BP 26: Posters: Biomaterials and Biopolymers (joint with CPP)

Time: Wednesday 17:30–19:30 Location: Poster C

BP 26.1 Wed 17:30 Poster C

Structural design of strategic materials for tissue regeneration — •Maria Helena V. Fernandes — Department of Materials Engineering and Ceramics &

A key factor for the success of tissue engineering targeted for regeneration is the choice of appropriate materials with properties that can fulfill the complex requirements imposed. The structural design of those materials can have a decisive impact on relevant properties, such as, biodegradability, bioactivity, piezoelectricity, cell response.

This talk will be centered on our expertise on some amorphous, semi-crystalline and crystalline strategic materials, namely Si-based bioglasses, Poly-L-Lactic Acid (PLLA) and ZnO nanoparticles to be used in tissue regeneration applications. The materials, in monoliths, films or particles are produced by different processing technologies (melt-quenching, spin coating chemical precipitation) and further characterized in terms of structure, microstructure, degradation, in vitro behavior and cell viability. Relevance will be given to aspects related to the processing technologies employed and to the parameters that can be controlled aiming to obtain tailored structures and custom-made properties in those strategic materials for tissue regeneration purposes, namely of the bone tissue.

BP 26.2 Wed 17:30 Poster C

Artificial hydroxyapatite pellets - mimicking hard tissues with simple surfaces — •Christian Zeitz[1], Samuel Grandthyll[1], Deniz Kahraman[2], Peter Loskill[1], Jörg Schmauch[1], Nicolas Thewes[1], Frank Müller[1], and Karin Jacobs[1] — [1]Experimental Physics, Saarland University, Saarbrücken, Germany — [2]Institute for ceramics in engineering, KIT, Karlsruhe, Germany

The interactions of proteins, cells or bacteria with hard tissue surfaces are of utmost importance. On the one hand, characterization of these interactions often employs simplified model surfaces featuring low roughness and controlled surface chemistry (mica, glass, silicon wafers). Thereby specific properties of tissue compounds such as hydroxyapatite are not included. Previous studies showed, however, that hydroxyapatite interacts with attaching proteins in a specific way. On the other hand, the drawback of tissue samples instead of model systems is the lack of controllability or reproducibility. Both approaches are necessary for a comprehensive understanding of the principles on the natural material but limited both in their own way.

Therefore, we have developed substrates consisting of hydroxyapatite featuring a low roughness and defined chemical composition. The local roughness is comparable to the one of silicon wafers. The chemical purity as well as the simple structure allow for controlled characterization of fundamental interactions. Using these samples, we investigate the adhesion of bacteria and adsorption of proteins on natural substrates.

BP 26.3 Wed 17:30 Poster C

Dynamics of vimentin filament aggregation studied in microfluidic drops — •Christian Dammann, Bernd Nöding, Susanne Bauch, and Sarah Köster — Institute for X-Ray Physics, University of Göttingen, Germany

Studying individual cytoskeletal constituents represents a bottom up approach towards an understanding of cellular mechanics. The structure and function of vimentin intermediate filament networks is influenced – amongst other things – by ions. To perform systematic studies of the influence of ions on vimentin *in vitro*, we use microfluidic devices to encapsulate the protein and multivalent ions in picoliter sized drops. After fast internal mixing, the drops are held in position to image the fluorescently tagged vimentin using fluorescence microscopy. In this trapping mechanism the drops enter a 'U'-shaped constriction that keeps them in position immediately after the protein and ions are in contact for the first time. Thus we directly image the time course of aggregation, *i.e.* how vimentin filaments form connected networks in the drops. The process depends on the ion concentration as well as valence and takes place within the first minutes after drop loading. Since we can resolve individual network features during the aggregation process, our method is promising to shed light on the mechanisms behind the network formation of vimentin in the presence of multivalent ions.

BP 26.4 Wed 17:30 Poster C

Spatio-Temporal Changes in Mechanical Properties of Extracellular Matrix of Hydra Magnipapillata — •Mariam Veschgini[1], Suat Özbek[2], Manfred Burghammer[3], Thomas Holstein[2], and Motomu Tanaka[1] — [1]Physical Chemistry of Biosystems, Physical Chemistry Institut, University of Heidelberg, 69120 Heidelberg, Germany — [2]Center for Organismal Studies, Department of Molecular Evolution and Genomics, University of Heidelberg, 69120 Heidelberg, Germany — [3]European Synchrotron Radiation Facility (ESRF), Grenoble Cedex 9 38053, France)

The extracellular matrix (ECM) of the freshwater polyp hydra, called mesoglea, is one of the early forms of ECM. Hydra mesoglea has a multilayered structure, which is dynamically changed during the development.

The main goal of this study is to investigate the time evolution of local elastic properties of isolated mesoglea by means of nanoindentation with an Atomic Force Microscopy (AFM).

The results indicate a clear change in the elasticity of mesoglea along the main body axis. Furthermore, the analysis of elasticity as a function of budding stage suggests the first sign of a turn-over from "soft" to "stiff" mesoglea during the growth and maturation of buds.

To further gain the local fine structure of mesoglea, the first grazing incidence small angle X-ray scattering experiments on isolated mesoglea were performed with a nano-focused beam (200 nm) at the European Synchrotron Radiation Facility (ESRF).

BP 26.5 Wed 17:30 Poster C

Temperature treatment of protein layers at the solid/liquid interface in different environments - An x-ray reflectivity study — •Irena Kiesel, Michael Paulus, Julia Nase, Sebastian Tiemeyer, Christian Sternemann, and Metin Tolan — Fakultät Physik / DELTA, Technische Universität Dortmund, 44221 Dortmund, Germany

Proteins at solid/liquid interfaces play a key role in technical, biomedical, and food processing applications. The interaction of bacteria and cells with surfaces is influenced by adsorbed proteins. These proteins can lose their functionality when denatured by e.g. heat treatment.

In our experiment we have investigated in situ the denaturation process of different model proteins (lysozyme, RNase A and BSA) induced by increasing temperature (up to 80°C) in two different environments, a pure buffer solution and a protein solution, which represents a protein reservoir. The measurements were performed using the 27 keV x-ray reflectivity setup at beamline BL9 of the synchrotron radiation source DELTA (Dortmund, Germany). The electron density profiles of the layer system and the amount of the adsorbed proteins were obtained by analysing the reflectivities at each temperature.

We observe that in pure buffer solution the proteins desorb with increasing temperature, whereas temperature treatment of protein layers in protein solution results in thicker protein layers and can be explained by additional protein adsorption.

Work was supported by BMBF (05K10PEC) and NRW Forschungsschule.

BP 26.6 Wed 17:30 Poster C

Melting of pectin gels — •Andrea Kramer[1], Romaric Vincent[2], Brad Mansel[3,4], Klaus Kroy[1], and Martin Williams[3,4,5] — [1]Institute for Theoretical Physics, Universität Leipzig, Germany — [2]Institute for Bioengineering of Catalonia, Spain — [3]Institute of Fundamental Sciences, Massey University, NZ — [4]MacDiarmid Institute for Advanced Materials and Nanotechnology, NZ — [5]Riddet Institute, NZ

Pectin gels are the major scaffolding structures responsible for the mechanical stability of plant cells. We have analyzed their slow dynamics and linear and nonlinear viscoelasticity as a function of temperature, using various (micro-)rhelogical techniques and theory. The results are compared to literature data for F-actin and live cells. We find that the linear microrheological and strain-stiffening responses of pectin networks are well-captured by the glassy wormlike chain (GWLC) model. The nonlinear mechanical response is much more sensitive to temperature changes than the linear response, a property that is also observed in F-actin networks and can be accounted for by the model. But the overall sensitivity to temperature changes turns out to be much more

pronounced in actin than in pectin, possibly hinting at a temperature anomaly of actin.

BP 26.7 Wed 17:30 Poster C

Development of hydrogel-based antiviral wound dressings — •Julian Riba and Oliver Lieleg — Zentralinstitut für Medizintechnik, Technische Universität München, Garching, Germany

Mucus is a biopolymer-based hydrogel that lines most of the inner surface in humans and animals and serves as a first layer of protection against pathogenic microorganisms. Recently, it has been shown in vitro that purified porcine gastric mucin biopolymers can act as a broad-spectrum antiviral agent. Yet, the low viscosity of reconstituted mucin solutions hampers their direct application for wound treatment. In this work, we aim to develop a novel mucin-based material for wound dressings. This novel material is supposed to maintain the antiviral properties of mucins while allowing for in situ gelation for easy application on inner wounds. We investigate composites of porcine gastric mucin and other gel-forming polymers such as methylcellulose, alginate, and chitosan so that gelation of the mixed polymer system can be induced by temperature or chemical crosslinking. Sample characterization is performed using macrorheological measurements and optical microscopy.

BP 26.8 Wed 17:30 Poster C

Electrical transport through self-assembled DNA superlattices — •Carlos Paez and Peter Schulz — Universidade Estadual de Campinas, Campinas Brazil

DNA has emerged as a versatile material for self-assembled molecular structures due to its intrinsic characteristics. Several proof concepts of regular two dimensional self-assembled DNA structures have been reported in the literature. Nevertheless, the electronic and transport properties of such systems remain unexplored. In this work we numerically investigate the transport properties of two dimensional square superlattice patterns build from two different DNA sequences (telomeric and random) by means of an effective tight binding model for the electronic structure, while the current is obtained within a Green's function framework. We show that the self-assembled square lattice structures based on telomeric DNA strands show current-voltage characteristics which make the system eligible for nanoelectronic applications. On the other hand, structures based on disordered sequences show currents that quickly go to undetectable ranges with increasing size. The robust plateau structures due to telomeric sequences are superimposed by additional features due to the DNA square superlattice. For the random sequencing case, interesting percolation mechanisms variations are observed, dependent on the competition between the localization length and the distance between the crosses in the self-assembled square superlattice structures.

BP 26.9 Wed 17:30 Poster C

Simulating peptide - ion interactions: choosing a realistic force field — •Jens Kahlen, Davide Donadio, and Christine Peter — Max Planck Institute for Polymer Research, Mainz, Germany

The impact of ions on biomolecules in solution can be tremendous. Classical atomistic simulations are a valuable tool to gain insight into this at a molecular level. However, a prerequisite for meaningful simulation results is a realistic description of the interactions between the different types of solutes. Recent publications (Reif, Hünenberger and Oostenbrink, *J. Chem. Theory Comput.* 2012, **8**, 3705-3723) have shown that a careful reevaluation of the interaction parameters between charged amino acid side chains and ions is necessary. For many force fields, these specific interactions have been only marginally taken into account in the parametrization process. Therefore, well-established force fields may yield significant differences in the description of such systems. In view of the difficulties to directly compare the observed association behavior of the simulated compounds to experimental data, the aim of our work is to identify a systematic way of choosing a force field parametrization, which yields a realistic description. Based on the example of polyglutamate interacting with calcium ions we show how a comparison of simulation results to experimental thermodynamic data and DFT-based calculations can be applied to achieve this aim.

BP 26.10 Wed 17:30 Poster C

Mechanical strength and intracellular uptake of CaCO3-templated layer-by-layer capsules composed of biodegradable polyelectrolytes — Raghavendra Palankar[1], Bat-El Pinchasik[2], Stephan Schmidt[2], Bruno De Geest[3], Andreas Fery[4], Helmuth Möhwald[2], André Skirtach[5,6], and •Mihaela Delcea[1,2] — [1]ZIK HIKE, Ernst-Moritz-Arndt-Universität Greifswald, Greifswald 17489, Germany — [2]Max-Planck Institute of Colloids and Interfaces, Golm 14424, Germany — [3]Laboratory of Pharmaceutical Technology, Department of Pharmaceutics, Ghent 9000 Belgium — [4]Physikalische Chemie II, Universität Bayreuth, Universitätsstrasse 30, D-95447 Bayreuth, Germany — [5]Department of Molecular Biotechnology, Ghent University, Ghent 9000, Belgium — [6]NB-Photonics, Ghent University, Ghent 9000, Belgium

Developing carriers comprised of biomaterials and capable of withstanding significant mechanical pressures, structural deformations and at the same time delivering biomolecules is of high interest for drug delivery. Using colloidal probe AFM combined with fluorescence microscopy, the mechanical and release properties from CaCO3-templated polymeric capsules made of biodegradable polymers are studied in comparison with those of CaCO3-templated capsules composed of synthetic polymers. The influence of the number of polyelectrolyte layers on the mechanical properties and release from biodegradable capsules will be shown. Mechanical deformation of capsules upon their intracellular uptake is determined and the implications for microcapsule design are discussed.

BP 26.11 Wed 17:30 Poster C

Minimization of Errors in the Determination of Elastic Moduli from Indentation Experiments — Michael Glaubitz, Mihaela Delcea, and •Stephan Block — ZIK HIKE, Fleischmannstr. 42 - 44, D-17475 Greifswald, Germany

Atomic force microscopes (AFMs) equipped with colloidal probe (CP) cantilevers allow to determine elastic moduli E with a lateral resolution below 1 μm by indentation experiments. Such experiments were used intensively in the past to study the elastic properties of surface coatings or changes in cell mechanics related to diseases like cancer or cardiomyopathies. Here, we present the first analysis of the Hertz model that allows to calculate the minimum possible error in the determination of E, which depends strongly on measurement noise but also on experimental parameters like spring constant and indentation depth. Scaling laws for these dependencies are analytically derived and supplemented by simulated and real indentation measurements. Our findings allow a systematic optimization of indentation experiments to increase the accuracy in the determination of E.

BP 26.12 Wed 17:30 Poster C

Imaging nanoscale deformation processes in collagen networks of native tendons — •Sebastian Ködel[1], Martin Neumann[1], Anke Bernstein[2], and Robert Magerle[1] — [1]Chemische Physik, TU Chemnitz, D-09107 Chemnitz, Germany — [2]Department für Orthopädie und Traumatologie, Muskuloskelettales Forschungslabor, Universitätsklinikum Freiburg, D-79106 Freiburg, Germany

A mechanical overload of tendons and ligaments leads often to a restriction of their functionality. To understand the nanoscale deformation processes in tendons under stress and relaxation, we use a microtensile testing device, which allows simultaneous imaging and measurements with atomic force microscopy (AFM) of the mechanical response. With this setup we study the deformation behaviour of individual collagen fibrils within about 10 μm thin slices of human tendons in native conditions. Series of AFM images reveal a large variety of deformation processes and the overall heterogeneous deformation behaviour. Our results show that individual collagen fibrils in a bundle are not permanently connected to each other and rearrange during deformation. AFM subsurface imaging experiments on individual collagen fibrils show evidence of a rearrangement of the tropocollagen molecules at large strain. We discuss the implications of these effects on the macroscopic mechanical properties of tendons.