BP 29: Posters: Biopolymers & Biomaterials

Time: Thursday 17:15–20:00 Location: P3

BP 29.1 Thu 17:15 P3

Plasma-chemical oxidation of titanium implants enhances peri-implant bone volume and bone-implant contact in a rat model — •Christian Schrader[1], Michael Diefenbeck[2], Sergiy Zankovych[3], and Ulrich Finger[4] — [1]Innovent e.V. Technologieentwicklung, Jena, Germany — [2]Universitätsklinikum, Jena, Germany — [3]Institut für Materialwissenschaft und Werkstofftechnologie, Jena, Germany — [4]Königsee Implantate GmbH, Aschau, Germany

Orthopaedic and dental implants rely on an early force-fit bonding to the host bone for good clinical outcome. The implant anchorage has two structural components: Bone-implant bonding (osseointegration [OI]) and peri-implant trabecula bone [PIB]. OI is established by trabecular conjunctions with the PIB, which bridge the implant to the bony cortex and lead to a structural unit between implant and skeleton. Though several approaches to enhance OI and PIB-formation have been used with good results some stimuli still might bear the risk of complication. Our approach is to modify the titanium surface of the implant by Plasma Chemical Oxidation. It is a processing technique in which the surface of the implant is converted into an oxide coating. The coatings presented in this paper not only serve as a diffusion barrier they are also supplemented with useful compounds to assist early OI and to fulfil biocompatible features besides bio-inert ones related to optimised surface properties. It is now confirmed by in vivo testing with a modified rat tibial implantation model and its bilateral implantation of titanium cylinders. Future project plans include investigations into functional coatings providing antibacterial properties.

BP 29.2 Thu 17:15 P3

Combining microfluidics and SAXS to access intermediate filament assembly — •Martha Brennich[1], Jens Nolting[1], Christian Dammann[1], Bernd Nöding[1], Susanne Bauch[1], Harald Herrmann[2], and Sarah Köster[1] — [1]Courant Research Centre Nano-Spectroscopy and X-Ray Imaging, University of Göttingen, Germany — [2]Division of Molecular Genetics, German Cancer Research Center (DKFZ), Heidelberg, Germany

In cells, intermediate filaments (IFs) form a complex network that is part of the cytoskeleton.Vimentin is a member of the IF multi-gene family which is found in cells of mesenchymal origin like fibroblasts. We use this model system to study the first steps of the hierarchical self-assembly of protein-subunits to extended filaments *in vitro* upon changes in the concentration of monovalent ions. In microfluidic laminar flow mixers the ion concentration can be precisely adjusted by tuning the diffusion time scales of ions into a hydrodynamically focused protein jet. We determine the ion and protein concentration distributions by confocal microscopy and finite element method simulations. As the protein in the device flows along one spatial axis, the time axis for the assembly process is projected onto the protein flow axis and we observe different assembly states by collecting data at different positions in the device. We find that the mean square radius of gyration perpendicular to the filament axis increases as the precursor proteins aggregate laterally. This increase occurs on the same timescale (seconds) as the diffusion of salt into the protein jet indicating a diffusion limit to the reaction rate.

BP 29.3 Thu 17:15 P3

Effect of bias voltage on wear particle size distribution of DLC coatings in artificial hip joints — •Ying Ren[1], Ingo Erdmann[1], Friederike Deuerler[1], Berrin Küzün[2], and Volker Buck[2] — [1]Faculty D-Department of Mechanical Engineering, University of Wuppertal, — [2]Thin Film Technology Group, Faculty of Physics, University Duisburg-Essen and CeNIDE, 47057, Duisburg, Germany

Due to the biocompatibility, DLC is an inert and impervious material with properties suitable for use in the biomedical field, particularly in tribological implants such as hip joint replacements. Currently the lifetime of such joints is just about 15 years. Therefore some (10%) of patients require second replacements. It is currently an urgent need to extend the life expectancy especially for younger patients under 50 years old. Wear particles causing bone resorption which may lead to aseptic implant loosening have been identified as the main factor limiting the lifetime of the implants. To date, the study of the amount of wear particles has attracted more and more researchers. However, reports about wear particle size distribution are rare to see. In this study, we deposited DLC coatings on P2000 steel substrates by vacuum arc adjustable from anodic to cathodic operation mode, and investigated the relation between the deposition parameters and wear particle size distribution. In order to improve the adhesion of DLC coatings on P2000 steel substrates, titanium metallic interface layers are deposited first by cathodic vacuum arc evaporation. It is shown that the wear particle size distributions are influenced by the deposition parameters.

BP 29.4 Thu 17:15 P3

Temperature-dependent Properties of Keratin 8/18 — •Ines Martin[1], Anke Leitner[1], Stephanie Portet[2], Michael Beil[3], Harald Herrmann[4], and Othmar Marti[1] — [1]Department of Experimental Physics, Ulm University, Ulm, Germany — [2]Department of Mathematics, University of Manitoba, Winnipeg, Canada — [3]Department of Internal Medicine I, Ulm University, Ulm, Germany — [4]Division of Molecular Genetics, German Cancer Research Center, Heidelberg, Germany

The cytoskeleton of epithelial cells consists of three types of filaments: microtubules, intermediate filaments and actin filaments. In our work, we have a closer look at intermediate filaments, which are responsible for the stiffness of cells and responses to mechanical stimuli.

The Keratin 8/18 dimer is a basic module of intermediate filaments. Its assembly process is a three step process which is highly sensitive to temperature changes and has very interesting kinetics. Therefore we assembled it in vitro at different temperatures (4°C, 21°C, 30°C, 37°C) and for different durations (10s, 1min, 10min, 20min). The resulting filaments were diluted to a suitable concentration for detection of single filaments and imaged with the help of Transmission Electron Microscopy. The samples were negatively stained with Uranylacetate to enhance the contrast.

With these pictures, the length and diameter of filaments of the different samples were measured and compared by fitting to existing models.

BP 29.5 Thu 17:15 P3

Effect of bias voltage on wear particle size distribution of DLC coatings in artificial hip joints — •Ying Ren[1], Ingo Erdmann[1], Friederike Deuerler[1], Berrin Küzün[2], and Volker Buck[2] — [1]Faculty D-Department of Mechanical Engineering, University of Wuppertal, 42119, Wuppertal, Germany — [2]Thin Film Technology Group, Faculty of Physics, University Duisburg-Essen and CeNIDE, 47057, Duisburg, Germany

Due to the biocompatibility, Diamond-like carbon(DLC)is an inert and impervious material with properties suitable for use in tribological implants such as hip joint replacements. Currently the lifetime of such joints is just about 15 years. It is an urgent need to extend the life expectancy especially for younger patients under 50 years old. Wear particles causing bone resorption which may lead to aseptic implant loosening have been identified as the main factor limiting the lifetime of the implants. To date, the study of the amount of wear particles has attracted more and more researchers. However, reports about wear particle size distribution are rare to see. In this study, we deposited DLC coatings on P2000 steel substrates by vacuum arc adjustable from anodic to cathodic operation mode, and investigated the relation between the deposition parameters and wear particle size distribution. In order to improve the adhesion of DLC coatings on P2000 steel substrates, titanium metallic interface layers are deposited first by cathodic vacuum arc evaporation. It is shown that the wear particle size distributions are influenced by the deposition parameters.

BP 29.6 Thu 17:15 P3

Effect of bias voltage on wear particle size distribution of DLC coatings in artificial hip joints — •Ying Ren[1], Ingo Erdmann[1], Friederike Deuerler[1], Berrin Küzün[2], and Volker Buck[2] — [1]Faculty D-Department of Mechanical Engineering, University of Wuppertal, 42119, Wuppertal, Germany — [2]Thin Film Technology Group, Faculty of Physics, University Duisburg-Essen and CeNIDE, 47057, Duisburg, Germany

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BP 29.7 Thu 17:15 P3

Volume imaging of collagen fibrils within human cortical bone — •Stephanie Röper[1], Alexander M. Gigler[2], Christian Riesch[1], Anke Bernstein[3], and Robert Magerle[1] — [1]Chemische Physik, Technische Universität Chemnitz, 09107 Chemnitz — [2]CeNS und Dept. für Geo- und Umweltwissenschaften, Ludwig-Maximilians-Universität München, 80333 München — [3]Dept. für Orthopädie und Unfallchirugie, Muskulosketettales Forschungslabor, Universitätsklinikum Freiburg, 79106 Freiburg

Biological materials such as bone and teeth are nanocomposites of a soft organic matrix (mainly type I collagen) that is reinforced by a stiff inorganic component (hydroxylapatite). Nanotomography based on scanning probe microscopy is a serial reconstruction approach for high resolution volume imaging of these materials. A specimen cut from human cortical bone from the femur was first mechanically grinded and polished, then layer-by-layer ablated by etching with diluted solutions of formic acid and sodium hypochlorite, followed by flushing to stop the etching process, and imaged with tapping mode scanning force microscopy (SFM) after each etching step. The resulting series of SFM images show the arrangement of collagen fibrils with the typical periodic D-band pattern with 67 nm period. A high resolution volume image of the spatial arrangement of collagen fibrils within native cortical bone can be reconstructed by registration of neighboring slices. The interpretation of SFM data is supported by results obtained with confocal laser scanning Raman spectroscopy and environmental scanning electron microscopy with energy dispersive X-ray spectroscopy.

BP 29.8 Thu 17:15 P3

Enhancing mechanical properties of calcite by Mg substitutions: A quantum-mechanical study — •Pavlina Elstnerova[1], Martin Friak[1], Tilmann Hickel[1], Helge Otto Fabritius[1], Dierk Raabe[1], Andreas Ziegler[2], Sabine Hild[3], and Joerg Neugebauer[1] — [1]Max-Planck-Institut for Iron Research, Duesseldorf, Germany — [2]University of Ulm, Ulm, Germany — [3]Johannes Kepler University Linz, Linz, Germany

Nearly 90 percent of all animal species in nature protect themselves by a cuticle that represents a hierarchical biocomposite often containing calcite as a mineral stiffening component. Calcite crystals rarely occur in their stoichiometric state and contain impurities. Common impurities in these systems are Mg or P, their role however is still the topic of intense debates. We present results of a parameterfree quantummechanical study of thermodynamic, structural, and elastic properties of calcite single crystals containing Mg atoms. Density functional theory calculations were performed employing 30atomic supercells within the generalized gradient approximation (GGA). Based on the calculated thermodynamical results, the site preference of Mg atoms was determined. Examining the structural characteristics, the behavior of the carbonate group is shown to be nearly independent on either the volume or concentration of Mg atoms. Based on the computed elastic values, the Mg atoms are predicted to stiffen the calcite crystals, specifically to increase the bulk modulus, but also to increase local strains due to the large sizemismatch when substituting Ca atoms by Mg ones (Elstnerova et al., Acta Biomaterialia 6 (2010) 4506-4512).

BP 29.9 Thu 17:15 P3

Cooperative dynamics of microtubule ensembles under force — •Björn Zelinski[1] and Jan Kierfeld[2] — [1]Physics Department, TU Dortmund, Dortmund, Germany — [2]Physics Department, TU Dortmund, Dortmund, Germany

We investigate the cooperative dynamics of an ensemble of microtubules growing against an external linear force. Stochastic simulations show that the interplay between force sharing and dynamic instability gives rise to a complex dynamics with synchronous growth, interrupted by cooperative switching into a shrinking state and cooperative rescue back to synchronous growth. We quantify the dynamic behaviour by a mean-field theory, which allows us to estimate the average number of cooperatively pushing microtubules and to calculate the generated ensemble polymerization force and its dependence on microtubule number. We also investigate the dependence on switching rates of the dynamic instability, which can be involved in cellular regulation mechanisms.

BP 29.10 Thu 17:15 P3

Microrheology of composite networks of microtubules and F-actin — •Marcel Bremerich[1], Frederick C. MacKintosh[2], and Christoph F. Schmidt[1] — [1]3. Physikalisches Institut, Georg-August-Universität, 37077 Göttingen — [2]Department of Physics & Astronomy, Vrije Universiteit , 1081 HV Amsterdam

Understanding the material properties of living cells remains challenging. The mechanics are determined by the viscoelastic properties of the cytoskeleton, which is composed of various biopolymer filaments together with associated proteins and vary over large spatial and temporal scales.

In optical trapping-based microrheology micron-sized probe particles are used to investigate the local mechanical response of reconstituted networks of biopolymers with high bandwidth and high spatial resolution.

We have performed one- and two-particle microrheology in composite networks of microtubules and F-actin as model systems for the cytoskeleton. We used a combination of active and passive measurements to quantify the material properties over a wide frequency range of up to 100 kHz. We obtained complex shear moduli and compared the results to theoretical descriptions of composite networks as well as to the properties of similar networks consisting only of microtubules or F-actin respectively.

BP 29.11 Thu 17:15 P3

Length Dynamics of Active Polar Filaments — •Christoph Erlenkämper and Karsten Kruse — Theoretische Physik, Universität des Saarlandes, 66123 Saarbrücken, Germany

F-actin and microtubules are linear polymers with distinct chemical properties at both ends. Assembly and disassembly of these polar filaments are active processes as they depend on the hydrolysis of energy rich ATP or GTP, respectively. Together, the polarity and the activity of the filaments can lead to treadmilling, where one end of the filament grows on average while the other shrinks. We theoretically study the length dynamics of active polar filaments and find that the steady-state length distribution peaks at a typical value. We show that the intrinsic length regulation is intimately linked to treadmilling as both depend on the formation of a gradient in the local ATP or GTP concentration along the filaments. We present approximate expressions for the typical filament lenghts and treadmilling velocities.

BP 29.12 Thu 17:15 P3

Measured and simulated valence band structure of cellulose and lignin — •Thomas Haensel[1], Syed Imad-Uddin Ahmed[1,2], and Markus Reinmöller[1] — [1]Institut für Physik and Institut für Mikro- und Nanotechnologien, TU Ilmenau, PF 100565, 98684 Ilmenau — [2]Ostfalia University of Applied Sciences, 38302 Wolfenbüttel

The regenerative biopolymers cellulose and lignin are available in large quantities. This makes them attractive for technical applications. Cellulose is used, for e.g. in the paper and textile as well as medical industry and in modern electronic devices. In the latter case they are utilized in batteries and solar cells as chemically inert isolating materials. In comparison, lignin is a waste product of the paper industry and is mainly used as fuel in combustion processes. It is also used as a filler in polymer compounds and applications in electronic devices are also targeted. While the structure and chemical composition of cellulose and lignin are well established, the molecular orbitals and valence band structures, which are important for understanding the electric properties, have not been thoroughly investigated. In this contribution, X-ray photoelectron spectroscopy (XPS) measurements of cellulose and lignin are combined with density functional theory (DFT) calculations of the basic units from cellulose and lignin to analyze their orbital and valence band structures. In particular, a structure at about 6 to 8 eV therein is attributed to oxygen rather than to carbon, as reported in literature. The results further indicate a significant dependence of the electronic properties on cross-linking and chemical processes leading to polymerisation.

BP 29.13 Thu 17:15 P3

The influence of van der Waals forces on protein adsorption kinetics — •Almuth Hoffmann, Hendrik Hähl, and Karin Jacobs — Department of Experimental Physics, Saarland University, D-66041 Saarbrücken, Germany

In contact with an aqueous solution of proteins, any surface is instantly covered by a thin layer of proteins. It is of great interest for many biological and biomedical applications to understand and control this adsorption process that depends on many parameters.

Concentrating on the influence of the substrate on the adsorption, the surface chemistry has been focus of many studies. Protein adsorption is mainly influenced by short-range forces arising from the surface chemistry and Coulomb interaction. Yet, it could be shown that van der Waals forces influence the adsorption kinetics. By a variation of the oxide layer thickness on a Si wafer, however, it could be shown that also van der Waals forces influence the adsorption kinetics [1,2].

Monte Carlo simulations explain the kinetics with a multi step process composed of the actual adsorption and subsequent surface processes. These simulations suggest that a variation of the van der Waals forces influences the time constant of the surface processes. Fitting the experimental curves with an appropriate model yields the time constants of the various processes involved and shows the influence of the vdW forces.

[1] A. Quinn et al., *EPL* **81** (2008) 56003.
[2] Y. Schmitt, H. Hähl et al., *Biomicrofluidics* **4** (2010) 032201.

BP 29.14 Thu 17:15 P3

Cyclic contraction of regenerated *Bombyx mori* silk fibroin nanofibers — Taiyo Yoshioka[1], Aurel Radulescu[2], Yutaka Kawahara[3], and •Andreas Schaper[1] — [1]Center for Materials Science, Philipps University, 35032 Marburg, Germany — [2]Department of Biological and Chemical Engineering, Gunma University, Gunma 376-8515, Japan — [3]Jülich Centre for Neutron Science at FRM II, 85747 Garching, Germany

Spider dragline silk is known to show significant shrinking (supercontraction) when the fiber is wetted under unrestrained conditions, restraining generates substantial stress (ca. 50MPa) accordingly. In addition to the irreversible supercontraction, a reversible (cyclic) relaxation-contraction response to wetting and drying has been found. By contrast, similar supercontraction has so far not yet been observed in natural *Bombyx mori* silk, but occurred in regenerated silk when a special spinning regime was applied.

We report first observations of cyclic contraction by EtOH and water vapour treatment of electrospun nanofibers of regenerated *Bombyx mori* silk fibroin. Mechanical measurements and time-resolved microscope observations showed that the contraction behavior is significantly influenced by the structural state of the original fibers. This was proved by scanning and transmission electron microscopy and diffraction, wide-angle x-ray diffraction and small-angle neutron scattering. From our observations we derived a tentative model of the irreversible and the cyclic contraction mechanisms.

T.Y. is grateful to AvH Foundation for a fellowship.

BP 29.15 Thu 17:15 P3

Rule of mixing in composite cytoskeletal networks — •C. Heussinger[1], E.M. Huisman[2], C. Storm[3], and G.T. Barkema[2,4] — [1]Institute for Theoretical Physics, University of Goettingen, Germany — [2]Instituut Lorentz, Universiteit Leiden, The Netherlands — [3]Department of Applied Physics and Institute for Complex Molecular Systems, Eindhoven University of Technology, The Netherlands — [4]Institute for Theoretical Physics, Universiteit Utrecht, The Netherlands

The basic design of most structural biological materials is that of a composite meshwork of different semiflexible protein polymers. The cell cytoskeleton, built up from microtubules, actin filaments and intermediate filaments, is just one striking example of such a filamentous composite. Here we study the mechanical properties of a model two-component system that consists of two types of filaments with different bending stiffnesses. Combining theory with network MC-simulations we can reveal a non-trivial relationship between the mechanical behavior of the network, the stiffness contrast between the filaments and the relative fraction of stiff polymer: when there are few stiff polymers, non-percolated stiff "inclusions" are protected from large deformations by an encompassing floppy matrix, while at higher fractions of stiff material the stiff network is independently percolated and dominates the mechanical response.

BP 29.16 Thu 17:15 P3

Instabilities of active gels confined by a fluid membrane — •Dominic Jourdain and Karsten Kruse — Theoretische Physik, Universität des Saarlandes, Postfach 151150, 66041 Saarbrücken, Germany

From a physical point of view, the cytoskeleton can be viewed as an active gel. Various theoretical analysis have shown that such a material can display instabilities, provided that the activity exceeds a critical threshold. Cellular systems are usually confined by lipid membranes. We are interested in the influence of such membranes on the dynamics of the cytoskeleton. As a simple example, we analyse the stability of an active gel inside a membrane tube. To this end, we use a multi-component hydrodynamic description that captures the behaviour of active gels on macroscopic length and time scales. We find that the active stresses in the gel can induce a pearling-like instability of the tube and determine the dependence of the activity threshold on parameters characterising the membrane.

BP 29.17 Thu 17:15 P3

Artificial biopolymer networks with optically trapped anchor points — •Matthias Koch, Dominic Ruh, and Alexander Rohrbach — University of Freiburg, Georges-Koehler-Allee 102, 79110 Freiburg, Germany

Microtubules are biopolymers which self-organize over a large spatial and temporal scale in living cells as a response to a variety of external stimuli. Most of the highly complex intracellular processes like cell-division or mechanotransduction are based on microtubule networks. The mechanical properties of single biopolymers like actin filaments or microtubules have already been studied in a wide context. However, the exploration of a coordinated, two dimensional microtubule network has not been studied so far.

Optical tweezers allow generating an array of anchor points for artificial polymer networks consisting of fluorescently labelled microtubule filaments attached to optically trapped 1μm spheres. We aim at building up such networks using time-multiplexed optical traps for both 3D force generation and measurements. Thereby, the trapping laser focus, steered by an acousto-optic deflector, is displaced in the focal plane of a photonic force microscope at a rate of up to 50 kHz in order to create multiple (up to 40) time shared optical traps. The positions of the trapped particles can be evaluated using back focal plane interferometry, allowing resolving momentum propagation through the microtubule network. This configuration will allow probing the viscoelastic properties of biopolymers and obtain deeper insights in their complex interaction as part of the cytoskeleton.

BP 29.18 Thu 17:15 P3

Van der Waals forces and their influence on the structure of protein adsorbates — •Hendrik Hähl[1], Florian Evers[2], and Karin Jacobs[1] — [1]Department of Experimental Physics, Saarland University, D-66041 Saarbrücken, Germany — [2]Faculty of Physics/DELTA, TU Dortmund, D-44221 Dortmund, Germany

The adsorption of proteins from aqueous solution to surfaces is an omnipresent phenomenon. Common examples for which adhesion control is of utmost importance are biomedical applications such as implants or artificial tissues. The adsorption process itself, however, is still not fully understood. In our study, we concentrate on the interactions present between proteins and substrate.

In former studies, it could already been shown that a variation of subsurface composition of the substrate may lead to altered adsorption kinetics [1]. Here, we present X-ray studies that reveal the *in situ* structure of the adsorbed protein layers. By a judicious choice of substrates, we could separate the influence of surface and underlying material on the adsorbing proteins. Additionally, proteins with different isoelectric points and conformational stability as well as different buffer solutions were used in order to separate the influence of the various interactions involved. The strong difference of protein film structure on hydrophobic and hydrophilic substrates—as expected from literature—could clearly be seen. Yet, even differences in subsurface composition altered the properties of the adsorbates demonstrating the influence of the van der Waals interactions.

[1] Y. Schmitt, H. Hähl et al. *Biomicrofluidics* **4** (2010) 032201.

BP 29.19 Thu 17:15 P3

Investigation of the nanomechanical properties of in vitro assembled Keratin 8/18 networks — •Anke Leitner[1], Tobias Paust[1], Kirsten Dammertz[1], Harald Herrmann[2], Michael Beil[3], and Othmar Marti[1] — [1]Institute of Experimental Physics,

Ulm University, Ulm, Germany — [2]Division of Molecular Genetics, German Cancer Research Center, Heidelberg, Germany — [3]Department of Internal Medicine I, Ulm University, Ulm, Germany

The mechanical properties of epithelial cells are mainly determined by the cytoskeleton. The cytoskeleton consists of three different protein networks: Microtubules, the transport pathways of the cell, actin filaments, responsible for the cell motility, and intermediate filaments that provide the stiffness and response to mechanical stimuli. In pancreatic cancer cells especially the keratin cytoskeleton plays a major role. In order to find out more about its mechanical properties it is useful to have a look on in vitro assembled keratin filaments. In the work presented here we investigate the mechanical properties of in vitro assembled keratin 8/18 networks in different polymerisation conditions. For this purpose we use microrheology measurements with embedded tracer beads. Observing the beads motion with a CCD-High-Speed-Camera then leads to the dynamic shear moduli. From electron microscopy images we calculated the meshsize and connectivity of the different network structures and link these results to the mechanical properties of the different networks.

BP 29.20 Thu 17:15 P3

Mechanically Tunable Hydrogels as Biomimetic Matrices — •Christina Jayachandran[1] and Florian Rehfeldt[2] — [1]Drittes Physikalisches Institut, Georg-August-Universität Göttingen, Germany — [2]Drittes Physikalisches Institut, Georg-August-Universität Göttingen, Germany

Cells face various micro-environments in vivo that differ significantly both in physical and biochemical properties and the extra cellular matrix (ECM) is essential to provide these cues. Mimicking the diverse environments in vitro is necessary to understand the fundamental processes that govern cell matrix interactions but also of great importance for medical applications such as regenerative medicine.

Polyacrylamide (PA) gels with varying elasticity are routinely used to study how cells respond to matrix stiffness. Our strategy is based on hyaluronic acid (HA), one of the major polysaccharides in the ECM that is FDA approved for various medical applications. Chemically modified HA is cross-linked to form a hydrogel and the stiffness of these gels can be finely tuned over the whole physiologically relevant range. Combining these mechanically tunable hydrogels with different ECM proteins we can mimic distinct in vivo niches and study the response of cells on the physical and biochemical cues.

BP 29.21 Thu 17:15 P3

About the stiffening-fluidization paradox in cell mechanics — Lars Wolff, •Andrea Kramer, and Klaus Kroy — ITP, Uni Leipzig

We examine the effect of inelastic breaking and reforming of transient bonds on the linear and nonlinear mechancis of biopolymer networks theoretically. We combine a natural mathematical representation of the kinetics of weak bonds with phenomenlogical models for the linear rheology, such as the Glassy Wormlike Chain or a generic power-law fluid, and thereby extend their range of validity to nonlinear experimental situations. We show that bond breaking can lead to robust non-Maxwellian absorption patterns in the linear and weakly nonlinear rheology, which are to a large extent independent of the particular viscoelastic model chosen. We further show that transient bond breaking and reforming can resolve the stiffening-fluidization paradox of cell mechanics, i.e. that a material vulnerable to transient bond breaking can show strain or stress stiffening *and* fluidization, depending on the particular experimental protocol.

BP 29.22 Thu 17:15 P3

Towards Non-Invasive Cell Sorting and Specific Insights into Differential Hsp70 Expression in Colon Carcinoma Sublines — •Patrice Donfack[1], Gabriele Multhoff[2], and Arnulf Materny[1] — [1]Center of Functional Materials and Nanomolecular Science, Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany — [2]Dpt. Radiation Oncology, Klinikum rechts der Isar, TU München, Germany

Raman scattering provides noninvasive discrimination and biomolecular insights into Hsp70 associated with human colon carcinoma sublines CX- and CX+ in-vivo. CX-/CX+ are different in Hsp70 membrane expression exhibiting biologically relevant chaperon functions with immunostimulatory effects. We have phenotypically characterized them by immunofluorescence and Raman spectroscopy, combined with robust clustering and multivariate analyses. Although, CX- and CX+ show similar Raman spectra due to their strong resemblance, their protein-dominated Raman spectra reveal changes in protein and amino acids. Also significant and specific changes in DNA/RNA nucleotides involve pyrimidine rings Raman hypochromic effects. Discriminating CX- from CX+ is ultimately achieved with one or two principal components, paving the way for label-free cell-sorting of the sublines. Changes in proteins point to tumor-specific interactions of regulatory proteins and changes in nucleobases indicate DNA-RNA/protein binding interactions. We suspect transcription deregulations as participating precursor onsets of different transport mechanisms leading to Hsp70 differential expression and associated CX-/CX+ phenotypic variation.

BP 29.23 Thu 17:15 P3

Viscoelastic in-vitro study of cellular actin structures — Timo Maier[1,2], •Tamás Haraszti[1,2], and Joachim P. Spatz[1,2] — [1]Max-Planck Institute for Metalsreseach, Stuttgart, Germany — [2]Biophysical Chemistry, University of Heidelberg, Heidelberg, Germany

Cellular actin structures are a crucial part of the cytoskeleton. These structures are determined by several factors, such as the presence of actin binding proteins (ABPs), ions and intracellular macromolecules. In their distinct forms of appearance they are able to adapt to physical and chemical changes and serve thus to sustain constitution and preservation of the cellular shape and motility.

In vitro biomimetic actin model networks open the possibility to analyse the physical and chemical properties in a controlled environment. We have previously developed a flow cell to form stress fiber like structures on pillar substrates. Shape of the filamentous topology is thereby controlled by the flow forces as well as crosslinker agents. Here we report the development of an *in situ* polymerization method within these microfluidic channels forming a refined mesh structure with a better visual resemblance to the actin cortex.

While in the last two decades, macro- and microrheological investigations of actin focused on the viscoelastic behaviour of three dimensional gels it is our ambition to determine distinctions in its characteristics due to the transition to two or one dimensional structures.

BP 29.24 Thu 17:15 P3

Single-walled carbon nanotubes as fluorescent probes — Alok Wessel, •Miquel Banchs Piqué, Nikta Fakhri, and Christoph Schmidt — III. Physikalisches Institut, Göttingen, Germany

Single-walled carbon nanotubes (SWNTs) have unique mechanical and optical properties. Typical SWNTs have a diameter of about 1 nm and a length on the order of microns. Depending on lattice structure SWNTs are conducting or semiconducting. Two-thirds of SWNT species have semiconducting properties. Individual and chemically intact SWNTs show band-gap fluorescence in the near-infrared (NIR) region between 900 to 1600 nm. The emission wavelengths are characteristic of their chirality and diameter. Since biomolecules and cells are relatively transparent in NIR range, the sharp spectra of SWNTs can be detected in complex biological media. We utilize the intrinsic near-infrared (NIR) fluorescence of water solublized SWNTs to image individual SWNTs and study their photostability i.e. resistance to photobleaching and lack of blinking.

BP 29.25 Thu 17:15 P3

Determination of the crystalline part within the cuticle of the isopods Porcellio scaber and Tylos europaeus determined by Raman spectroscopy — Katja Huemer[1], •Sabine Hild[1], Bastian Seidel[2], and Andreas Ziegler[2] — [1]Institute of Polymer Science, Johannes Kepler University, Altenbergerstrasse 69, 4040 Linz, Austria — [2]2 Central Facility for Electron Microscopy, University of Ulm, Albert-Einstein-Allee 11, 89069 Ulm, Germany

The exceptional properties of biological composites, such as the exoskeleton of crustaceans, are based on a complex hierarchical architecture of inorganic and organic components which are organized at different structural levels ranging from the nano- to the meso-scale. The cuticle of crustaceans is an excellent model to study biological composite materials that consists of an organic matrix composed of chitin-protein fibers associated with various amounts of crystalline and amorphous calcium carbonate (ACC). Using the combination of SEM and sacnning confocal Raman microscopy (SCRM) for isopods, a subgroup of the Crustaceans- is was possible to show that mineral phases have a layered arrangement where calcite is restricted to the outer area of the cuticle and ACC is localized in the middle having only little overlap with the crystalline layer. Additionally, to the composi-

tional distribution the SCRM investigations reveal the oriented growth of nanocrystalline calcite within the outer part of the crystalline layer of the cuticle, with homogenous layers seen for Porcellio scaber and a specific orientation pattern seen for Tylos europaeus.

BP 29.26 Thu 17:15 P3

Mechanical measurements reveal high bending but low twisting rigidity of 3D DNA-origami — •Dominik Kauert[1], Tim Liedl[2], and Ralf Seidel[1] — [1]Biotechnology Center, TU Dresden — [2]Ludwig-Maximilians-Universität München

DNA-origami is a recently developed method to design and assemble DNA nanostructures of arbitrary shape and property. The understanding of their mechanical behavior is crucial to develop a toolbox of these nanostructures for a broad range of applications. We used magnetic tweezers that support also direct torque measurements to determine the bending and torsional rigidities of DNA multi-helix bundles assembled by the origami method. In particular we investigated 4-helix bundles of 480nm and 6-helix bundles of 400nm length. To analyze the measurements Monte Carlo simulations and numerical finite-element-modeling was applied. The bending rigidity was found increased about 15-fold and 40-fold for 4-helix bundles and 6-helix bundles compared to double-strand DNA, respectively. In contrast, the torsional rigidity increased only 4-fold and 6-fold for 4-helix bundles and 6-helix bundles. We also show the importance of a rigid attachment of the multi-helical structures, necessary to effectively use their rigid properties.

BP 29.27 Thu 17:15 P3

Homogeneous Hydroxyapatite Surfaces for Dental Studies — •Christian Zeitz[1], Stefan Fünfschilling[2], Samuel Grandthyll[1], Jörg Schmauch[1], Frank Müller[1], Mathias Werth[1], and Karin Jacobs[1] — [1]Saarland University, Department of Experimental Physics, D-66041 Saarbrücken — [2]Institute for Ceramics in Engineering, D-76131 Karlsruhe

Due to its biocompatibility, hydroxyapatite (HAP) has become a versatile material for various biomedical applications. However, a comprehensive explanation for the cell or tissue interactions with HAP is still missing, as is e.g. the influence of surface roughness or fluoridation. One of the obstacles for fundamental studies is the preparation of suitable HAP samples, which exhibit usually a rough and porous surface that is hard to prepare in a reproducible manner. These types of samples are moreover unsuitable for many surface science analysis methods such as x-ray photoelectron spectroscopy (XPS) or atomic force microscopy (AFM). We therefore have developed a preparation procedure that allows the fabrication of locally smooth (RMS roughness < 1 nm) and dense HAP surfaces (without open porosity).