BP 26: Posters - Cell Adhesion

Time: Tuesday 14:00–16:00 Location: P2-EG

BP 26.1 Tue 14:00 P2-EG

Fracture test of epithelial monolayers — •Dave Ahrens[1], Georg Dreissen[1], Matthias Rübsam[2], Bernd Hoffmann[1], Wolfgang Ziegler[3], Carien Niessen[2], and Rudolf Merkel[1] — [1]Institute of Complex Systems, ICS-7: Biomechanics, Forschungszentrum Jülich, 52425 Jülich, Germany — [2]Department of Dermatology, Center for Molecular Medicine Cologne, University of Cologne, 50931 Cologne, Germany — [3]Hannover Medical School, Dept. of Paediatric Kidney, Liver and Metabolic Diseases, 30625 Hannover, Germany

One vital function of epithelial tissue is providing a physical barrier against high mechanical loads in order to protect underlying tissues. Due to experimental limitations for mechanical characterizations of cell layers we developed a monolayer cell-sheet model on highly elastic silicone rubber chambers. These chambers allow single cell and cell sheet straining by 150% and more in single as well as cyclic tensile straining events. Furthermore, cell-cell contact formation and epithelial cell sheet maturation was induced by Ca2+ for different time periods before stretching. We could show that epithelial cells completely change their mechanical behavior in response to strain with increasing incubation times in Ca*+ containing media. Previously acting as a system whose components respond largely independent from each other, cells mechanically function as unit after sheet maturation. Stretching epithelial cells lacking vinculin as a component of cellular adhesion could prove the importance of vinculin for mechanical resistance in cell-matrix adhesions on single cell level while vinculin KO cell sheets were rarely affected in their mechanical integrity.

BP 26.2 Tue 14:00 P2-EG

Revealing contact formation characteristics of bacteria — •Nicolas Thewes, Christian Spengler, Friederike Nolle, and Karin Jacobs — Experimental Physics, Saarland University, Germany

Bacteria exhibit an outstanding ability to adhere to various kinds of surfaces. Single cell AFM force spectroscopy has proven to be a powerful tool to quantify the acting forces if combined with a clever choice of substrates. On hydrophobic surfaces, the hydrophobic interaction plays the main role for the adhesion of bacteria and the contact formation process is dominated by the longest cell wall macromolecules. In our AFM study, we were able to observe the process of making contact by observing the snap-in process in detail [1]. To interpret the data, Monte Carlo simulations were set up, involving a simple model for a bacterium. The simulations yield strikingly matching results, corroborating the interpretation that the contact formation of S. aureus relies on thermally fluctuation cell wall proteins that tether to a surface and subsequently pull the bacterium to the surface. That way, e.g. S. aureus is able to attach to surfaces over distances far beyond the range of classic surface forces! Our results therefore suggest that the bacterial adhesion process in general, can be described by solely taking into account the tethered macromolecules between a bacterium and a surface.

[1] N. Thewes et al, Stochastic binding of Staphylococcus aureus to hydrophobic surfaces, Soft Matter 2015, 11, 8913 - 8919

BP 26.3 Tue 14:00 P2-EG

Microbial Adhesion Influenced by Nanoroughnesses — Claudia Lüdecke-Beyer[1,3], Martin Roth[2,3], Nathalie Stefani[2,3], •Christian Helbing[1], Jörg Bossert[1,3], and Klaus D. Jandt[1,3] — [1]Chair of Materials Science, Otto Schott Institute of Materials Research, Friedrich Schiller University, Jena, Germany — [2]Leibniz Institute for Natural Product Research and Infection Biology, Bio Pilot Plant, Hans Knöll Institute, Jena, Germany — [3]Jena School for Microbial Communication (JSMC), Excellence Graduate School, Friedrich Schiller University, Jena, Germany

An advanced understanding of the microbe-material-interaction is required for the current development and progress in nanoscale structuring of materials surfaces to control microbial adhesion. This study aimed to investigate the nanostructure of the microbe-material-interface and to link it to microbial adhesion kinetics as a function of the titanium surface nanoroughness. A statistically significantly reduced microbial adhesion on titanium surfaces, prepared by physical vapor deposition, with a nanoroughness of 6 nm compared to 2 nm was observed. Direct insight into the microbe-titanium-interface was gained by cross-sectioning of the microbial cells with a focused ion beam. High resolution scanning electron microscopy images gave first evidence that the surface peaks are the loci of initial contact between the microbial cells and the materials surface which is proposed in a qualitative model. This new understanding will help towards the design of materials surfaces for controlling microbial adhesion.

BP 26.4 Tue 14:00 P2-EG

Cell-cell adhesion in the optical stretcher - Methods for experimental and analytical force measurements — •Pablo Gottheil, Steffen Grosser, and Josef Käs — Germany, University of Leipzig, Faculty of Physics and Earth Sciences, Institute of Experimental Physics I, Soft Matter Physics Division

The optical stretcher is a dual-beam laser trap used to micromanipulate single cells in order to measure their viscoelastic properties. Here however, we use it to measure cell-cell adhesion forces, by stretching them apart from each other. The experimental way of approximating this force is to track the cells in the stretcher chamber and measure the speed in order to calculate the Stokes' law. Calculate the beampropagation and its diffraction by the cells can be used to analytically get the momenta in the whole cell chamber respectively before and after the diffraction. Comparing these two methods would give a nuanced view on the cell-cell adhesion forces.

BP 26.5 Tue 14:00 P2-EG

Mechanosensitivity of Murine Kidney Epithelial Cells — •Theresa Hoppe and Florian Rehfeldt — Third Institute of Physics, University of Göttingen

Recent experiments have shown that cell adhesion and subsequent spreading is dictated by the elasticity of the underlying substrate. Additionally, the ligand density and type of ligand employed result in differences in a cell's spreading behavior.

Here we investigate cellular spreading on two different types of collagen (Collagen I and IV) and by way of using two cell types. Collagen I is a major component of the connective tissue extracellular matrix (ECM), whereas collagen IV is primarily prominent in the ECM of epithelial tissue cells. Previous studies have well established optimal ligand concentrations of Collagen I for hMSC's. In this study, we determined the optimal collagen IV concentration for the maximal spreading of human mesenchymal stem cells (hMSC) on 10kPa polyacrylamide (PA) gels. We also studied the adherence of primary murine tubular epithelial cells on PA gels of varying elasticity coated with the same concentrations of collagen I and IV as for the hMSCs. We analyzed cell spreading via fluorescence microscopy.

Results indicate that on comparison with collagen I hMSC's spread area is lower on collagen IV for the same 10kPa PA gels. Surprisingly murine cell adherence seems to be ligand specific. On varying substrate stiffness, collagen I promotes spreading of these cells whereas collagen IV failed to supply sufficient adhesion sites.

BP 26.6 Tue 14:00 P2-EG

Measuring Cell Dynamics at the Substrate-Interface with Surface Plasmon Resonance Miscroscopy — •Eva Kreysing, Hossein Hassani, and Andreas Offenhäusser — ICS8/PGI8, Forschungszentrum Juelich, 52425 Juelich

In neuroelectronics the cell-electrode distance is one of the most critical parameters during cell recordings. Cardiomyocyte-like cells are among the most popular model systems because they periodically generate an action potential. This feature also leads to a cell contraction which affects the cell-electrode distance. To achieve a qualitative and quantitative characterization of the dynamics at the interface in vitro and lable-free, we built a surface plasmon resonance microscope (SPRM). Using gold coated sapphire chips as the substrate for cell culture it is possible to excite plasmons in the gold layer due to specific illumination. The resonance frequency of the plasmons depends strongly upon the dielectric constant of the gold's environment. In turn the angle spectrum of the reflected light depends upon said resonance frequency. Due to these dependencies it is possible to deduce the cell-substrate distance. Our microscope is capable of imaging the interface in a live-imaging mode where we can observe cell dynamics qualitatively. A scanning mode uses localized surface plasmons to measure the cell-substrate distance. The resolution in z-direction lies in the nanometer

range. This allows us to measure the movement of the cell membrane at each scanning point with a time resolution of 150 ms. Using this method we have been able to record the dynamics of multiple cardiomyocytes.

BP 26.7 Tue 14:00 P2-EG

Microbial adhesion forces on nanostructured surfaces — •Carolin Dewald[1,2,3], Claudia Lüdecke-Beyer[1], Martin Roth[2,3], Jörg Bossert[1], and Klaus D. Jandt[1,3] — [1]Chair of Materials Science, Otto Schott Institute of Materials Rsesearch, Friedrich Schiller University Jena, Löbdergraben 32, 07743 Jena — [2]Bio Pilot Plant, Leibniz Institute for Natural Product Research and Infection Biology, Hans Knöll Institute Jena, Beutenbergstraße 11, 07745 Jena — [3]Jena School for Microbial Communication, Neugasse 23, 07743 Jena

Often only qualitative adhesion properties are analyzed limiting the quantitative information about adhesion forces between microbial cells and materials surfaces. Force-distance curves are one option to measure adhesion forces. Therefore, the aim of this study is to investigate the adhesion kinetics and forces of Candida albicans as function of nanoparticle structured materials surfaces. The investigated surfaces with different AuNPs densities as well as unstructured control surfaces showed no statistically significant differences in contact angle and surfaces chemistry. A reduced microbial adhesion was observed on the nanostructured surfaces compared to the control surface. The AuNPs act as contact points for initial microbial adhesion which was confirmed by force-distance curves. A lower AuNP density led to a reduced microbial adhesion due to reduced adhesion forces between microbial cells and materials surfaces. This study will provide new insight into microbial adhesion on materials surfaces structured in the nanometer range.

BP 26.8 Tue 14:00 P2-EG

Morphological, Mechanical and Adhesion Properties of Neutrophil Extracellular Traps — •Ricardo H. Pires[1,2,3], Mihaela Delcea[2,3], Stephan B. Felix[2,3], and Oliver Otto[1,3] — [1]Universität Greifswald, Greifswald, Germany — [2]Universitätsmedizin Greifswald, Greifswald, Germany — [3]DZHK, Greifswald, Germany

Neutrophils are immune system cells that have recently been found to engage in a suicidal pathway that leads to the extrusion of partially decondensed chromatin, or neutrophil extracellular traps (NETs). In the circulatory system, NETs bind and capture pathogens thus limiting their spread, but they have also been associated with thrombus formation, as well as other cardiovascular disorders. Despite their relevance, little is known about the molecular mechanisms behind their adhesive and mechanical properties. In this work we combine fluorescence and atomic force microscopies with force spectroscopy to obtain detailed information on the morphology of NETs, on parameters that affect their mechanical behavior and their adhesive properties. We report that NETs are not a simple bundle of chromatin fibers, but exhibit an order evidenced by its web-like appearance with openings in the sub-micron range. Partial proteolysis assays further indicate that the protein content of NETs is not only relevant to its mechanical behavior but to its morphology as well, thus highlighting the inextricable role of proteins in defining the architecture of NETs. In addition, force spectroscopy also indicates that the adhesive mechanism of NETs may in part be governed by unspecific electrostatic interactions.