BP 3: Biopolymers, Biomaterials and Bioinspired Functional Materials (joint session CPP/BP)

Time: Monday 9:30–11:15 Location: ZEU 114

BP 3.1 Mon 9:30 ZEU 114

Dichroic FTIR spectrocopy on recombinant spider silk films at texturised silicon substrates — Mirjam Hofmaier[1,2], Birgit Urban[1], Sarah Lentz[3], Thomas Scheibel[3], Andreas Fery[1,2], and •Martin Müller[1,4] — [1]Leibniz-Institut für Polymerforschung Dresden e.V., Institute of Physical Chemistry and Polymer Physics, D-01069 Dresden — [2]Technische Universität Dresden, Chair of Physical Chemistry of Polymeric Materials, D-01062 Dresden — [3]Universität Bayreuth, Chair of Biomaterials, D-95447 Bayreuth, Germany — [4]Technische Universität Dresden, Chair of Macromolecular Chemistry, D-01062 Dresden

Films of recombinant spider silk protein eADF4 were deposited onto unidirectionally scratched silicon substrates (Si-sc) and analysed by dichroic transmission (T-) and ATR-FTIR spectroscopy addressing conformation and orientation. eADF4 films (d=0-200 nm) were casted from hexafluoroisopropanol solutions onto Si-sc. Both FTIR methods revealed low b-sheet (<10%) and high random coil content (>80%) based on Amide I band analysis. Dichroic ratios R of all Amide I components close to those of isotropic samples were found by T- and ATR-FTIR indicating no eADF4 orientation. Whereas, eADF4 films after swelling in MeOH vapor revealed higher b-sheet (>30%) and lower random coil content (<60%). By ATR-FTIR high R values for the Amide I component at 1696 cm-1 assigned to antiparallel b-sheet structure were found indicating out-of-plane orientation of b-sheets, which increased with decreasing thickness. Whereas, by T-FTIR isotropic R values indicating no in-plane orientation of b-sheets were found.

BP 3.2 Mon 9:45 ZEU 114

Keratin films from human nail and hair as artificial nail plate model — •Kim Thomann, Andreas Späth, and Rainer H. Fink — Lehrstuhl für Physikalische Chemie II, Friedrich-Alexander Universität Erlangen-Nürnberg, Erlangen, Germany

Human fingernails can be studied ex vivo only in form of clippings which offer limited insight as they do not necessarily reflect the behavior of the whole nail. Keratin films (KFs) can potentially serve as human fingernail substitute which is especially relevant for the medical and beauty sector. In order to model the nail's adhesive characteristics, films from keratin extracted from human hair and nails were produced [1]. With the fingernail serving as reference, the KFs were characterized with a number of methods, including AFM, contact angle (CA) measurements, XPS, ATR-FTIR and Raman spectroscopy. In terms of composition, KFs show a good resemblance. The topography however differs as the films are much smoother than the micro-structured nail. CA measurements revealed that the surface free energy was in the same range, but the polar component was much stronger for the KFs compared to the fingernail. KFs matching the nail's microstructure represents one approach to achieve a more satisfying model, potentially realized by micro-contact printing.

[1] Lusiana, et al., Eur. J. Pharm. Biopharm. 2011, 78, 432

BP 3.3 Mon 10:00 ZEU 114

Tracing the film formation of biotemplated titania nanostructures during spray coating with in situ GIXS techniques — •Julian E. Heger[1], Wei Chen[1], Calvin J. Brett[2,3], Wiebke Ohm[3], Stephan V. Roth[2,3], and Peter Müller-Buschbaum[1,4] — [1]Technische Universität München, Physik-Department, Lehrstuhl für Funktionelle Materialien, James-Franck-Straße 1, 85748 Garching, Germany — [2]Royal Institute of Technology KTH, Teknikringen 34-35, 100 44 Stockholm, Sweden — [3]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [4]Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, Lichtenbergstr. 1, 85748 Garching, Germany

An interesting approach in soft matter science is to substitute synthetic polymers with biopolymers, such as proteins. Being water soluble and non-toxic, they open a way to greener processing. We are interested in the structure directing properties of the bovine whey protein ß-lactoglobulin (ß-lg) for thin titania films. For this, denatured ß-lg is mixed with established titania precursors to form a sol-gel, which can be eventually deposited. Spray deposition is chosen as a fast technique of low material wastage and hence of industrial relevance. In situ grazing incidence X-ray scattering measurements are performed simultaneously in small- and wide-angle regime (GISAXS/GIWAXS) to reveal the morphological changes and timescales of lateral growth upon film formation. After calcination of the as-deposited samples, the remaining titania scaffolds can be backfilled with organic semiconductors in order to build e.g. hybrid photoactive layers.

BP 3.4 Mon 10:15 ZEU 114

Structural and physical properties of Cellulose/Silver nanoparticle multi-layer film by layer-by-layer deposition — Qing Chen[1], •Andrei Chumakov[1], Calvin Brett[1,2], Anton Plech[3], Peng Zhang[4], and Stephan Roth[1,2] — [1]Deutsche Synchrotron (DESY), 22607, Hamburg, Germany — [2]KTH Royal Institute of Technology, 10044, Stockholm, Sweden — [3]Karlsruhe Institut of Technology (KIT), 76021, Karlsruhe, Germany — [4]Sun Yat-sen University, 510275, Guangzhou, China

Silver nanoparticles and assembled structures thereof have attracted growing interest due to peculiar optical, electrical, catalytic and stimuli-responsive properties of these nanostructures during the past decade. We report a new strategy to fabricate multilayered cellulose/AgNP-based thin-film by layer-by-layer (LBL) coating method, and the kinetics during each layer coating cycle was monitored by using grazing incidence small-angle X-ray scattering (GISAXS). Multilayered films were prepared by spray-coating technique. Spray conditions and solvent treatment of cellulose and AgNP layer were optimized according to structural and morphological characterization for the formation of an AgNP layer and each cellulose interface. Atomic force microscopy (AFM) was performed to visualize the morphological characteristics of the film surface. Moreover, our strategy provides a platform for easy and scalable production of large-area AgNP LBL films.

BP 3.5 Mon 10:30 ZEU 114

Self-assembly of aligned cellulose nanofibrils during gel drying — •Ariane Suzzoni[1], Calvin Jay Brett[1,2,3], Susumu Yada[1], Korneliya Gordeyeva[1], Stephan Volkher Roth[1,2], and Daniel Söderberg[1,3] — [1]KTH Royal Institute of Technology, SE-11428 Stockholm, Sweden — [2]Deutsches Elektronen-Synchrotron (DESY), D-22607 Hamburg, Germany — [3]Wallenberg Wood Science Centre, SE- 11428 Stockholm, Sweden

Cellulose nano fibrils (CNF) are largely studied in order to replace synthetic materials with natural ones. These materials based on natural fibers are an alternative to materials made from fossil energies, a big challenge in today's world. High mechanical performance can be related to the nanostructure of fibrils which composed the filaments. However, the mechanism involved is still unknown. A possible hypothesis is the mesoscale structure self-assembling occurs during consolidation and drying phase. Small Angle X-Ray scattering (SAXS) is a powerful technique to investigate the system arrangement at nanoscale. A flow-focusing system has been developed in a previous project to assemble CNF fibers with a highly ordered arrangement. The suspension formed using this microfluidic device is a gel containing a low concentration of CNF. SAXS experiments have been carried out directly on the gel filament lifted up in the air. The nanostructural changes were observed by SAXS during gel drying. We will present results obtained about the structure of cellulose nanofibrils as a function of drying time. This knowledge about CNF nanostructure formation will be a key to develop new eco-friendly materials.

BP 3.6 Mon 10:45 ZEU 114

Wrinkling instability in 3D active nematics — Tobias Struebing[1], Amir Khosravanizadeh[2], Andrej Vilfan[1], Eberhard Bodenschatz[1], Ramin Golestanian[1], and •Isabella Guido[1] — [1]Max Planck Institute for Dynamics and Self-Organization, Goettigen, Germany — [2]Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran

Networks of biopolymers and motor proteins are useful model systems for the understanding of emergent behaviour of active matter. An interesting class of such systems comprises active nematics, fluids constituted by self-organising elongated particles that in-vitro assemble in dynamical structures at length scales larger than those of their components by several orders of magnitude. In the last years the active nematic behaviour of biopolymer-motor networks confined on a 2D substrate was reported. Here we present an experimental and theo-

retical study on 3D active nematics made of microtubules, kinesin-1 motor proteins and a depleting agent. The network is subjected to the force exerted by the motors that crosslinked the filaments and let them slide against each other. In this way the system evolves toward a flattened and contracted 2D sheet that undergoes a wrinkling instability and subsequently loses order and transitions into a 3D active turbulent state. We observe that the wrinkle wavelength is independent of the ATP concentration and our theoretical model describes its relation with the appearance time. The experimental results are compared with a numerical simulation that confirms the key role of kinesin motors in the contraction and extension of the network.

BP 3.7 Mon 11:00 ZEU 114

Viscoelastic AFM characterization of the S2 layer of wood pulp fibers — •Caterina Czibula[1,3], Christian Ganser[1,3], Tristan Seidlhofer[2,3], Ulrich Hirn[2,3], and Christian Teichert[1,3] — [1]Institute of Physics, Montanuniversitaet Leoben, Austria — [2]Institute of Paper, Pulp and Fibre Technology, TU Graz, Austria — [3]CD Laboratory for Fiber Swelling and Paper Performance, TU Graz

Wood fibers consist of several cell wall layers which differ in thickness, chemical composition, and alignment of cellulose microfibrils. The S2 layer is the thickest layer, and dominates the mechanical behavior of the fibers. Several investigations with depth-sensing methods have so far focused on the characterization of the mechanical properties of the S2 layer. However, studies on the influence of relative humidity (RH) and the viscoelastic behavior of this layer are still missing. This work focusses on the viscoelastic behavior of the S2 layer at different RH by implementing an atomic force microscopy (AFM) based method. Here, wood pulp fibers have been prepared by microtome cutting, and a possible penetration of the embedding material in the cell wall layers has been ruled out by Raman spectroscopy. The evaluation of the experimental AFM data combines contact mechanics and viscoelastic models. It will be demonstrated that the Generalized Maxwell model yields reasonable results for the S2 layer measured at different RH. With increasing RH, the S2 layer shows a decrease in elastic and viscous parameters. The effect of different load rates will be discussed, and the viscoelastic results will be compared to AFM based nanoindentation data.