BP 3: Biopolymers and Biomaterials I (with CPP)

Time: Monday 10:30–13:00 Location: ZEU 222

Topical Talk BP 3.1 Mon 10:30 ZEU 222

Crayfish combine amorphous and crystalline mineral to build a functional tooth structure — •Barbara Aichmayer[1], Shmuel Bentov[2,3], Ali Al-Sawalmih[1], Admir Masic[1], Paul Zaslansky[1], Peter Fratzl[1], Amir Sagi[3,4], and Amir Berman[2,4] — [1]Department of Biomaterials, Max Planck Institute of Colloids and Interfaces, 14424 Potsdam, Germany — [2]Department of Biotechnology Engineering, Ben-Gurion University of the Negev, 84105, Israel — [3]Department of Life Sciences, Ben-Gurion University of the Negev, 84105, Israel — [4]The National Institute for Biotechnology in the Negev, Israel

Various strategies allow for the formation of functional tooth structures including examples as different as the self-sharpening teeth of sea-urchins and our durable human teeth. The freshwater crayfish Cherax quadricarinatus follows a unique approach of using amorphous and crystalline minerals to build the molar extension of its mandible, which serves as an efficient grinding tool. Mechanical properties with an astonishing similarity to human teeth are achieved by the combination of an enamel-like layer of oriented fluorapatite crystals and a graded structure of chitin and amorphous mineral with an increasing phosphate/carbonate ratio. The composition and structure of the crayfish molar, measured by state of the art techniques such as Raman imaging, synchrotron X-ray diffraction and micro-CT, are related to its mechanical properties and discussed with respect to the role of the calcium phosphate, which allows for the formation of the hard, crystalline coating and also helps to stabilize the amorphous mineral.

BP 3.2 Mon 11:00 ZEU 222

Structure-property relationships of natural silk fibers as studied by time-resolved Fourier-Transform Infrared Spectroscopy (FTIR) — •Roxana Ene[1], Periklis Papadopoulos[2], and Friedrich Kremer[1] — [1]Institüt für Experimentelle Physik I, Leipzig, Germany — [2]Max-Planck- Institut für Polymerforschung, Mainz, Germany

Polarized IR-spectroscopic and mechanical measurements are combined to analyse the conformational changes in hydrogenated and partially deuterated major ampullate spider silk of Nephila edulis[1].Crystal stress can be measured from the frequency shift of main-chain vibrations. The results show that in both states of silk a serial arrangement between the crystalline and amorphous phase dominates the nanostructure. The determination of the molecular order parameters of the different moieties proves that the amide hydrogen exchange is a selective process, taking place at the surface of β-sheet nanocrystals, implying that these regions are accessible by water[2].The mechanical properties are changing dramatically when the fiber is wet due to the fact that the pre-stress of the chains interconnecting the nanocrystals is irreversibly released. A three-component combined model of crystals in serial arrangement with amorphous chains and a fraction of chains bypassing them can describe all aforementioned states of spider silk[3]. [1] P. Papadopoulos, R. Ene, I. Weidner, F. Kremer Macromol. Rapid Commun 30,(2009). [2] R.Ene, P. Papadopoulos, F. Kremer Polymer 51,(2010) [3] R. Ene, P. Papadopoulos, F. Kremer, Soft Matter 5 (2009)

BP 3.3 Mon 11:15 ZEU 222

Mechanical properties of fiber-fiber bonds in paper studied by atomic force microscopy — •Franz Schmied[1,4], Wolfgang Fischer[2,4], Ulrich Hirn[2,4], Robert Schennach[3,4], and Christian Teichert[1,4] — [1]Institute of Physics, University of Leoben, 8700 Leoben, Austria — [2]Institute for Paper, Pulp and Fiber Technology, Graz University of Technology, 8010 Graz, Austria — [3]Institute of Solid State Physics, Graz University of Technology, 8010 Graz, Austria — [4]CD-Laboratory for Surface Chemical and Physical Fundamentals of Paper Strength, Graz University of Technology, 8010 Graz, Austria

Paper has been used as a packaging material and for printing purposes for a long time, however a fundamental quantitative understanding for the mechanisms of paper strength has not yet been worked out. A sheet of paper is a network of individual single fibers extracted from wood. During the production cycle, these single fibers need to approach close enough to form bonds between each other. The resulting network is than called paper. Here, we present a comprehensive AFM investigation of single fibers as well as fiber-fiber bonds to achieve a deeper insight into the various mechanisms [1] that bind two single pulp fibers together. Beside morphological investigations, we present force versus distance curves to study the separation of two bonded fibers as distance and force controlled experiments. With these experiments it is possible to learn more about the mechanical properties of single fiber-fiber bonds. Supported by **Mondi** and the **Christian Doppler Research Society**, Vienna, Austria. [1] Lindström, T. et al., Proc. 13th Fundamental Research Symp, 2005.

BP 3.4 Mon 11:30 ZEU 222

Influence of temperature on the morphology of casein micellar films — •Ezzeldin Metwalli[1], Alexander Diethert[1], Joseph Adelsberger[1], Robert Cubitt[2], Ulrich Kulozik[3], and Peter Müller-Buschbaum[1] — [1]TU München, Physik Department, LS Funkt. Mat., James-Franck-Str. 1, 85748 Garching, Germany — [2]ILL, 6 rue Jules Horowitz, b.p. 156, 38042 Grenoble, France — [3]TU München, Chair for Food Proc. Eng. and Dairy Tech., 85354 Weihnstephan, Germany

Casein micelles for non-food applications such as coatings, adhesives and cosmetics are the main drive to study casein micelles structure in the thin film format. The effect of temperature on the structure of casein micelle films is investigated using grazing incidence small angle neutron scattering (GISANS). GISANS has proved sensitivity to micellar structure due to a high contrast imparted by an outer shell of D_2O on the objects [1]. At different temperatures, various average micelle sizes with large size distribution are due to an aggregation behavior of the casein proteins. For freshly prepared samples, the average micelle size is increasing from about 80 to 120 nm with increasing temperatures from 5 to 35 °C. Aged casein micelles films for 100 days at room temperature indicate a continuous structural reorganization. The continuous aggregation between hydrated micelles in the film to reach equilibrated structures explains the high stability of casein-based coatings and adhesives by the ability to adapt itself to varying environmental conditions. [1] E. Metwalli et al., Langmuir 25, 4124 (2009)

BP 3.5 Mon 11:45 ZEU 222

Thermodynamics of chondroitin sulfate solutions using field-theoretic methodologies — •Stephan A Baeurle[1], Michael G Kiselev[2], Elena S Makarova[2], and Evgenij A Nogovitsin[2] — [1]Department of Chemistry and Pharmacy, Institute of Physical and Theoretical Chemistry, University of Regensburg, Universitätsstr. 31, D-93053 Regensburg, Germany — [2]Institute of Solution Chemistry, Russian Academy of Sciences, 153045 Ivanovo, Russia

Articular cartilage is predominantly composed of chondroitin sulfates, which are known to affect in a decisive way the mobility and flexibility of our joints. Progress in understanding their frictional-compressive behavior on the molecular level has been hindered due to the lack of reliable experimental data and the multitude of controlling parameters, influencing their structure and properties under physiological conditions. Here, we discuss the thermodynamic response of aqueous chondroitin sulfate solutions to changes in the monomer and added salt concentrations, using a recently developed field-theoretic approach beyond the mean-field level of approximation (S.A. Baeurle et al, Polymer 50, 1805-1813 (2009)). We compare our calculation results to experimental as well as molecular modeling data, and demonstrate that our field-theoretic approach provides useful estimates for important physical properties, affecting their frictional-compressive behavior.

BP 3.6 Mon 12:00 ZEU 222

The swelling/stability effect of hyaluron on a lipid multilayer system — •Martin Kreuzer[1], Markus Strobl[2], Matthias Reinhardt[2], Reiner Dahint[1], and Roland Steitz[2] — [1]Universität Heidelberg, Physikalisch Chemisches Institut, 69120 Heidelberg, Germany — [2]Helmholtz-Zentrum Berlin GmbH, 14109 Berlin, Germany

Hyaluron (HA) is a high molecular weight polysaccharide. HA is involved in a wide range of processes in the human body, such as wound healing, severe stress, tumor progression and invasion. It was possible to show, that HA also stabilizes lipid multilayer systems at physiological conditions: Neutron reflectometry measurements, carried out at V6 and BioRef neutron reflectometer at the Helmholtz-Zentrum Berlin, in excess D2O verified, that a oligolamellar DMPC lipid bilayer coating remains stable on a silicon substrate at 21°C in its ordered state (Lβ)

with a d-spacing of 66Å, but detaches almost completely at 38°C in its chain-disordered Lα state from the solid support - the origin of the loss of the oligolamellar DMPC bilayer stack at 38°C is unclear. By contrast oligolamellar lipid bilayers remain stable on a substrate at 38°C when incubated with a solution of HA in D2O: In an independent experiment, an oligolamellar lipid bilayers stack was measured against a solution of 3mg/mL HA in D2O. The sample was investigated shortly after incubating at 21°C and after raising sample temperature to 38°C. The oligolamellar lipid layer remained stable on the substrate, but an immense swelling occurred until a d-spacing of 209Å is reached. We will discuss a possible mechanism of the transformation of the oligolamellar lipid system with incubation time.

BP 3.7 Mon 12:15 ZEU 222

Influence of the intercalating fluorescent dye YOYO-1 on DNA properties — •Katrin Günther[1], Ralf Seidel[2], and Michael Mertig[1] — [1]Technische Universität Dresden, Institut für Physikalische Chemie, Mess- und Sensortechnik, 01069 Dresden, Germany — [2]Technische Universität Dresden, Biotechnology Center, Tatzberg 47-51 01307 Dresden, Germany

Fluorescent dyes of the cyanine family are widely used for staining DNA in order to explore the statistical-mechanical properties and the dynamical behaviour of DNA, even though their impact on the mechanical and structural properties has not been reliably quantified so far.

The influence of the bis-intercalating fluorescent dye YOYO-1 on the mechanical and structural properties of the molecule duplex is investigated in a wide range of staining ratios. Magnetic tweezers were used to measure the persistence and the contour length as well as the dye-induced untwisting of DNA molecules. The ionic conditions were found to considerably affect the stability of YOYO-1 binding to DNA. In contrast to other intercalating dyes, we found the persistence length remaining constant independent on the amount of bound YOYO-1.

BP 3.8 Mon 12:30 ZEU 222

Stiffening effect of cholesterol on large unilamellar vesicles based on POPC — •Thomas Hellweg[1], Laura Rodriguez-Arriaga Rodriguez-Arriaga[2], Ivan Lopez-Montero[2], Bela Farago[3], and Francisco Monroy[2] — [1]Universität Bielefeld, PC III, Universitätsstr. 25 33615 Bielefeld, Germany — [2]Universidad Complutense, 28040 Madrid, Spain — [3]ILL, 6 rue Jules Horowitz, BP 156, F-38042 Grenoble Cedex 9, France

In the present contribution the center of mass diffusion and shape fluctuations of unilamellar POPC vesicles are studied by means of neutron spin-echo (NSE) in combination with dynamic light scattering (DLS). The intermediate scattering functions were measured for several different values of the momentum transfer q and for different cholesterol contents in the membrane. The combined analysis of NSE and DLS data allows the calculation of the bending elastic constant κ of the bilayer. A stiffening effect monitored as an increase of κ with increasing cholesterol molar ratio is evidenced from these measurements [1]. At high values of q apparently intermonolayer friction modes can be resolved using NSE [2]. The presented approach could also be applied to study the influence of membrane proteins on κ or of substances like e.g. Gramicidine.

[1] Rodriguez Arriaga, L., I. Lopez-Montero, F. Monroy, G. Orts Gil, B. Farago und T. Hellweg: Biophys. J., **96**, 3629–3637, 2009.

[2] Arriaga, L. R., R. Rodriguez-Garcia, I. Lopez-Montero, B. Farago, Th. Hellweg, und F. Monroy: Euro. Phys. J. E, **31**, 105–113, 2010.

BP 3.9 Mon 12:45 ZEU 222

Investigation of L-Cysteine in aqueous solution using the RIXS-map approach — •Frank Meyer[1], Lothar Weinhardt[1], Monika Blum[2], Marcus Bär[3], Regan Wilks[3], Wanli Yang[4], Clemens Heske[2], and Friedrich Reinert[1] — [1]Exp. Physik VII, Universität Würzburg — [2]Department of Chemistry, University of Nevada Las Vegas, USA — [3]Solar Energy Research, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH — [4]Advanced Light Source, Lawrence Berkeley National Laboratory, USA

Amino acids are the building blocks of many biologically relevant macro-molecules. Consequently, their electronic structure is of fundamental interest and hence has been the topic of many studies. Most investigations focus on solid-state samples, the study of amino acids in their native (i.e. aqueous) environment with core-level spectroscopy has only become possible as a result of the development of specialized experimental set-ups. In combination with a high-transmission soft x-ray spectrometer, our liquid flow through cell allows us to measure two-dimensional resonant inelastic x-ray scattering (RIXS) maps of liquids and solutions. RIXS maps display the x-ray emission intensity as a function of emission and excitation energy and hence provide a comprehensive picture of the electronic structure of the investigated material. In this contribution, we will present RIXS maps of aqueous cysteine solutions at various pH values. We observe a significant impact of the pH value and evidence for proton dynamics on the time scale of the RIXS process. The results are compared to RIXS and photoemission measurements of cysteine thin films and of related molecules.