promising technology for compostable information storage and sensing systems is introduced.

BP 12.4 Tue 10:30 H46

Enhancing drug release at interfaces with photoresponsive surfactant-polyelectrolyte mixtures — •Ipsita Pani, Michael Hardt, and Björn Braunschweig — Institute of Physical Chemistry, Center for Soft Nanoscience (SoN), University of Münster, Corrensstraße 28-30, Münster 48149, Germany

Using micellar nanocarriers of a photoresponsive arylazopyrazole (AAP) surfactant, we have recently demonstrated the drug release at air-water interface.[1] In this work, we use a biopolymer poly-L-lysine (PLL) to form surfactant-polyelectrolyte mixtures to enhance the drug release of a chemotherapeutic drug doxorubicin. We observe a strong binding between the negatively charged AAP and the positively charged PLL at equimolar ratio. The information from UV-visible spectroscopy, light scattering studies, surface tensiometry and SFG spectroscopy has been utilized to identify the concentration of PLL at which the light-induced drug release is enhanced at the interface. We found that at higher PLL:AAP ratio, the complexes have low net charge and colloidal stability and the release of Dox from the bulk solution to the air-water interface is not observed. However, at lower PLL:AAP ratio, when the system is colloidally stable with a net negative charge, the drug release to the air-water interface is significantly enhanced. Further, the kinetics of drug release to the interface is faster in presence of PLL-AAP mixtures in comparison to pure AAP micelles. Reference : [1] Pani et al. Chem. Sci., 2024, 15, 18865-18871.

BP 12.5 Tue 10:45 H46

Proteins as foam stabilizers: From single foam lamellas to macroscopic foams — •Kevin Gräff, Sebastian Stock, Luca Mirau, Matthias Kühnhammer, Olaf Soltwedel, and Regine von Klitzing — Terchnische Universität Darmstadt, Darmstadt, Germany

Foams consist of foam lamellas, which separate single air bubbles from each other. Investigation of lamellas is crucial to understand foam properties. In order to untangle electrostatic, steric and network stabilization effects, we compare two globular proteins (β-lactoglobulin and Lupine Protein Isolate) and a disordered, flexible protein (whole casein) at different pH values. The Thin Film Pressure Balance (TFPB) device based on image intensity measurements generates spatially resolved disjoining pressure isotherms. We introduce feature tracking for the measurement of interfacial mobility and stiffness of lamellas as a novel method. Around the isoelectric point, Newton Black Films (NBFs) form, which are stable for the globular proteins while they are unstable for the disordered flexible one. This difference in film stability is explained by different characteristics of network structures in the lamellas from the respective protein solutions. Small-Angle Neutron Scattering (SANS) evaluation with a new model for foams proves the presence of NBFs within macroscopic foams. For a complete picture we compare the TFPB findings with X-ray reflectometry as well as with Brewster Angle Microscopy on single interfaces.

[1] Gräff, K. et al, (2022), Untangling effects of proteins as stabilizers for foam films, Front. Soft. Matter 2:1035377.

BP 12.6 Tue 11:00 H46

What makes a polysaccharide biomaterial a good candidate for tissue engineering applications? — •Emma Bobu Cimpoi[1], Codrut Costinas[1], Emilia Licarete[2], Tamás Gyulavári[3], Klara Magyari[4], and Monica Baia[4,5] — [1]Doctoral School of Physics, Babes-Bolyai University, Cluj-Napoca, Romania — [2]Centre for Systems Biology, Biodiversity and Bioresources "3B", Cluj-Napoca, Romania — [3]Department of Applied and Environmental Chemistry, University of Szeged, Hungary — [4]INSPIRE Research Platform, Babes Bolyai University, Cluj-Napoca, Romania — [5]Faculty of Physics, Babes-Bolyai University, Cluj-Napoca, Romania

Biomaterials are inovative systems used to solve medical issues. Daily, injuries produce major bleeding that affects people and, without proper care, leads to other health problems. Traditional care methods are limited and outdated, so the focus is on natural materials with hemostatic properties, that are biocompatible and non-toxic. The aim of this work was to develop biomaterials based on pullulan, alginate and gelatin in various combinations, which could stop the bleeding and regenerate the wound. The developed sponge-like materials were characterized by FT-IR spectroscopy and X-ray diffraction. Then they were evaluated in vitro in terms of porosity, toxicity, swelling and charge on the surface, using SEM, cell viability assays, water up-take and mechanical tests. The investigations revealed good results as the synthesis was succesfull, the samples swell a lot, have good shape memory properties, are porous and non-toxic. These indicate their potential to stop bleeding, and therefore further in vivo tests will be carried out.