BP 27: Biomaterials and biopolymers II (joint session BP/CPP)

Time: Thursday 15:00–17:00 Location: H10

BP 27.1 Thu 15:00 H10

Cell Adhesion as a Function of Hydrogel Layer Thickness: From Thin Layers to Bulk Samples — •Sandra Sindt, Galen Ream, and Christine Selhuber-Unkel — Institute of Materials Science, CAU Kiel, Germany

Cells are in vivo in contact with a large range of different mechanical environments. However, many tissues have complicated structures without distinct elasticity values, which can result in stiffness gradients close to their interfaces and cells are known to be capable of sensing a more rigid substrate underneath a soft structure. For example, Buxboim et al. have recently shown that mesenchymal stem cells show increased adhesive spreading on thin soft hydrogels due to a stiff underlying substrate. A threshold of rigidity sensing of fibroblasts was reported to be 60-70 micrometer thickness at approximately 1 kPa of elastic modulus. We here report results on the dependency of cell adhesion on hydrogel thickness and elasticity. This is of great importance for the design and development of coatings for various biomedical applications. We use polyacrylamide layers on glass slides with thicknesses below 100 micrometer to semi-infinite bulk samples (ca. 500 micrometer). Furthermore, we use two different elasticities to determine, if the effective cellular substrate sensing depth is affected by the elasticity of the samples. Our results demonstrate that the spreading area and circularity is strongly influenced by the thickness of the polyacrylamide samples. However, there was no conclusive difference in this effect for both stiffnesses.

BP 27.2 Thu 15:15 H10

Liquid-like protein condensates are glassy — •Louise Jawerth[1,2], Elisabeth Fischer-Friedrich[3], Suropriya Saha[1], Anthony Hyman[2], and Frank Jülicher[1] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany — [3]Biotechnology Center, Technische Universitat Dresden

Liquid-like protein condensates (LLPCs) are intracellular compartments that segregate material without the use of a membrane. The liquid-like behavior of the condensates is a defining characteristic and the viscosity, surface tension and other material properties determine how segregated species diffuse into and within condensates; they, thus, critically impact the biological function of the condensates. It has become increasingly clear that some LLPCs do not have time-independent material properties, but can, instead, transition to more solid, gel-like materials. Here, we present our efforts to quantify these new materials as they age in vitro. We measure the visco-elastic material properties of two proteins, PGL-3 and FUS, by means of a combination of active and passive microrheology. At early times, we find that the droplets behave much like simple liquids but gradually become more elastic. Surprisingly, the changing mechanical properties can all be scaled onto a single master curve using one characteristic time scale which grows as the sample ages. This and other features we observe bear a striking resemblance to the behaviors observed in materials with glass-like aging suggesting that LLPCs are in fact not simple liquids but, rather, a type of soft glass.

BP 27.3 Thu 15:30 H10

The Poisson ratio of the cellular actin cortex is frequency-dependent — Marcel Mokbel[1], Kamran Hosseini[2], Sebastian Aland[1], and •Elisabeth Fischer-Friedrich[2] — [1]Hochschule für Technik und Wirtschaft, Dresden, Germany — [2]Biotechnology Center, Technische Universität Dresden, Dresden, Germany

Cell shape changes are vital for many physiological processes such as cell proliferation, cell migration and morphogenesis. They emerge from an orchestrated interplay of cellular force generation and cellular force response both crucially influenced by the actin cytoskeleton. To model cellular force response and deformation, cell mechanical models commonly describe the actin cytoskeleton as a contractile isotropic incompressible material. However, in particular at slow frequencies, there is no compelling reason to assume incompressibility as the water content of the cytoskeleton may change. Here we challenge the assumption of incompressibility by comparing computer simulations of an isotropic actin cortex with tunable Poisson ratio to measured cellular force response. Comparing simulation results and experimental data, we determine the Poisson ratio of the cortex in a frequency-dependent manner. Our results show that the Poisson ratio of the cortex depends on the frequency and may deviate from the incompressible case. In addition, our results suggest that the assumption of cortex isotropy is violated at large time scales likely due to anisotropic actin cortex repolymerization from the membrane.

Invited Talk BP 27.4 Thu 15:45 H10

3D scaffolds as cell-instructive biomaterials — •Christine Selhuber-Unkel — Institute for Materials Science, University of Kiel, Kiel, Germany

In vivo, many cell types are embedded in densely structured 3D environments. Such environments typically contain nano- and micropores or consist of nano- and microfibrous interwoven biopolymer structures. Mimicking such natural environments by synthetic materials can provide novel functionalities in many applications, particularly in tissue engineering. We therefore investigate 3D scaffold materials for their impact on cellular properties. As a first example, microchannels are embedded in a hydrogel matrix of well-defined stiffness, chemistry and conductivity. The scaffold provides a large and spatially controlled cell-surface contact area through the specific architecture of its pores, such that the specific properties of the environment have large impact on the cells and induce, e.g., cell capture. As a second example, carbon-based fibrous scaffolds will be introduced. These are highly attractive for applications that require conductive materials. In addition, they resemble the structural features of the natural extracellular environment and can be equipped with bioactive particles. Hence, 3D microstructured environments are promising candidates for instructing cells to execute specific and coordinated functions.

BP 27.5 Thu 16:15 H10

Effect of drug treatment on the formation of malaria pigment crystals — •Szilvia Mucza[1], Ana Strinic[2], Agnes Orban[1], Petra Molnar[3], Peter Furjes[4], Beata Vertessy G.[3], and Istvan Kezsmarki[1,2] — [1]Department of Physics, Budapest University of Technology and Economics — [2]Experimental Physics V, University of Augsburg — [3]Hungarian Academy of Sciences Research Centre for Natural Sciences — [4]Institute of Technical Physics and Materials Science, Centre for Energy Research, Hungarian Academy of Sciences

The malaria pigment crystals are a by-product of the metabolic process of malaria parasites. These few-hundred-nanometer sized needle-like crystals are unique indicators of the presence of infection. Our group developed a magneto-optical device for malaria diagnosis, which can precisely measure the concentration of the crystals produced by the parasites. The increasing crystal concentration in time indicates the growth of the parasites in a culture, thus, the device is also sufficient for drug screening using parasite cultures. In the present study, we found that the magneto-optical method is able to determine the size distribution of the crystals in addition to their concentration. By following the size distribution of the crystals throughout the life cycle of the parasites for drug-treated and untreated cultures we could specify the stage when the drug action takes place. The same method can also be used to reveal if the drug action is related to the blocking of crystal formation or has a different pathway.

BP 27.6 Thu 16:30 H10

Efficient hemozoin extraction from Plasmodium falciparum parasites — •Ana Strinic[1], Agnes Orban[2], Szilvia Mucza[2], Petra Molnar[3], Beáta Vértessy[3], Stephan Krohns[1], and Istvan Kezsmarki[1,2] — [1]Experimental Physics V, University of Augsburg — [2]Department of Physics, Budapest University of Technology and Economics — [3]Hungarian Academy of Sciences Research Centre for Natural Sciences

Hemozoin crystals are a natural biomarker of malaria infection. A prototypical magneto-optical setup uses magnetic and optical properties of hemozoin for a rapid and cheap, yet sensitive detection of malaria parasites within blood samples. As the parasites mature the volume of the crystallites produced within their food vacuole continuously increases. However, the age distribution of parasites within human blood and cell cultures is not homogenous. Thus, unveiling the relation between their age distribution and the size distribution of the hemozoin crystals may facilitate the monitoring of stage-specific drug actions and target oriented drug testing. Taking advantage of the high

sensitivity of the magneto-optical method not only to the crystal concentration but also to their size distribution, we aim to determine the relation of size versus age distribution. This however strongly depends on a successful hemozoin extraction from in vitro cultures. Here, I show, how the crystal extraction process and sample preparation affect the quality of the extracted crystals and the magnitude of the magneto-optical signal. This allows determining the optimal procedure and investigating reactions along the preparation, which reduce the hemozoin concentration.

BP 27.7 Thu 16:45 H10

Results of field trials of the rotating-crystal magneto-optical method for malaria detection — •Agnes Orban[1], Leandra Arndt[2], Tamarah Koleala[2], Jetsumon Sattabongkot[3], Stephan Karl[2], and Istvan Kezsmarki[1,4] — [1]Dept. of Phys., Budapest Uni of Tech. and Econ., Hungary — [2]Papua New Guinea Inst. of Med. Res., Madang, PNG — [3]Mahidol Vivax Res. Unit, Fac. of Tropical Medicine, Mahidol Uni, Bangkok, Thailand — [4]Exp. Phys. V, Center for Electronic Correlations and Magnetism, Uni. of Augsburg

Although malaria is still a global health burden, the current standard for its detection still remains the microscopic observation of stained blood smears. A novel cost-effective, automated, yet sensitive diagnostic method is needed for malaria detection both as an in-field instrument and as a laboratory tool.

Our group aims to design such a compact and inexpensive diagnostic device based on the detection of the magnetically induced linear dichroism exhibited by malaria pigment (aka. hemozoin). These micrometer-size crystals are promising malaria-diagnostic targets as they are unique indicators of the infection.

The rotating magnetic field employed in our system enables a very high sensitivity detection of hemozoin as tested on suspensions of synthetic crystals; on *Plasmodium falciparum* cultures, on mouse models and on human samples from field trials performed in Thailand and Papua New Guinea, the latter being the main focus of the talk.