BP 8: Posters: Biopolymers and Biomaterials (with CPP)

Time: Monday 17:30–19:30 Location: Poster A

BP 8.1 Mon 17:30 Poster A

Sample preparation of softwood with cryo-microtome and focused ion beam for X-ray nano-diffraction studies - a comparison — •Selina Storm[1,2], Malte Ogurreck[1], and Martin Müller[1] — [1]HZG, Geesthacht — [2]IEAP, University of Kiel

The cell structure of softwood has been investigated to understand the exceptional mechanical strength of this biological material. X-ray diffraction with nano-focused synchrotron radiation beam allows a spatial resolution of below 100 nm so that the transition zones between different cell wall layers as well as the cell wall layers themselves can be investigated in previously unknown quality.

A crucial point in this context is the sample preparation and the knowledge of its orientation. Thin sample slices (d<10 μm) can be cut out with a cryo-microtome or a focused ion beam. The use of a cryo-microtome has the disadvantage that the sample is easily damaged, e.g. splintering of the cell wall which leads to misleading results in the diffraction patterns. The achievable accuracy of the sample alignment is only in the order of several degrees which is insufficient for a detailed analysis. To overcome these disadvantages a focused ion beam is a promising alternative. Here, the results will be discussed and compared.

BP 8.2 Mon 17:30 Poster A

A Dielectrophoresis Study on the Frequency-Dependent Behaviour of Sepsis Pathogens in Media with Different Conductivities — •Ulrich-Christian Schröder[1,2], Uwe Glaser[1,2], Christian Leiterer[2], Andrea Csâki[2], Wolfgang Fritzsche[2], Uwe Hübner[2], Jürgen Popp[2,3], Michael Bauer[1], and Ute Neugebauer[1,2] — [1]Center for Sepsis Control and Care, Jena University Hospital — [2]Institute of Photonic Technology Jena e.V. — [3]Institute for Physical Chemistry and Abbe Center of Photonics, University Jena

Sepsis is a heavy inflammatory response of the human body due to the invasion of pathogenic organisms, which leads to high mortality rates. To ensure a start of early therapy, we are developing a highly sensitive, rapid, label-free and culture independent Lab on Chip method to estimate the resistance of sepsis pathogens towards antibiotics. Dielectrophoresis makes use of the interaction of high frequency non-uniform electrical fields with dielectric nano- and microparticles and can be used to manipulate sepsis pathogens within microsized regions. In the presented work the dielectrophoretic behaviour of the sepsis pathogens is studied for different frequency ranges as well as for different medium conductivities to trap and collect these organisms for further non-invasive optical characterization and furthermore to use dielectrophoresis as a diagnostic tool to distinguish between living and dead bacteria. Acknowledgement: The financial support of the BMBF (FKZ 01EO1002) is highly acknowledged.

BP 8.3 Mon 17:30 Poster A

The nacre protein perlucin - homology model and properties — •Malte Launspach[1], Martin Zacharias[2], and Monika Fritz[1] — [1]Institute of Biophysics, University of Bremen — [2]Biomolecular Dynamics (T38), Technical University Munich

The natural composite nacre is known for its iridescence as well as high fracture toughness. Both properties emerge from a well defined microstructure of nacre. Aragonite - a calcium carbonate polymorph - polygonal platelets with a diameter in the micrometer range and a height of about 500 nanometer are embedded in an organic layer comprised of proteins and chitin. One of these proteins of the organic layer is perlucin. This protein seems to be the most abundant one in nacre and it influences the growth of calcite as it was shown by AFM measurements. Currently we try to characterise this protein and its function in nacre formation.

Here we present a model of the C-type lectin perlucin derived from comparative modelling and tested with molecular dynamics simulations. Further we use common gelfiltration techniques and a computer docking program to investigate the perlucin-perlucin interaction. To probe the mineral interaction capabilities of perlucin we perform AFM imaging of aragonite and calcite surfaces in supersaturated calcium carbonate solutions in presence of perlucin.

BP 8.4 Mon 17:30 Poster A

Ab-initio characterization of potential siderophore-mediated metal transport systems — •Angelica Zacarias[1], Mabel Moreno[1,2], Mato Knez[1], Luis Velasquez[2], Andrea Porzel[3], and E.K.U. Gross[1] — [1]Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle (Saale) — [2]CEDENNA and Universidad de Santiago de Chile, Avda. Ecuador 3493, Estación Central, Santiago, Chile — [3]Department of Bioorganic Chemistry, Leibniz Institute of Plant Biochemistry, Weinberg 3, 06120 Halle (Saale)

The high affinity of enterobactin for iron has a wide range of biological applications (such as the treatment of bacterial diseases) as it allows its use for complex-mediated iron transport.

We present preliminary results that analyze the electronic and spectroscopic properties of the bare enterobactin as well as other metal-enterobactin systems.

We will show that the computer aided characterization of the products synthesized via Atomic Layer Deposition (ALD) techniques allows a better understanding not only of the iron-enterobactin association but also the further affinity of the enterobactin and iron-enterobactin for other metals. The extensive knowledge of this relationship and the use of ALD as synthetic technique has potential uses of the enterobactin complex in the treatment of bacterial diseases as well as in the area of environmental contamination.

BP 8.5 Mon 17:30 Poster A

Systematic investigation of lipids on a titanium layer on the incubation time in water and in growth medium via x-ray reflectometry — •Anahita Shahin[1], Dieter Lott[1], Regine Willumeit[1], Bérengère Luthringer[1], Alexander Grünwald[2], and Andreas Schreyer[1] — [1]Helmholtz-Zentrum Geesthacht, Max-Planck-Str. 1, 21502 Geesthacht — [2]II. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, 50937 Köln

Soft matter is increasingly investigated with x-ray scattering during the last years for the detailed structural characterization of this important class of samples. In particular it provides a valuable contribution to the area of medical physics, for instance for the optimization of implants. In this work in-situ x-ray reflectometry and diffraction under small angles is used to analyze the structural properties of lipid bilayers under a variety of conditions. Particular attention is paid to a solid-supported membrane system in which a 70 nm titanium layer deposited on a silicon substrate is coated by lipids. The main objective is to analyze how many lipid bilayers can be attached to the solid titanium layer and how the number of layers changes upon the incubation time in growth medium (Dulbecco's Modified Eagle's Medium (DMEM)) and in water. Here we concentrate on time-dependent measurements to find the optimal incubation time for the lipids in the different media. The combination of experiments and simulation of the scattering data is a valuable tool to understand the ordering and time dependence.

BP 8.6 Mon 17:30 Poster A

Tissue growth as mass generation in a linear elastic medium — •Niko Komin, Lars Ole Schwen, and Tobias Preusser — Fraunhofer MEVIS, Bremen, Germany

The liver as a major metabolic organ fulfils a huge variety of vital metabolic tasks in a mammalian organism. Its great ability to regenerate after injury allows for the transplantation of a large part of the organ from a living donor to a recipient in need. Liver mass and function is restored within a matter of months after operation.

In the talk we will present the regeneration process as the generation of mass (tissue) within a linear elastic medium. Cell proliferation depends on nutrition via the regrowing vascular structure and the topology of the vascular structure is governed by optimization criteria. We will present modelling techniques and results.

BP 8.7 Mon 17:30 Poster A

Basic investigation of skin under Plasma treatment — •Marcel Marschewski[1], Joanna Hirschberg[2], Tarek Omairi[2], Oliver Höfft[3], Steffen Emmert[4], Wolfgang Viöl[2], and Wolfgang Maus-Friedrichs[1] — [1]IEPT, TU Clausthal, Leibnizstr. 4, 38678 Clausthal-Zellerfeld, Germany — [2]Fakultät Naturwissenschaft und Technik Hochschule für angewandte Wissenschaft und Kunst Hildesheim/Holzminden/Göttingen, Von-Ossietzky-Str. 99, 37085 Göttingen, Germany — [3]IMV, TU Clausthal, Arnold-Sommerfeld-Str.

6, 38678 Clausthal-Zellerfeld, Germany — [4]Department of Dermatology, Venerology and Allergology Georg-August-University Göttingen, Robert-Koch-Strasse 40, 37075 Göttingen, Germany

The lipids of the stratum corneum loom large for the barrier function of human skin. Recently several important findings related to mutations of the fillaggrin-gen and according to this, diseases like ichthyose and atopic dermatitis were made but not yet completely understood. Cold plasma treatment on e.g. skin diseases causes in an abatement of diseases by the assured disinfected effect of plasma [1]. Here, we present our first results on the basic investigation of skin, studied with X-ray photoelectron spectroscopy. We have prepared our samples by using current skin glue which is usually used for cut closure. Furthermore we have investigated the change in plasma treated skin samples to understand the basic effects of plasma treatment of biological systems.

[1] Morfill G E, Shimizu T, Steffes B and Schmidt H-U 2009 Nosocomial infections - a new approach towards preventive medicine using plasmas New Journal of Physics 11, 115019

BP 8.8 Mon 17:30 Poster A

Moderate Swelling of Type I Collagen Fibrils in Humid Air — •Eike-Christian Spitzner, Stephanie Röper, and Robert Magerle — Chemische Physik, TU Chemnitz, D-09107 Chemnitz, Germany

We investigate purified type I collagen extracted from bovine hide. In aqueous solution, triple helices of collagen molecules (tropocollagens) form fibrils driven by hydrogen bonding processes. Single collagen fibrils, deposited on a silicon substrate, were exposed to air with controlled relative humidity (RH). We used in-situ multi-setpoint intermittent contact mode atomic force microscopy for imaging the collagen fibrils at 20% RH, during moderate swelling at 80% RH, as well as dried again at 20% RH. Changes in the mechanical properties of the characteristic D-band structure were observed. At 20% RH, the typical 67 nm spacing appears in the shape of the fibril, whereas at moderate swelling (80% RH) it is visible as a periodic variation of local material properties. Furthermore, in parts of the fibrils, where no D-band structure was observed in the initial state, reconfigurations take place during swelling, which we attribute to a phase transition in the liquid crystalline alignment of the tropocollagen units.

BP 8.9 Mon 17:30 Poster A

Characterization of Protein Films on Dental Materials — •Fabian Kratz[1], Nils Körber[1], Christine Müller[1], Natalia Umanskaya[2], Matthias Hannig[2], and Christiane Ziegler[1] — [1]Department of Physics and Research Centre OPTIMAS; University of Kaiserslautern; D-676632 — [2]Clinic of Operative Dentistry, Clinic of Operative Dentistry, Periodontology and Preventive Dentistry, University Hospital, Saarland University, D-66424

In dentistry a greater knowledge of protein film establishment processes is of high concern, because protein films are the basis for bacterial adhesion. Especially in the human mouth caries is a consequence of a biofilm. The ambition is to characterize protein films on model materials and continuative on dental relevant materials like titanium, gold, natural enamel, PMMA and PTFE under the influence of dental relevant parameters (like pH and the roughness of the material) by using different surface science methods in combination with biochemical assays. The thickness of the protein films, measured by ellipsometry and scanning force microscopy (SFM), corresponds to the size of the protein molecules. This hypothesizes a monolayer adsorption process.. The combination with biochemical methods like BCA assay and enzymatic activity determines the adsorbed amount of protein and its activity in the case of lysozyme. An influence of the surface roughness, the pH value and the surface material on the adsorbed amount is observed by BCA assay. As a function of the surface material and the pH (thus carious conditions) the enzymatic activity differs.

BP 8.10 Mon 17:30 Poster A

Influence of subsurface properties on proteins, bacteria and geckos: Is adhesion superficial? — •Peter Loskill[1], Hendrik Hähl[1], Jonathan Puthoff[2], Kellar Autumn[2], and Karin Jacobs[1] — [1]Saarland University, Experimental Physics, D-66041 Saarbrücken, Germany — [2]Department of Biology, Lewis & Clark College, Portland, OR 97219, USA

Understanding and controlling the adhesion of biological objects to inorganic surfaces are important tasks that find application in various topics such as in the development of antimicrobial surfaces or artificial adhesives. To characterize biological adhesion, most studies describe a substrate solely by its surface properties. The composition of the material beneath the surface is frequently overlooked. That way, long-range van der Waals (vdW) interactions are disregarded. Previous studies revealed that microscopic biological objects such as proteins are affected by vdW interactions. We could show now that mesoscopic and even macroscopic objects are also influenced by differences in the microscopic interface potential. By using tailored silicon wafers with variable silicon dioxide layer thickness, we were able to tune the vdW part of the interface potential independently of the surface properties. On these substrates, we performed adhesion measurements with bacteria of the Staphylococcus genus and with a species of tropical gecko. The bacterial adhesion was explored via atomic force microscopy in the forces spectroscopy mode, using cantilevers on which living bacteria were immobilized. To characterize the gecko adhesion, we mimicked the typical gecko movement with a custom mechanical testing platform.

BP 8.11 Mon 17:30 Poster A

Understanding the Basis of Nacre Formation: Instabilities and Pattern Formation in Growing Polymer Brushes — •Björn Nadrowski[1], Ingrid Weiss[2], and Karsten Kruse[1] — [1]Theoretische Physik, Universität des Saarlandes, 66123 Saarbrücken, Germany — [2]Leibniz-Institut für Neue Materialien, 66123 Saarbrücken, Germany

Nacre is strong, resilient and beautiful. It is a composite material consisting of layers of biominerals such as aragonite and organic molecules such as chitin. It is thought that the particular mechanical properties of nacre are due to its composite nature and the microstructure of the arrangements of aragonite platelets and the softer organic layers in-between those platelets[1]. Formation of nacre starts with the secretion of chitin into the extrapallial space[2]. The secretion process itself might be of importance for the ensuing microstructure of the nacre-in-being. Inspired by this biological-physical background, we study instabilities and pattern formation in growing polymer brushes. Using analytical and computational approaches, we study the different structures and instabilities that can be observed depending on polymer growth velocity, pore density, bending rigidity, and monomer interaction strength.

[1] Currey, J. D. et al.,Proc Biol Sci **268** (2001) 107.
[2] Weiss, I. M., Chembiochem **11** (2010) 297.

BP 8.12 Mon 17:30 Poster A

Preparation of dense hydroxyapatite samples for surface science application — •Christian Zeitz[1], Deniz Kahraman[2], Samuel Grandthyll[1], Frank Müller[1], Jörg Schmauch[1], and Karin Jacobs[1] — [1]Saarland University, Experimental Physics, D-66041 Saarbrücken, Germany — [2]KIT, Ceramics in Mechanical Engineering, D - 76131 Karlsruhe, Germany

Hydroxyapatite (HAP) is a conflicting material: On the one hand, HAP is greatly available in nature as bone or tooth mineral material, but, on the other hand, these natural samples only hardly fulfill the needs of science concerning chemical composition or structural simplicity. Therefore and because the material has important influence in physiology, this study aims for a preparation method for artificial HAP samples of high density. In order to make available the basic interactions, best possible homogeneity and chemical purity is achieved as well as structural smoothness. A thorough characterization of the samples is presented together with some results of an investigation of the effects of fluoridation.

BP 8.13 Mon 17:30 Poster A

Microrheology in syncytial Drosophila embryos — •Alok D. Wessel[1], Takuma Kanesaki[2], Jörg Grosshans[2], and Christoph F. Schmidt[1] — [1]Drittes Physikalisches Institut, Georg-August-Universität Göttingen, Göttingen, Germany — [2]Zentrum für Biochemie und Molekulare Zellbiologie, Universitätsmedizin, Georg August-Universität, Göttingen

In early development, Drosophila melanogaster embryos are in a syncytial stage, i.e. multiplying nuclei are not yet separated by membranes, but are interconnected by cytoskeletal polymer networks consisting of actin and microtubules. Between division stages 9 and 13, nuclei and the cytoskeletal network form a 2D cortical layer. We characterize the mechanical properties of this composite network and spatial variations across nuclear compartments as well as temporal variations over the nuclear division cycles via high-speed video-microrheology. We record position fluctuations of injected micron-sized beads with a high-speed camera at sampling frequencies up to tens of kHz. From single-particle dynamics and from multi-particle correlations we can

compute viscoelastic material properties.

BP 8.14 Mon 17:30 Poster A

Mechanically Tunable Composite Hydrogels as Biomimetic Matrices — •Christina Jayachandran[1], Christoph Schmidt[2], and Florian Rehfeldt[3] — [1]3rd Institute of Biophysics,Georg-August Universität,Göttingen,Germany — [2]3rd Institute of Biophysics,Georg-August Universität,Göttingen,Germany — [3]3rd Institute of Biophysics,Georg-August Universität,Göttingen,Germany

In vivo cells face various micro-environments which differ significantly both in their physical and biochemical properties and the extra cellular matrix (ECM) plays a key role in providing these cues. Mimicking these diverse environments in vitro, is necessary to understand the fundamental processes that govern cell matrix interactions and also of paramount importance for medical applications, e.g. regenerative medicine. The standard methods of preparing elastic matrices employ homogenous polyacrylamide (PA) gels or PDMS rubber substrates coated with extracellular matrix proteins to facilitate adhesions.

Our strategy is based on hybrid matrices composed of an isotropic hyrdogel and a fibrous protein scaffold to better mimic the in vivo niche. Contrary to the conventional substrates which exhibit a linear response, these matrices show non- linear elastic behaviour characteristic of biopolymers and tissues. We study the mechanical properties of these novel substrates by bulk rheology and atomic force microscopy and also discuss the differential cellular response of cells to them compared to conventional PA gels.

BP 8.15 Mon 17:30 Poster A

Untersuchungen zur Biostabilität eines implantierbaren Glucosesensors — •Marlen Froehlich, Karl-Ernst Ehwald, Philipp Kulse, Oksana Fursenko, Jens Katzer und Mario Birkholz — IHP - Leibniz-Institut für innovative Mikroelektronik, Im Technologiepark 25, 15236 Frankfurt (Oder)

Es wurde ein Biosensorchip, der für die Verwendung in einem implantierbaren Glucosemonitor vorgesehen ist, in Hinblick auf seine Stabilität in biologischen Milieus untersucht. Der Sensorchip wurde in der Pilotlinie des IHP in einer CMOS/BiCMOS-Technologie gefertigt. Er arbeitet mit einem mikroelektromechanischen System und funktioniert nach dem Prinzip der Affinitätsviskosimetrie. Die Untersuchungen erfolgten durch Exposition der Chips in verschiedenen Modell-Lösungen und Vorher-Nachher-Vergleiche, wobei die auftretenden Schadensprofile mit optischer Mikroskopie, Ellipsometrie und AFM bestimmt wurden. Es erfolgten in vitro und in vivo Tests, wobei die ersten der Methodenentwicklung dienten. Dazu wurden Waferbruchstücke für den Zeitraum von Wochen in körpermilieuartigen Lösungen eingebracht. Eine in vivo Untersuchung an einem menschlichen Probanden ermöglichte eine dem Einsatzgebiet entsprechende Analyse der Teile des Mikroviskosimeters, die der Körperflüssigkeit ausgesetzt waren. Es wurden nur geringe Änderungen von Schichtdicke und Rauheit beobachtet. Der stärkste Effekt betraf die SiON-Passivierung mit einer Abbaurate von rund 50 nm/Monat. TiN zeigte keinen Abbau durch Biokorrosion. Danach ist zu erwarten, dass die Sensorchips für einen Zeitraum von mindestens zwölf Monaten stabil im menschlichen Gewebe arbeiten.

BP 8.16 Mon 17:30 Poster A

Lipid-Coated Implant Materials under Load — •Martin Kreuzer[1,2], Matthias Reinhardt[2], Markus Strobl[3], Jochen Stahn[4], Maksym Golub[5], Regine Willumeit[5], Reiner Dahint[1], and Roland Steitz[2] — [1]Universität Heidelberg, Deutschland — [2]Helmholtz-Zentrum Berlin, Deutschland — [3]European Spallation Source, Schweden — [4]Paul-Scherrer Institut, Schweiz — [5]Hemholtz-Zentrum Geesthacht, Deutschland

In the last decade, the search for biocompatible materials has become a major topic in medical research. In that context coating of implants by lipid layers seems an obvious strategy for achieving better acceptance of the implant in the human organism. The combination of suitable metallic implants with lipid coverage is most promising for forthcoming implant modifications. Here, one of the fundamental requirements is the reliable preparation of stable lipid coatings on the implant surfaces. We investigated the stability of oligolamellar lipid bilayers prepared by spin coating on silicon discs and titanium-coated silicon substrates against an excess water phase under shear load by neutron reflectivity. We evaluated a critical temperature region at which a stack of DMPC lipid bilayers detaches from titanium-coated and bare silicon surfaces, respectively, against heavy water under shear load. The critical temperature region coincides with the main phase transition temperature of DMPC in excess heavy water. The experimental setup made it possible to follow the unbinding process on a molecular scale. Our experiments did not show a significant difference between the lipid coatings on bare silicon and titanium coated silicon supports.