BP 28: Biomedical Applications

Time: Friday 11:00–12:30 Location: H44

BP 28.1 Fri 11:00 H44

Can Polymer Physics Help Cellular Biomedicine? — •Josef Käs — Abt. f. Physik weicher Materie, Fak. f. Physik u. Geowiss., Universität Leipzig

The cytoskeleton, an intracellular polymeric scaffold, stabilizes and organizes biological cells. As a compound of highly dynamic protein filaments and active nano-sized molecular motors it mechanically senses a cell's environment and generates forces for cellular motion sufficiently strong to push rigid AFM-cantilevers out of the way. The study of the cytoskeleton from a polymer physics perspective with novel optical micro- and nano-manipulation techniques, scanning force microscopy, time lapse image analysis of intracellular processes, and modern genetic manipulation methods leads to results, which simultaneously promote physics and medicine (diagnosis as well as therapy). The extremely sensitive polymeric properties of single cells' cytoskeletons measured with the laser-based Optical Stretcher distinguish different cell types and monitor cellular changes such as cancer progression and stem cell differentiation proving recent theories on semiflexible polymers. Cellular motion required for neuronal plasticity and nerve regeneration - but also found in cancer metastasis - inspire the emerging field of active polymer networks. The resulting, novel perception of cell migration will impact therapies to reduce metastatic aggressiveness and inspire new strategies for nerve regeneration.

BP 28.2 Fri 11:15 H44

Bildgebende Zweiphotonen Fluoreszenz zur Untersuchung von Hautschädigung durch Laserstrahlen — •Andreas Garz[1], Christian Spitz[1], Andreas Krink[2], Hans Peter Berlien[2] und Ralf Menzel[1] — [1]Universität Potsdam — [2]Elisabeth Klinik, Berlin

Zweiphotonenangeregte Fluoreszenz mit Anregung im nahen Infrarot ist für die Darstellung von Gewebezuständen besonders geeignet, da die Anregungsstrahlung mit geringer Störung ins Gewebe eindringen kann. Bei Beschränkung auf endogene Fluorophore kommt man ohne Markierungsfarbstoffe aus und die Messmethode ist in vivo einsetzbar. Diese Technik hat sich bereits in der Mikroskopie mit subzellulärer Auflösung zur Bildgebung bewährt, da durch die nichtlineare Intensitätsabhängigkeit eine optische Biopsie in der Fokalebene ähnlich wie bei konfokaler Mikroskopie möglich ist.

Bei geringerer Auflösung und größeren Bildausschnitten von einigen Millimetern eröffnen sich neue Möglichkeiten, da der Bezug zu örtlich variierenden Krankheitsbildern oder Schädigungen hergestellt werden kann. Demonstriert wird die Untersuchung der schädigenden Wirkung von Erbium-Laserstrahlung auf gesunder Haut.

Gefördert durch das BMBF und den VDI-TZ

BP 28.3 Fri 11:30 H44

CXCR2 determines invasiveness, traction forces and cytoskeletal dynamics of tumor cells — •Claudia Tanja Mierke, Philip Kollmannsberger, Daniel Paranhos Zitterbart, Carina Raupach, and Ben Fabry — Biophysics, University Erlangen, Germany

Tumor cells consist of populations with different capacities to invade and different CXCR2 expression. We tested the hypothesis that highly invasive tumor cells reorganize their cytoskeleton more rapidly and can generate higher tractions than less-invasive cells. We isolated a highly- and a low-invasive variant of MDA-MB-231 carcinoma cells (231-high/-low) with a 5-fold difference in CXCR2 expression. Invasiveness was analysed in a collagen gel. Cytoskeletal dynamics was determined from the creep response of cells and from spontaneous nanoscale-movements of magnetic particles. Step forces from 1-10 nN were applied to fibronectin-coated beads. Bead displacement vs. time followed a power-law. The exponent was taken as a measure of cytoskeletal dynamics, with low values corresponding to a solid-like, static and high corresponding to a liquid-like, dynamic behavior. 231-high cells had a substantially higher exponent compared to 231-low cells. Spontaneous bead motion showed significantly more superdiffusive behavior in 231-high compared to 231-low cells. Tractions measured during adhesion onto collagen-coated gels showed that 231-high cells generate 8x higher contractile forces compared to 231-low cells. In summary, the ability of tumor cells to remodel their cytoskeleton and to generate high tractions seems be key factors for metastasis formation.

BP 28.4 Fri 11:45 H44

Ellipsometric studies on protein adsorption kinetics — •Christoph Gilow[1], Hubert Mantz[1], Anthony Quinn[1], Karin Jacobs[1], Markus Bellion[2], and Ludger Santen[2] — [1]Saarland University, Experimental Physics, D-66041 Saarbrücken, Germany — [2]Saarland University, Theoretical Physics, D-66041 Saarbrücken, Germany

Adsorption processes of proteins play an important role in many biomedical systems. Examples are the protein films on teeth or tissue compatibility.

From a physical point of view these processes raise a number of challenging questions, e.g., which substrate properties (chemical composition, roughness,...) have an impact on protein adsorption.

We investigated the adsorption kinetics of several salivary proteins in a liquid environment on tailored substrates by means of ellipsometry and found a new type of adsorption kinetics. A comparison to extensive Monte Carlo simulations strongly suggests that long-range contributions to the surface potential lead to conformational changes of the protein on the surface which are responsible for the observed unusual kinetics of the amylase.

BP 28.5 Fri 12:00 H44

Strain Energy during Tumor Cell Invasion in 3-D Collagen Gels — •Thorsten Koch, Claudia Mierke, Daniel Paranhos Zitterbart, Stefan Münster, and Ben Fabry — Friedrich-Alexander-Universität Erlangen-Nürnberg - Zentrum für Medizinische Physik und Technik - Lehrstuhl für Physikalisch-Medizinische Technik - Henkestraße 91 - D-91052 Erlangen

Cells cultured on 2D rigid substrates behave differently from cells suspended in a 3D connective tissue matrix, e.g. in 3D cells exhibit a more elongated morphology, less pronounced stress fiber formation, and marked differences in focal adhesion composition. In this study we compared the strain energies resulting from forces exerted on 2D vs. 3D extracellular matrices by MDA-MB-231 breast carcinoma cells. Cells were plated on the surface of 2D polyacrylamide hydrogels (Young's modulus $E = 1.5$ and 6 kPa), or 3D collagen gels ($E = 50$ Pa), and allowed to spread onto, or invade into, the gels for two days. Gel deformation was quantified by tracking the 3D positions of embedded fluorescent beads (ø 1 μm). The undeformed state was obtained by disrupting the actin cytoskeleton and hence force transmission with Cytochalasin-D (4 μM). The strain energy, calculated from displacements of beads between the initial and final states, was $U = 1.01$ pJ ($E = 6$ kPa) and $U = 0.2$ pJ ($E = 1.5$ kPa) on 2D gels. Surprisingly, cells in a soft 3D matrix generated significantly higher strain energy $U = (1.8 \pm 0.2)$ pJ ($n = 47$). These results demonstrate that tumor cells can exert substantial forces on surrounding tissue during invasion that cannot be inferred from traction measurements in 2D.

BP 28.6 Fri 12:15 H44

Analysis of radiation-induced damages of DNA molecules by means of SFM and gel-electrophoresis — •Mihail Brezeanu, Frank Träger, and Frank Hubenthal — Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology - CINSaT, Universität Kassel, Germany

Studying radiation-induced damages in DNA molecules is important to understand the processes that occur in radiotherapy and DNA repair. The most serious damages of DNA molecules are double-strand breaks (DSB), i.e. the rupture of both DNA strands in the range of a few base pairs and single-strand breaks (SSB), when one of the DNA strands is broken. In this contribution we present our recent analysis of radiation-induced damages in phiX174 plasmids after X-ray and carbon-ion irradiations. The percentages of plasmids with DSBs, SSBs, and multiple strand breaks, i.e. linear fragments (LF), have been determined as a function of radiation dose by means of scanning force microscopy (SFM) and gel-electrophoresis measurements. The results show an increase of the DSBs percentage from initially 0% to 12.5% after X-ray irradiation, while after carbon ion irradiation 19% of DSBs have been found for the same applied dose of 1 kGy. In addition, a detailed SFM analyses revealed that the distribution of LF after irradiation with C-ions contains a significant higher amount of

small fragments in the range from 50 nm to 700 nm, compared to the X-rays, while a clear reduction of large fragments has been observed. The results explain, for example, why the DNA repair rate after carbon ion irradiation is much lower that for X-rays at the same dose.