CPP 31: Biomaterials and Biopolymers (joint session BP/CPP)

Time: Monday 15:00–17:30 Location: ZEU 250

CPP 31.1 Mon 15:00 ZEU 250

Reptation of DNA nanotube tracers in semiflexible polymer networks — •Tina Händler[1,2], Cary Tutmarc[1,2], Martin Glaser[1,2], Josef Käs[1], David Smith[2], and Jörg Schnauss[1,2] — [1]University of Leipzig, Soft Matter Physics Division — [2]Fraunhofer Institute for Cell Therapy and Immunology, DNA Nanodevices Unit, Leipzig

Over many decades, actin has been the gold standard for exploring the theories about mechanics and dynamics of semiflexible polymers. Unfortunately, naturally occurring biopolymers are limited in their properties such as stiffness and interaction strengths. Programmable polymers enable us to study parameters otherwise unavailable in natural systems and therefore expand theoretical approaches. Nanotubes formed from synthetic DNA strands are ideal model polymers: they are semiflexible and can be hybridized to have characteristics such as a persistence length which is similar to actin filaments or can be varied in a controllable way. Additionally, DNA nanotubes are extremely stable, making them both favorable for polymer physics experiments and material science applications. We visualize the dynamics of nanotube tracer filaments in entangled and crosslinked semiflexible biopolymer networks. The results can be used to measure the networks' tube width and mesh size. Scaling laws concerning the parameter persistence length that have been beyond reach before are accessible now. Furthermore, reptation analysis with our programmable filaments enables the test of latest predictions about the dynamics of single filaments inside entangled solutions vs. crosslinked networks.

CPP 31.2 Mon 15:15 ZEU 250

Dynamics during thermal gelation of egg-white studied using X-ray photon correlation spectroscopy — •Nafisa Begam[1], Anita Girelli[1], Anastasia Ragulskaya[1], Hendrik Rahmann[2], Fabian Westermeier[3], Christian Gutt[2], Fajun Zhang[1], and Frank Schreiber[1] — [1]Universität Tübingen, Germany — [2]Universität Siegen, Germany — [3]DESY, Germany

Gelation of proteins is a fundamental topic in food industry as well as in condensed matter physics [1]. We report a systematic time dependent study of the dynamics of hen egg-white during its gelation at 80°C using X-ray photon correlation spectroscopy in the ultra-small angle X-ray scattering mode. Two distinct regimes of dynamics are identified. The initial growth of the aggregates, as expected for heat-induced coagulation of egg-proteins, results in an early stage non-equilibrium dynamics. Interestingly, at the later stage (after $\sim$ 30 min of heating), the system reaches an equilibrium dynamical state with an average characteristic time scale of few tens of seconds. The intermediate scattering function changes from an exponential to a compressed exponential decay, indicating gel formation. The aggregates eventually show correlated temporally heterogenous dynamics. Such dynamical fluctuations are further quantified in terms of a fourth order intensity correlation function. The monotonic increase in heterogeneity as a function of wave vector transfer observed here is similar to the behavior of strongly attractive colloidal gels [2].

[1] Croguennec et al., *J. Food. Sci.*, **67**, 2, (2002)
[2] Fluerasu et al., *Phys. Rev. E*, **76**, 010401(R), (2007)

CPP 31.3 Mon 15:30 ZEU 250

Reversible Underwater Adhesion in Beetles — •Pranav Sudersan, Thomas Endlein, Michael Kappl, and Hans-Jürgen Butt — Max Planck Institute for Polymer Research, Mainz, Germany

Many animals are able to climb smooth surfaces using adhesive pads on their feet. Unlike artificial glues, animals can adhere reversibly i.e. attach and detach easily to a wide variety of surfaces. Insects such as beetles have hairy pads on their feet and also secrete an adhesive fluid resulting in capillary forces for strong attachment. In contrast to adhesion in air, reversible adhesion underwater is particularly challenging. Insects drawing their adhesive force from the capillary action of the air-fluid interface would not stick underwater as such an interface is usually abolished. Some terrestrial beetles are however able to easily adhere and walk underwater by using an entrapped air bubble around their hairy pads to de-wet the surface upon entering water. But it is unclear as to what extent the air bubble influences adhesion. In our study, we measure adhesion and friction forces in live ladybug beetles (Coccinella septempunctata) under controlled conditions. The effect of surface hydrophobicity, pad attachment/detachment speeds and de-wetted area on adhesion and friction performance is examined and compared for dry and wet surfaces. Our study aims to draw inspiration from an animal model in order to fabricate artificial adhesives which would work in a similar way.

CPP 31.4 Mon 15:45 ZEU 250

Visco-elastic properties of albumin films upon periodical mechanical loading — •Lukas Böttcher[1], Sven Kraft[1], Regina Lange[1], Ingo Barke[1], Jessica Hembus[2], Carmen Zietz[2], Rainer Bader[2], and Sylvia Speller[1] — [1]Institute of Physics, University of Rostock, 18059 Rostock — [2]Biomechanics and Implant Technology Research Laboratory, University Medical Center Rostock, 18057 Rostock

The synovial fluid in human natural and endoprosthetic joints usually implies outstanding lubrication and low wear. The question is how this fluid or its components, such as albumin and hyaluronic acid, participate in this performance. The high periodic forces acting on the protein in hips and knees during walking lead to changes in protein structure and visco-elastic-plastic behavior. Therefore, we mimic the situation in the joint using a tapping nanoprobe-sample junction in a force microscope. Films from albumin and synthetic synovial fluid are prepared and maintained wet in a humidifying chamber during treatment and data acquisition. Upon applying 200000 cycles at high force of several hundred nN the albumin film has swollen by about 5 nm in height. With increasing mechanical load the film gets softer and ropier. This may be explained in terms of loosening the protein secondary structure and incorporating additional fluid in the pores.

CPP 31.5 Mon 16:00 ZEU 250

Towards transparent living tissues — •Kaushikaram Subramanian[1,2,3], Heike Petzold[1], Lena Hersemann[1,2], and Moritz Kreysing[1,2,3] — [1]Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany — [2]Center for Systems Biology Dresden, Dresden, Germany — [3]Cluster of Excellence, Physics of Life, Technische Universität Dresden, Germany

Most biological tissues are optically opaque, largely precluding access by light microscopy. In stark contrast, some living tissues and organisms have evolved to be highly transparent. Examples include many deep-sea fish and your retina that enables you to read this text. We asked the question if directed evolution can be used to change the optical phenotype of cells. For this we used a mutation, selection, and replication scheme, in which we favoured the growth of genetic mutant cells that showed reduced light scattering. After only few rounds of selection we gained mammalian cells with upto 2-fold reduced side scattering. Further analysis revealed that the induced partial transparency goes along with last changes of the transcriptome and frequently a reduction of nuclear substructure, a phenotype similar to the photoreceptor cells in the mouse retina. Our results encourages the possibility that deep microscopy on genetically cleared living tissues might one day become reality.

15 min. coffee break

Invited Talk CPP 31.6 Mon 16:30 ZEU 250

Optoregulated force application to individual cellular receptors using molecular motors — •Aránzazu del Campo — INM-Leibniz Institute for New Materials, Campus D2 2, 66123 Saarbrücken, Germany — Chemistry Department, Saarland University

Inspired by cellular mechanisms for force application, a unique molecular machine that can apply forces at cell-matrix and cell-cell junctions using light as energy source will be presented. The key actuator is a light-driven rotatory molecular motor linked to polymer chains, which is intercalated between a membrane receptor and an engineered biointerface. The light-driven actuation of the molecular motor is converted in mechanical twisting of the polymer chains, which will in turn effectively *pull* on engaged cell membrane receptors (integrins, cadherins*) within the illuminated area. Applied forces have the adequate magnitude and occur at time scales within the relevant ranges for mechanotransduction at cell-friendly exposure conditions. The presnetation will provide experimental demonstrations of force-dependent focal adhesion maturation and T cell activation in vitro using the ro-

tary motor.

CPP 31.7 Mon 17:00 ZEU 250

Experimental setups to mimic the Peritoneal Dialysis in humans — •Bernd Eberle[1,2], Christian Wagner[1], and Thomas John[1] — [1]Experimentalphysik, Universität des Saarlandes, Saarbrücken, Germany — [2]Fresenius Medical Care Deutschland GmbH, St. Wendel, Germany

Peritoneal dialysis (PD) uses the peritoneum as a semipermeable dialysis membrane to clear the patient's blood. Therefore, dialysate solution gets filled into the abdominal cavity through an implanted catheter. Due to the osmotic concentration gradient between the blood capillarys and the dialysate, excess water and uremic toxins are removed from the blood by diffusing through the pores in the peritoneum into the dialysate. In contrast to Hemodialysis, the artificial filter membrane is well characterized, properties of the peritoneum are divers and vary for each patient. Consequently, a better understanding of membrane parameters is a crucial step for optimization treatment conditions. At present, commercially available software tools are used to simulate the membrane characteristics of the peritoneum but are lacking the precision to predict the ultrafiltration behavior in vivo. Hence, we present experiments which mimic the diffusion, convection and ultrafiltration through the peritoneum with artificial membranes allowing a patient-tailored PD-therapy with higher efficiency. Various osmotic agents and membrane compositions were investigated, and characteristic membrane parameters were extracted from the measurements.

CPP 31.8 Mon 17:15 ZEU 250

Characterization of microstructures obtained by the cryo-printing method for rapid microfluidic chip fabrication — •Sebastian Ronneberger, Ales Charvat, Claudia Hackl, Christian Elsner, and Bernd Abel — Leibniz Institute of Surface Engineering (IOM), Leipzig, Germany

Cryo-printing is a non-conventional rapid prototyping method for microfluidic devices in which liquid state (aqueous) micro-droplets are deposited onto a cooled substrate surface like glass or silicon which immediately undergo transition to the frozen solid state. By a controlled motion between the substrate surface and the microdrop printing head microstructures of ice can be scribed. After coverage of the microstructures with an UV-cured polymer coating thawing releases an *inverse imprint* in the covering coating which is still bonded to the substrate forming a microfluidic device. The talk presents off-line characterization methods for the topological analysis of cryo-printed ice microstructures by using datasets obtained from a laser-scanning profilometer. The datasets were automatically analyzed applying self-coded Python3 scripts to obtain channel parameters such as channel widths and channel depths at different positions. Analysis of crafted microchannels shows that this method can be used for optimizing the printing parameters which have an influence on the shape of the created microchannel structures. Furthermore, the reproducibility of the printing process was assessed. This might enable cryo-printing of microfluidic channels with variable and customized channel parameters which could be applied in advanced cryo-printed microfluidic chips.