BP 17: Posters: Physics of Cells

Time: Wednesday 17:30–19:30 Location: Poster A

BP 17.1 Wed 17:30 Poster A

Complex flow patterns of microbial populations growing in constrained geometries — •Hedvika Toncrova and Oskar Hallatschek — Max Planck Research Group for Biophysics and Evolutionary Dynamics, MPI for Dynamics and Self-Organization, Göttingen, Germany

During biofilm development cells have to push away their surroundings to free space for their own growth and that of their offspring. Although a lot of interesting physics and biology is involved in this complex process, it remains poorly understood.

In an attempt to shed light on the mechanics of biofilm growth, we have measured the forces and flows that microbial populations generate when their growth is limited by space rather than nutrients. Using small populations of yeast cells confined in a microfluidic device we have measured pressures of approximately 0.5 MPa, generated purely by their growth and division. In addition, we have observed that imperfect caging of the cells leads to flows characteristic of granular media just above the jamming transition (succession of elastic and plastic events). We relate our measurements to a recently proposed theory of a homeostatic pressure arising in collective tissue dynamics.

BP 17.2 Wed 17:30 Poster A

Tracking and Simulation of Human T-Cells' Motility — •Marc Neef[1], Hélène Lyrmann[2], Carsten Kummerow[2], Markus Hoth[2], and Karsten Kruse[1] — [1]Theoretische Physik, Universität des Saarlandes, 66041 Saarbrücken — [2]Biophysik, Universität des Saarlandes, 66421 Homburg

As a part of cell-mediated immunity, killer T-cells detect infected or cancerous cells and trigger their programmed cell death. It has been shown, that T-cells perform an active, self-propelled random motion. However, the characteristics of this motion on large scales are unknown. Since the effectiveness of the immune response depends on how many defect cells can be eliminated within a certain period of time, we investigate the search mechanism of killer T-cells. To this end, we observe primary human T-cells under different conditions by light microscopy and analyse the motion using tracking algorithms and statistic methods. To analyse the data, we use a simple phenomenological stochastic model, where the motion of a single cell is caused by active forces of several pseudopodia. Comparing experimental and simulated data, we connect macroscopic parameters like motility and persistence of the cells' motion to microscopic variables like the (mean) number of active pseudopodia or the duration of their activity, and we determine how these values change under external signals.

BP 17.3 Wed 17:30 Poster A

The Mechanics of Cellular Compartmentalization and Its Impact on Tumor Spreading — •Steve Pawlizak, Anatol Fritsch, Mareike Zink, and Josef A. Käs — Institute for Experimental Physics I, Soft Matter Physics Division, University of Leipzig, Germany

Compartmentalization is a fundamental process of cellular organization that occurs in particular during embryonic development. A simple model system demonstrating compartmentalization involves mixing together two different populations of suspended cells. After a certain time, this mixture will eventually segregate into two phases, whereas mixtures of the same cell type will not. The *differential adhesion hypothesis* by Malcolm S. Steinberg (1960s) explains this organization behavior by differences in surface tension and adhesiveness of the interacting cells. To understand to which extent the same physical principles affect tumor growth and spreading between compartments [1], we investigate cellular mechanical properties and interactions of various cell types, such as healthy and cancerous breast cell lines of different malignancy as well as primary cells from human cervix carcinoma. To this end, a set of techniques is applied: The *Optical Stretcher* is used for whole cell rheology. Cell-cell-adhesion forces are directly measured with a modified *atomic force microscope*. 3D segregation experiments are employed with a newly developed setup for long-term observation of *droplet cultures*. The combination of these techniques will help to clarify the role of cellular adhesion for tumor spreading.

[1] A. Fritsch et al., Nature Physics **6** (10): 730–732 (2010)

BP 17.4 Wed 17:30 Poster A

Three-dimensional obstacles for bacterial surface motility — •Claudia Meel, Nadzeya Kouzel, Enno Oldewurtel, and Berenike Maier — Biozentrum, University of Cologne

Many bacterial species live at surfaces. On the one hand they must attach firmly to avoid clearance but on the other hand they must be motile to spread. Many species have solved this problem by using polymers called type IV pili. They use pili as grappling hooks for pulling themselves over surfaces. Here we addressed the question how moving bacteria behave when they encounter microscopic elevations at the surface. We used two different species with very different lifestyles and morphologies, namely both the round human pathogen Neisseria gonorrhoeae and the rod-shaped soil-dweller Myxococcus xanthus. We showed microscopic elevations guide bacterial movement, i.e. bacteria preferentially move in groves whose dimensions are comparable to the size of the bacteria. Although both species sense the topology we propose that they derive different benefits from this ability in agreement with their different lifestyles.

BP 17.5 Wed 17:30 Poster A

Mechanical properties of filopodia quantified by photonic force microscopy — •Felix Kohler and Alexander Rohrbach — University of Freiburg, Germany

Filopodia are highly dynamic protrusions of the cell surface that are filled with tight bundles of actin. They can extend and retract on a timescale of seconds to minutes. We use photonic force microscopy (PFM) to investigate the mechanical concepts of the filopodial retraction. An optically trapped bead is attached to a tip of a filopodium. During retraction the motion of this bead is tracked interferometrically in 3D with nanometer precision at a microsecond timescale. We have measured F-actin dependent steps inside living cells during filopodial retraction likely belonging to actin-based molecular motors [1]. The high forces a filopodium can exceed as well as the retraction dynamics indicate that coordinated molecular motor movement controls filopodial mechanics. Experimental results are shown together with a Morkov chain model, which describes the cooperative behavior of molecular motors in biological systems like filopodia.

[1] Kress, H. et al.,"Filopodia act as phagocytic tentacles and pull with discrete steps and a load-dependent velocity", pnas ,Vol.104, 2007, 11633-11638

BP 17.6 Wed 17:30 Poster A

Different elasticity of left-ventricular and right-ventricular fibroblasts of DCM-patients — •Michael Glaubitz[1], Stephan Block[1], Jeannine Witte[2], Kay E. Gottschalk[3], Stephan B. Felix[2], Alexander Riad[2], and Christiane A. Helm[4] — [1]ZIK HIKE - Zentrum für Innovationskompetenz Humorale Immunreaktionen bei kardiovaskulären Erkrankungen, D-17487 Greifswald, Germany — [2]Universitätsmedizin Greifswald, Klinik und Poliklinik für Innere Medizin B, 17475 Greifswald — [3]Institut für Experimentelle Physik, Universität Ulm, D-89069 Ulm — [4]Institut für Physik, Ernst-Moritz-Arndt Universität, D-17487 Greifswald, Germany

Dilated cardiomyopathy (DCM) is a significant type of heart failure leading to increased morbidity and mortality. Left ventricular fibrosis and dilation are hallmarks of this disease. Cardiac fibroblasts (CF) are the main source for matrix regulating mediators in the heart, but their role in DCM is largely unknown. Using a colloidal particle as an AFM probe, we measure the cell elasticity of human cardiac fibroblasts derived from right and left ventricular endomyocardial biopsies. Spatially resolved measurements reveal that the elastic modulus is inhomogeneously distributed over a fibroblast, but shows less variation in the vicinity of the nucleus. By measuring at this position for several fibroblasts (of a certain patient) we observe a lognormal elastic modulus distribution. Interestingly, cells extracted from the left ventricle show generally a smaller average elastic modulus than the ones from the right side. Our findings indicate a contribution of the cellular mechanical properties to the etiology of DCM.

BP 17.7 Wed 17:30 Poster A

Microfluidic Shear Alters Network Dynamics in Living Cells — •Jens-Friedrich Nolting and Sarah Köster — Institute for X-Ray Physics and CRC Physics, University of Göttingen, Germany

Intermediate filaments are a major component of the eukaryotic cy-

toskeleton along with microtubules and microfilaments. They play a key role in cell mechanics, providing cells with compliance to small deformations and reinforcing them when large stresses are applied. Here, we present a study of fluorescent keratin intermediate filament networks in living cells with respect to their behavior in the presence of external forces. We expose the cells to controlled shear forces applied by microfluidic methods and investigate the response of the keratin network *in situ*. We track the nodes in the keratin network to deduce the dynamic behavior of the network as a function of the external shear forces. The time tracks show that the fluctuations dampen upon the application of flow. We then characterize the network dynamics by looking at the mean square displacements over time which grants access to effective diffusion constants. We find that the effective diffusion constant is reduced under shear flow conditions but seems to recover after a certain time. This may be a result of an adjustment of the cell as a response to the external shear forces.

BP 17.8 Wed 17:30 Poster A

Photo-switchable Cell Adhesion on Functionalized Nanostructures — •Laith Kadem[1], Michelle Holz[2], Saskia Viebig[1], Rainer Herges[2], and Christine Selhuber-Unkel[1] — [1]Institute for Materials Science, Technical Faculty, CAU Kiel — [2]Institute for Organic Chemistry, CAU Kiel

Cell adhesion is a crucial process, which plays an important role in a number of cell activities such as cell motility, differentiation and apoptosis. We aim at developing surfaces where light-induced switchable cell adhesion is feasible. On the one hand, we are preparing surfaces with photo-switchable hydrophobicity by using functionalized azobenzene molecules. On the other hand, we are using azobenzene molecules that are functionalized with RGD peptides in order to mediate specific cell adhesion to surfaces through integrins. Azobenzene molecules are reversible photo-induced isomerization units, so that the adhesion of cells can be photo-switched in a spatially and temporally defined fashion by UV and white light, respectively. The main adhesion platform for our adhesion experiments are nanostructured surfaces that have been fabricated using block-copolymer micelle nanolithography and that are functionalized with the azobenzene molecules. Here we show first results of cell adhesion on our photoswitchable surfaces.

BP 17.9 Wed 17:30 Poster A

Analysis of cell-substrate impedance fluctuations induced by motile cells — •Helmar Leonhardt[1], Carsten Beta[2], and Matthias Gerhardt[3] — [1]Universität Potsdam, Mathematisch-Naturwissenschaftliche Fakultät / Institut für Physik und Astronomie, Raum 2.28. 1.006 — [2]Raum 2.28 1.003 — [3]Raum 2.28 1.006

Electric cell-substrate impedance sensing (ECIS) measures the frequency dependent impedance of a small gold electrode to ac current flow. Cells on the electrode restrict the current path, forcing it to flow under the cells and out between neighboring cells or through the cell membranes. We have applied ECIS to the social amoebae Dictyostelium discoideum during starvation conditions, where chemotactic cells aggregate in streams to clusters. The chemotactic motility of Dictyostelium cells, requiring formation and retraction of lamellipodia, is connected with cyclic periodicities in changes of cell shape and size, which lead to distinct oscillations in the impedance signal due to waves of the chemoattractant cAMP, which are emitted from pacemaker centers and propagate through the population, thereby synchronizing the movement of neighboring cells. We investigated the role of actin disrupting drugs (Latrunculin A) on the fluctuations in the impedance signal and complemented our population data with systematic single cell recordings.

BP 17.10 Wed 17:30 Poster A

Cell migration on different substrates - An investigation with optical microscopy under homogeneous conditions — •Thorsten Robel[1], Daniele Martini[1], Michael Beil[2], and Othmar Marti[1] — [1]Institute for Experimental Physics, Ulm University, 89081 Ulm, Germany — [2]Internal Medicine I,Ulm University, 89081 Ulm, Germany

In this poster we discuss the influence of the substrate interaction of pancreatic carcinoma cells (line Panc-1).

The physical and chemical properties of different substrates can influence the cell motility. Over night time lapse video microscopy observations of cultivated cells were used to measure the Mean Square Displacement of the cells as well as their mean velocity. The set-up was based on an inverted Leica microscope (Leica Dmirb). An incubation chamber was used to regulate temperature, CO_2-concentration and humidity to assure identical environmental conditions for the cells. From time lapse images the trajectories of a subset of all cells were extracted with the program ImageJ.

First measurements to compare the motility of Panc-1 cells with different other cell lines were accomplished.

These observations revealed different motilities regarding cell type and substrate.

BP 17.11 Wed 17:30 Poster A

A real-time adaptive exposure system for studies of eukaryotic chemotaxis — •Alexander Anielski and Carsten Beta — Biological Physics, Universität Potsdam, Germany

The aim of our project is to quantify the chemotactic motion of eukaryotic cells. In particular, we developed a setup that allows us to separately address the dependencies of the chemotactic motion on the average background concentration and on the gradient steepness. Also, the role of spatial versus temporal sensing can be analyzed with this setup. Our method is based on compensating the cell movement by automated motion of the microscope stage. To achieve this, a software grabs frames from a camera, recognize the cell position, and moves it to the center of the field of view by automatically adapting the position of the microscope stage. To generate a well definied gradient signal, caged compounds in a fluid flow are used in combination with a computer controlled switchable gradient mask (flow photolysis). We exemplify our method with chemotactic cells of the social amoeba Dictyostelium discodideum. The motion and fluorescence data will be used to test competing models of eukaryotic chemotaxis.

BP 17.12 Wed 17:30 Poster A

Ferromagnetic guidance of paramagnetic microspheres and magnetically marked cells — •Thorsten Grassmann[1], Yuri Koval[1], Ben Fabry[2], and Paul Müller[1] — [1]Dpt. of Physics and Interdisciplinary Center for Molecular Materials, Universität Erlangen-Nürnberg, Germany — [2]Dpt. of Physics and Center for Medical Physics and Technology, Universität Erlangen-Nürnberg, Germany

We investigated thin film stripes of a ferromagnetic Permendur alloy with a high saturation magnetization aligned in a zig-zag geometry. This setup shows highly localized and permanent magnetic field gradients, both attractive and repulsive, located at the stripes' kinks. External out-of-plane magnetic fields are used to simultaneously alter depth and height of the magnetic field gradients. An external in-plane magnetic field is used to create an asymmetry in the gradient, selecting a preferred direction. This device allows the controlled motion of paramagnetic microspheres and magnetically marked biological cells along the stripes in a liquid environment, floating from kink to kink. The force acting on the paramagnets shows an inverse square-law behavior. A hardware setup with a computer-controlled vector magnet for programmable control of the field gradients and a video camera for measuring the microspheres' positions and speed was developed. The forces acting on the microspheres were measured directly via Stokes' drag. The possibility to move single living biological entities has been verified using living mouse liver cells incorporating magnetic microspheres. It is shown that the acting forces are in a range useful for rheological studies of living cells.

BP 17.13 Wed 17:30 Poster A

The influence of substrate stiffness on integrin mediated cell properties — •Maja Gulic[1], Reinhard Fässler[2], and Kay-E. Gottschalk[1] — [1]Institute for Experimental Physics, Ulm University, Germany — [2]Max Planck Institute of Biochemistry, Department of Molecular Medicine, Martinsried, Germany

Mechanical cues influence very basic cell properties like proliferation, cell shape or cell migration. Important components of the cell adhesion and migration machinery are the integrins, the actin cytoskeleton and messenger proteins. The analysis of the exact contribution of the individual components of this machinery to cellular properties is hampered by its complexity. Therefore, we reduced the complexity and examined mouse fibroblasts expressing only the fibronectin-binding integrins avb3 or a5b1 or a combination of the two.

To analyze the effect of substrate stiffness and correlate it with integrin expression, we performed experiments on cells growing on differently polydimethylsiloxane (PDMS). We then analyzed cell proliferation and morphology of the cells on the different substrates. We show that the substrate stiffness has an integrin subtype dependent influence on cell proliferation and cell shape.

BP 17.14 Wed 17:30 Poster A

Measuring local elasticity and membrane tension on differentiating cells — •Paula Sanchez[1], Kai Bodensiek[1], Schanila Nawaz[2], Mikael Simons[2], and Iwan Schaap[1] — [1]III Physikalisches Institut, Faculty of Physics, Georg-August Universität, Göttingen, Germany — [2]Max-Planck Institute for Experimental Medicine, Göttingen, Germany

The myelin sheet is a specialized membrane structure that allows rapid conduction of nerve impulses and it is essential for the integrity of the axon. In the central nervous system it is produced by differentiation of oligodendrocytes in a multistep process accompanied by dramatic changes in cell morphology. Because cell shape is controlled by cellular mechanics we want to study the mechanical properties of oligodendrocytes in order to better understand the mechanics of cell differentiation. We are using a combination of atomic force microscopy and vertical laser trapping to quantify the spatial distribution of elasticity and membrane tension over the whole cell. With our results we aim to provide links between the mechanical development of these cells and changes in their physiology and morphology.

BP 17.15 Wed 17:30 Poster A

Non-Equilibrium Cell Mechanics Studied with Optical Traps — •Florian Schlosser, Florian Rehfeldt, and Christoph F. Schmidt — Drittes Physikalisches Institut, Georg-August-Universität Göttingen

Tissue cells communicate with their surroundings biochemically, but at the same time also sense the mechanics of their micro-environment. Cells can "feel" mechanical stress by generating contractile forces through their acto-myosin cytoskeleton and use these forces to actively probe the mechanical response of their extra-cellular matrix.

With a dual optical trap setup we have performed force measurements on cells suspended between two fibronectin-coated beads to ensure focal-contacts. We analyzed the correlated fluctuations of the beads with high spatial and temporal resolution by laser interferometry. Using a combination of active probing and passive recording of fluctuations (microrheology), we can simultaneously determine the (non-thermal) forces generated by the cells and quantitate their viscoelastic response properties.

The amount of contractile force transmitted to the outside varied with the trap stiffness. To elucidate the contributions of different mechanical elements to active and passive mechanical properties of the cell we employ biochemical perturbations and fluorescence microscopy allows us to visualize the distribution of cytoskeletal proteins in the cell.

BP 17.16 Wed 17:30 Poster A

Device for mechanical stretching of adherent cells and application to pancreatic carcinoma cells (type:PANC-1) — •Patrick Paul, Tobias Paust, and Othmar Marti — Institute for Experimental Physics, Ulm University, Ulm, Germany

The structural and mechanical properties of cells are determined in part by the properties of their cytoskeleton systems. Healthy cells and cancerous cells were found to differ in their viscoelastic behavior. Softer cells were found to migrate faster through narrow channels.

The quasi-static viscoelastic behavior of cells is investigated with a deformable substrate. The stress and stress rate of the substrate is controlled. The response of the adherent cells is monitored by optical microscopy. Our apparatus contains an opto-mechanical feedback loop which centers the cell under investigation at the optical axis of the microscope. We report on the performance of our stretching device and we show first measurements with PANC-1 cells.

BP 17.17 Wed 17:30 Poster A

Lipid membrane mechanics in cytokinesis — •Jochen A. M. Schneider[1], Andrea M. Pereira[2], Ewa Paluch[2], and Guillaume Salbreux[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

Cytokinesis, the process of physically dividing the cell at the end of mitosis, is achieved through the regulated variations of forces within the cell. A key player in this process is the cell cortex, a thin layer of actin filaments and myosin molecular motors. Recently, Sedzinski *et al.* have introduced a mathematical model to describe the role of the cell cortex in cytokinesis [1]. The model has shown that one striking consequence of the contractile behavior of the cell cortex is the appearance of cell oscillations: because these oscillations can be seen as perturbations of the cellular shape, they give a window on important parameters controlling cell mechanics. Here we use this experimental assay to focus more particularly on the role of the lipid bilayer membrane in cytokinesis. The membrane is attached to the cell cortex and it has to mechanically balance the difference between extracellular and intracellular pressure. Under simple hypothesis on the membrane mechanical behavior and its area regulation by the cell, we investigate how its interaction with the cortex influences cell shape. Interestingly, preliminary results suggest that the membrane could play an important role in maintaining the cell shape stability.

[1] Sedzinski, J. *et al.* Polar actomyosin contractility destabilizes the position of the cytokinetic furrow. *Nature* **476**, 462-466 (2011).

BP 17.18 Wed 17:30 Poster A

Stochastic modeling of malaria parasite motility — •Thorsten Erdmann[1], Yin Cai[2], and Ulrich S. Schwarz[1,2] — [1]Institute of Theoretical Physics, Heidelberg University, Heidelberg, Germany — [2]BioQuant, Heidelberg University, Heidelberg, Germany

During its lifecycle, the unicellular malaria parasite from the *Plasmodium* family alternates between insect and vertebrate hosts. A critical step of its lifecycle is the entry of *Plasmodium* sporozoites into blood vessels after injection into the skin of a vertebrate host during a mosquito bite. *In vitro* experiments on two-dimensional substrates with microfabricated arrays of obstacles reveal complex motion patterns resembling the ones observed *in vivo* in the skin, with long stretches of circular or linear motion separated by abrupt changes of direction. We model the sporozoite motion using a stochastic glider model, in which the rod-like glider describes a circular path when unperturbed, but changes direction randomly upon collisions with an obstacle. This model leads to patterns of motion similar to those observed in experiment and describes well the average displacement as function of time. On the sub-second time-scale, sporozoites seem to move in a stick-slip-like fashion. In order to assess short time-scales, we introduce a model for the propulsion mechanism of sporozoites, in which the sporozoite body attaches to a substrate via specialized binding molecules, which are then displaced by small groups of non-processive motors.

BP 17.19 Wed 17:30 Poster A

Mechanics of cellular materials: Adhesion, disease and nonlinearities - a rheometric approach — •Mathias Sander and Albrecht Ott — Universität des Saarlandes

Biological cells are capable of sensing mechanical cues from their environment and they respond to them. The cell reactions range from cell adhesion, shape changes, motility, proliferation up to an adaption of mechanical properties (kinematic hardening, stress stiffening, fluidization) and even to gene expression modifications. All these abilities are essential for various biological processes among them tissue formation, wound healing or cancer metastasis. Investigation of cell mechanical properties has been driven for decades with various methods, however, it is still poorly understood, due to the complexity and the huge variety of cell behavior. In our experiments we investigate the nonlinearity of the cell mechanical response characterized by means of Fourier-Transform-Rheology. For this purpose we have developed a rheometric cell monolayer shear apparatus consisting of a commercial rheometer modified to accomodate the needs of biological cells. We also study cell adhesion, here on inorganic AL/Al2O3- nanowire-substrates, using the same technique. We also present data on tissue mechanics, namely the impact of atherosclerotic lesions on the mechanical properties of aortic tissue.

BP 17.20 Wed 17:30 Poster A

Influence of Extracellular Matrix Topography on Cell Motility — •Mari Gorelashvili and Doris Heinrich — Physics of Cell Dynamics Group, Physics Department and Center for Nanoscience CeNS, Ludwig-Maximilians Universität München, Geschwister-Scholl-Platz 1, 80539, Munich, Germany

Cell migration is governed by intracellular signaling in response to external stimuli. Recent advances have been made in investigating cell motility on flat 2D surfaces, but our understanding of basic cellular motility in 3D extracellular matrix (ECM) is less progressed.

Here, we investigate the influence of micro-scale surface topography on the amoeboid motility of D. discoideum. We aim at predicting and controlling cellular migration in well-defined pillar arrays by disturbing and eliminating key proteins in the cells. By using our home-made local mean-squared displacement algorithm we extract a time-resolved motility characterization.

Our results reveal that D. discoideum spontaneous migration con-

sists of alternating phases of directed (dir) runs and random (rm) migration modes. Contrary to expectations, dir-runs are of lower frequency and of higher velocities in pillar array. Further, pillar network geometry is reflected in the migration angle distribution of wild type cells but not of cells lacking microtubules [1].

[1] D. Arcizet S. Capito, M. Gorelashvili, C. Leonhardt, M. Vollmer, S. Youssef, S. Rappl and D. Heinrich, Soft Matter, 2011, DOI: 10.1039/c1sm05615h

BP 17.21 Wed 17:30 Poster A

Three-dimensional templates produced by direct laser writing for dental implant surface optimization — •Judith Katharina Hohmann[1], Erik Waller[1], Rainer Wittig[2], Rudolf Steiner[2], and Georg von Freymann[1] — [1]Physics department and research center OPTIMAS, University of Kaiserslautern — [2]Institute for Laser Technologies in Medicine and Measurement Technology (ILM) at the University of Ulm

Dental implant failure occurs in up to eight percent, usually resulting from deficit osseointegration or insufficient adaptation of soft tissue. Many approaches to improve dental implant acceptance deal with chemical and/or physical surface treatments (e.g. acid-etching, sand blasting) leading to randomly shaped two-dimensional patterns. These patterns lack true three-dimensional motifs with defined sizes. In general, results generated in two-dimensional systems can hardly be transferred to natural, three-dimensional systems.

Our aim is to understand the relation between various three-dimensional candidate structures and differentiation of osteoblastic cells and to use these results to generate implant surfaces which promote osseointegration.

Structures are produced by direct laser writing and coated with titanium dioxide. Smallest feature sizes realized yet are 330 nm, allowing to design and generate structures on both nano- and micrometer scale. To observe cellular behavior, osteosarcoma cells are applied to the structures in order to test growth, morphology, adhesion and differentiation via fluorescence and staining techniques.

BP 17.22 Wed 17:30 Poster A

When Folding does not Imply Pullout: Different Modes of Growth Cone Collapse in NG 108-15 Cells — Philipp Rauch[1], •Paul Heine[1], Barbara Göttgens[2], and Josef Käs[1] — [1]Institute of Experimental Physics I, University of Leipzig, Germany — [2]Institute of Biology, University of Leipzig, Germany

Neuronal pathfinding is crucial for the proper wiring of the central and peripheral nervous system. A growth cone at the tip of every neurite detects and follows multiple guidance cues initiating directional changes, outgrowth, or neurite retraction. However, when focusing on cytoskeletal retraction mechanisms it is rarely considered that even partial retractions of the neurite appear excessive in cases where outgrowth is merely supposed to locally cease or stall.

We evaluated cytoskeletal dynamics of transiently transfected NG108-15 growth cones using fluorescence time lapse microscopy and could identify an alternative mode of growth cone collapse leading to a controlled halt of neurite extension without retraction. Our findings show that lateral movement and folding of actin bundles confine microtubule extension and limit their expansion. This process stands in stark contrast to neurite retraction where collapsing actin structures buckle microtubules. The flexure of these stiff polymers most likely generates considerable forces on the remaining adhesion sites, which inevitably leads to their disintegration and subsequent neurite retraction. Altogether the described mechanisms elucidate neuronal growth regulation by closing the gap between full retraction and small scale fluctuations.

BP 17.23 Wed 17:30 Poster A

Mitotic Spindle Positioning by Cortical Force Generators — •Rui Ma[1,2], Nenad Pavin[3], Liedewij Laan[4], Marileen Dogterom[4], and Frank Jülicher[1] — [1]Max Planck Institute for the Physics of Complex Systems (MPI-PKS), Dresden, Germany — [2]Institute for Advanced Study Tsinghua University, Beijing, China — [3]Department of Physics, Faculty of Science, University of Zagreb, Zagreb 10002, Croatia — [4]FOM Institute for Atomic and Molecular Physics (AMOLF), Science Park 104, 1098 XG Amsterdam, the Netherlands

In animal cells, the plane of cell division is determined by the position of the mitotic spindle. During asymmetric cell division of the C. elegans embryo the mitotic spindle is displaced away from the geometric cell center. This displacement results from the asymmetric activation of cortical force generators which pull on astral microtubules. We present a physical description of the interplay of pushing and pulling forces on astral microtubules in a three dimensional geometry. The Key element in this description is the fact that growing microtubules can slide along the cell cortex thus experiencing a pushing force. Once they are attached to a force generator, they would experience a pulling force before undergoing disassembly. We show that the net force acting on the pole depends on the angular distribution of astral microtubules which results from the combination of microtubule nucleation, growth, sliding and disassembly. Asymmetric activation of pulling force generators can lead to stable positioning of the the centrosome at positions displaced off the geometric center.

BP 17.24 Wed 17:30 Poster A

Static and dynamic adhesion of Staphylococci on model substrates, studied by AFM — •Nicolas Thewes, Christian Spengler, Peter Loskill, and Karin Jacobs — Saarland University, Experimental Physics, D-66041 Saarbrücken, Germany

Bacterial adhesion to surfaces is a complicated process that depends on many factors such as the type of bacterium, the type of surface, the composition of the material and the time of contact. To distinguish effects due to the different factors, the relevant parameters have to be varied independently. A set of tailored silicon wafers allows for this variation. Using AFM-force spectroscopy, we studied the adhesion of bacteria of the Staphylococcus genus to these model substrates. Measurements on wafers with different oxid layer thicknesses show that the subsurface composition of the material influences the adhesion forces. Responsible for this fact are the different van der Waals interactions between the bacteria with wafers with thin and thick oxide layer. Furthermore, a variation of the time of contact between bacteria and substrate reveals differences in the dynamics of the adhesion forces for different species, viz. different call wall compositions.

BP 17.25 Wed 17:30 Poster A

Mechanical instabilities of tubular cellular protrusions — •Dominic Jourdain and Karsten Kruse — Theoretische Physik, Universität des Saarlandes, Postfach 151150, 66041 Saarbrücken, Germany

Cellular systems present a multitude of tubular protrusions, e.g., filopodia, axons or stereocilia. These structures are essentially cylinders delimited by a lipid membrane and filled with cytoskeletal filaments. The intrinsic activity of such protrusions can induce mechanical instabilities. For example, peristaltic shape transformations of axons have been observed subsequent to osmotic perturbations [1]. To further understand possible mechanical instabilities of tubular protrusions, we study the dynamics of active gels inside cylindrical membrane tubes. A multi-component hydrodynamic theory is used to describe cytoskeletal dynamics on a continuum level and on macroscopic length and time scales. We find that sufficiently large active stresses in the gel induce peristaltic instabilities.

[1] Pullarkat et al., *Phys. Rev. Lett.* **96**, 048104 (2006)

BP 17.26 Wed 17:30 Poster A

Contact formation between pathogenic amoebae and target cells — •Julia Reverey[1], Saskia Viebig[1], Matthias Leippe[2], and Christine Selhuber-Unkel[1] — [1]Institute for Materials Science, Kaiserstr. 2, 24143 Kiel, Germany — [2]Zoological Institute, Am Botanischen Garten 1-9, 24118 Kiel, Germany

Acanthamoeba are parasitic amoebae, which can cause severe diseases, such as amoebic encephalitis and keratitis. They destroy certain target cells like nerve cells by an extracellular killing mechanism that is induced by the formation of a close contact between amoebae and nerve cells. In Acanthamoeba the target cell can be phagocytosed through membrane invaginations called food cups.

For a deeper understanding of this amoebic killing mechanism, Acanthamoeba are cocultured with nerve cells. Using high-speed live cell imaging, cocultures of amoebae and nerve cells are studied and the contact formation and related processes like phagocytosis are investigated. In order to mimic the contact formation, beads with different carbohydrate coatings are brought into contact with the amoebae. Also here live-cell imaging is used to achieve a better understanding of the interrelations between carbohydrate functionalization, contact formation and phagocytosis.

BP 17.27 Wed 17:30 Poster A

Cells & stress: integrin dependent mechanical properties of fibroblasts — •Fenneke KleinJan[1], Tobias Pusch[1], Thomas

Kerst[1], Reinhard Fässler[2], and Kay Gottschalk[1] — [1]Ulm University, Institute of Experimental Physics, Ulm, Germany — [2]Max-Planck Institute of Biochemistry, Department of Molecular Medicine, Martinsried, Germany

Like humans, cells are often under stress. Blood flow influence endothelial cells, skin cells have to resist stretch and pressure. The protein-family of integrins is a key element in responding to this force, functioning as a bidirectional force signalling protein between the cytoskeleton and the extracellular matrix. Cells are able to respond to force by changing their internal structural elements (cytoskeletal filaments), thereby affecting their mechanical properties.

The 24 integrins in mammals form a dynamic and complex signalling network. In this study we use mouse fibroblasts with reduced complexity. They express or only one specific integrin ($\alpha\nu\beta3$ or $\alpha5\beta1$) or both ($\alpha\nu\beta3\alpha5\beta1$). So we can study the effect of different integrins individually and together on the mechanical properties of the cell.

Due to the structural heterogeneity of the cell we have to probe the mechanical response locally. Our main method is microrheology, where mechanical properties are extracted from moving micron-sized beads. We studied both living cells and isolated intermediate filament network, also as a function of force. Preliminary results show that cells expressing both integrins have a stiffness which is in between the $\alpha5\beta1$ (least stiff) and $\alpha\nu\beta3$ (most stiff).

BP 17.28 Wed 17:30 Poster A

Spontaneous actin waves in a deformable domain — •Alexander Dreher and Karsten Kruse — Theoretische Physik, Universität des Saarlandes, Postfach 151150, 66041 Saarbrücken, Germany

The crawling of eukaryotic cells on substrates is driven by the cytoskeleton. How the cytoskeleton is organized in this process is still poorly understood. It has been suggested that spontaneous polymerization waves provide a possible answer to this question. We examine this possibility theoretically by analyzing a system of treadmilling filaments in a deformable domain. It is known that treadmilling filaments can spontaneously generate polymerization waves [1]. The domain boundary is characterized by a surface tension and a bending rigidity and evolves due to interactions with the filaments. We find spiral waves as well as states with a net directional motion of the system's geometric center of mass. In contrast to [2], we solve the full system of dynamic equations and consider a more realistic length regulation of the filaments.

[1] Doubrovinski and Kruse, *EPL* **83** (2008) 18003
[2] Doubrovinski and Kruse, *PRL* in press

BP 17.29 Wed 17:30 Poster A

Subsurface Imaging Using Atomic Force Acoustic Microscopy at GHz Frequencies — •Matthias Büchsenschütz-Göbeler[1], Yuansu Luo[1], Shuiqing Hu[2], Chanmin Su[2], Walter Arnold[1,3], and Konrad Samwer[1] — [1]1. Physikalisches Institut, Universität Göttingen — [2]Bruker-Nano Inc., Santa Barbara, CA, USA — [3]Department of Materials, Saarland University

We describe a technique to image subsurface structures using Atomic Force Acoustic Microscopy operated at 1 GHz. The devices or samples to be imaged are insonified with 1 GHz ultrasonic waves which are amplitude modulated at a fraction or multiple frequency of cantilever contact-resonance [1]. The transmitted signals are demodulated by the nonlinear tip-surface interaction, enabling one to image defects in the device based on their ultrasonic scattering power which is determined by the ultrasonic frequency, the acoustic mismatch between the elastic properties of the host material and the defects, by their geometry, and by diffraction effects. We investigated defect structures in specially prepared samples, in silicon wafers as well as the cytoskeleton in living cells. Concerning the living cells we are interested to understand the contrast mechanism for imaging and the response to different substrate morphologies. Especially the interplay of cellular elasticity, adhesion and motility are brought into focus.

Financial support by the DFG SFB 937 is thankfully acknowledged.

[1] Imaging of Subsurface Structures Using Atomic Force Acoustic Microscopy at GHz Frequencies S. Hu and C. Su, and W. Arnold, J. Applied Phys. 109, 084324 (2011)

BP 17.30 Wed 17:30 Poster A

Live Cell Rheology — •Zhanna Santybayeva, Alexander Zielinski, Wolfgang Rubner, Johannes Fleischhauer, Bernd Hoffman, and Rudolf Merkel — Institute of Complex Systems 7, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany

Endothelial cells are responsive to mechanical stress. The objective of the current work is to observe immediate reaction of human umbilical vein endothelial cells upon single and cyclic stretch, and to analyze force exertion to an elastic substrate at adhesion sites. With the help of live cell imaging and fluorescence microscopy, whole cell reorientation and its inner reorganization can be detected, both during stretch and at extreme stretch amplitudes. The setup in development and specifically designed software allow observing cell immediate reaction to mechanical stress.

Precise alignment is achieved via programmable xy- and z-stages, enabling live acquisition. Devices are controlled individually or combined in a certain sequence, depending on the demands of an experiment, e.g. frequency and amplitude adjustable cyclic stretch, z-focus control with image processing on fly, multi-channel acquisition during stretch (movie), time-resolved z-stacks, etc. The substrate is a 350 um thick cross-linked silicone rubber (polydimethylsiloxane) with fluorescent beads embedded on the surface. When attaching to the substrate, cells exert point-like forces at adhesion sites, so called focal adhesions (FA). Displacements on the substrate give information on the force exercised at FA. Analyzing image sequences, we can reconstruct dynamics of force, focal adhesions and whole cell reorientation.

BP 17.31 Wed 17:30 Poster A

Cancer cell migration through narrow channels — •Caroline Gluth[1], Irina Harder[2], Amy C. Rowat[3], and Ben Fabry[1] — [1]LPMT, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany — [2]ODEM-Gruppe, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany — [3]SEAS, Harvard University, Cambridge, USA

Cancer cells have the ability to migrate through narrow pores and channels of the extracellular matrix. To study this process under defined conditions and to find a minimum pore size through which cancer cells can migrate, we used soft lithography to fabricate 3-dimensional polydimethylsiloxane (PDMS) substrates with rectangular channels of varying width (2 - 10 um) and height (3 - 7 um). The channels had a length of 20 um at constant width, or a length of 140 um with a tapered shape (opening angles of 4 - 16 deg) and a width of 2 um at the narrow end. MDA-MB-231 breast carcinoma cells were able to migrate through the narrowest openings (2 x 3 um). We found two dominating migration strategies which are not commonly observed in cells migrating on planar 2-dimensional substrates. The majority of cells protruded thin (< 3 um) and long (order of 100 um) dendritic-like filopodia into the channel lumen, while some cells also showed extensive blebbing and amoeboid-like movements. Similar behavior can also be seen in mouse embryonic fibroblasts and in cancer cells migrating through a 3-dimensional collagen network. These results demonstrate that cancer cells are able to choose between multiple migration strategies for navigation through a highly confined environment.

BP 17.32 Wed 17:30 Poster A

Adhesion forces during immunological synapse formation — •Janosch Deeg[1,2], Anastasia Liapis[3], David Depoil[3], Catharina Cadmus[1,2], Michael Dustin[3], and Joachim Spatz[1,2] — [1]Max-Planck-Institute for Metals Research, Department of New Materials and Biosystems, Stuttgart, Germany — [2]University of Heidelberg, Institute for Physical Chemistry, Biophysical Chemistry Group, Heidelberg, Germany, — [3]Skirball Institute of Biomolecular Medicine, New York University School of Medicine, New York

A key element of the adaptive immune response is the interaction between T lymphozytes and antigen presenting cells (APC), which can lead to the so-called T cell activation. During interaction a complex molecular structure, the immune synapse (IS) at the T cell/APC-interface is formed. In order to quantify the interaction forces and kinetics during synapse formation we measured adhesion forces using an atomic force microscope. Our ongoing research focuses on mimicking the APC interface by a synthetic analogue allowing for the control of arrangement of involved proteins. Highly structured nanoparticles are employed as molecular anchor points for proteins of interest which in turn are then used to activate T cells and investigate the complex process of IS formation while having precise control over important parameters at the nanometer scale.

BP 17.33 Wed 17:30 Poster A

Insight into the cell-beam interaction in the Optical Stretcher — •Steffen Grosser, Anatol Fritsch, Tobias Kiessling, Roland Stange, and Josef Käs — Universität Leipzig, Leipzig, Germany

In the optical cell stretcher, force on cells is exerted by two counter-

propagating beams. Usually, these forces are calculated using a ray-optics approach, assuming the same refractive index for all cells. The effect of the cells on the beam has so far been disregarded.

We use an extension of the optical stretcher setup that allows to partially track the laser beams after having passed the cell in the stretcher chamber. We report that the effect of the cells on the beam can, to first order, be described by a cell-lens analogy: The cells reduce the divergence of the laser beam or can even refocus the beams. Smaller cells have a higher radius of curvature and are thus stronger lenses; an expectation which we experimentally confirm.

Parameters such as cell size and ellipticity are used in a ray-transfer-matrix calculation to predict the expected focussing, making it possible to give an estimate of the refractive index of the individual cell by comparing the expected and the actual measured focussing. This in turn allows to readress the problem of determining the force exerted on the cell.

BP 17.34 Wed 17:30 Poster A

Filopodia-Lamellipodia Interaction Dynamics in Neuronal Growth Cones — Melanie Knorr and •Josef Käs — Universität Leipzig, Institut für Experimentelle Physik 1, Linnéstr. 5, 04103 Leipzig, Germany

Neurons are one of the most specialized cells in living organisms, capable of detecting weak signals in a very noisy environment. Explorations of its surrounding is guided by the so called growth cone, a thin veil-like structure at the tip of each neurite consisting of actin and microtubules. As these structures move on two-dimensional substrates, they exhibit vast fluctuations at their leading edge. These fluctuations are driven by the polymerization of the underlying actin network [1,2], switching stochastically between On and Off states. Previous studies investigated the dynamics of the growth cone lamellipodia, neglecting the contribution of filopodia to the dynamics. Therefore we focused on the interaction of filopodia and lamellipodia dynamics in primary neuronal growth cones and will show first results concerning correlations of speed, length and distances.

[1] T. Betz, D. Koch, D. Lim and J. A. Kas, Biophys. J., 2009, 96, 5130-5138.

[2] M. Knorr, D. Koch, T. Fuhs U. Behn and J. A. Kas, Soft Matter, 2011, 7, 3192-3203.

BP 17.35 Wed 17:30 Poster A

Random and directed modes of one-dimensional ameboid motion — •Oliver Nagel, Matthias Theves, and Carsten Beta — Institut für Physik und Astronomie, Universität Potsdam, Germany

We use narrow microfluidic channels to study the quasi one-dimensional motion of starvation developed Dictyostelium discoideum cells, a model organism for amoeboid movement. Confined in channels with a crosssection on the order of an average cell diameter (10 x 20 microns), two modes of movement were observed. On the one hand, cells may perform a one-dimensional random walk, frequently switching the direction of motion in the channel. On the other hand, we observed cells that moved persistently in one direction along the channel for more than half an hour without reversing their direction of motion. Surprisingly, these cells even continued their persistent movement in an unbounded area for several minutes after leaving the narrow confinement of the channel. Furthermore, we have performed fluorescence microscopy experiments that provide insight into the degree of cytoskeletal polarization of these persistently moving cells by imaging the intracellular distribution of actin and myosin II in the cell cortex.

BP 17.36 Wed 17:30 Poster A

Force Generation in Blood Platelets — •Sarah Schwarz G. Henriques[1], Hansjörg Schwertz[2], and Sarah Köster[1] — [1]Institute for X-Ray Physics & CRC Physics, University of Göttingen, Germany — [2]Division of Vascular Surgery, University of Utah, USA

Cellular contraction is of vital importance to living organisms. Thus, for example, blood clotting is achieved by contracting blood platelets. To that effect, platelets activate at damaged blood vessel sites, aggregate and finally pull on intercellular fibrin links. Consequently, they solidify the clot mass, forming a plug to effectively seal the wound. Apart from being of great medical importance, blood platelets represent an ideal model system for studies of cellular contraction for two main reasons: They are simple, being anucleate, and their activation, which occurs within minutes, can be triggered and synchronized by the addition of thrombin. In our experiments we look at force generation at the level of single cells during platelet contraction. To this end, we use traction force microscopy, which provides access to the temporal evolution and spatial distribution of generated forces. Furthermore, we fix cells at different activation stages and stain actin in order to describe cytoskeletal reorganization steps. In combining both traction force microscopy and fluorescence imaging we can resolve traction force maps for single cells and simultaneously access information about force generating mechanisms in the cytoskeleton. We find that force transduction occurs predominantly at the periphery of the cell body and total forces are in the range of 30 nN, which is comparable to literature values.

BP 17.37 Wed 17:30 Poster A

Continuum Theory and Vertex Model Simulations of Self-organized Growth in Developing Epithelia — •Peer Mumcu[1], Ortrud Wartlick[2], Marcos González-Gaitán[2], and Frank Jülicher[1] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Department of Biochemistry and Department of Molecular Biology, Geneva University, Switzerland

Developing tissues possess intrinsic growth control mechanisms which determine the final size and shape. The basic principles of growth control are still poorly understood. However, there is a lot of evidence that certain morphogens act as growth factors and play a key role in this process. Morphogens are a special class of signaling molecules that are secreted from localized sources, spread throughout the tissue and form graded concentration profiles. We study growth control from a theoretical viewpoint using a two-dimensional vertex model that describes the organization of cells by a network of polygons, including the dynamics of morphogen distributions as additional variables. In this theoretical framework, we study the consequences of specific growth rules according to which cells divide when subject to relative temporal changes of the cellular morphogen levels. We discuss a scenario which is consistent with experimentally observed growth curves obtained in the fruit fly Drosophila. Furthermore we show that essential features of the vertex model simulations are captured by a simple dynamical system, which provides deeper insight into the dynamics and stability properties of the growing system.

BP 17.38 Wed 17:30 Poster A

Mechanics and morphology of the interface between two cell populations during tissue growth — •maryam aliee[1], Jens-Christian Röper[2], Christian Dahmann[2], and Frank Jülicher[1] — [1]Max Planck Institute for the Physics of Complex Systems, 01187 Dresden, Germany — [2]Max Planck Institute of Molecular Cell Biology and Genetics, 01307 Dresden, Germany

During the development of tissues distinct cellular compartments are established. The interface between these compartments remains sharply defined and on average straight during growth and development. Using a vertex model to describe cell mechanics we discuss several physical mechanisms that contributes to interface morphology. We analyze the influence of cell bond tension, cell proliferation, oriented cell division, cell area pressure, and cell elongation, on the time dependence of interface morphology and mechanics. We show that a local increase in cell bond tension at the interface and a reduced cell proliferation rate in the vicinity of the interface produce effective interfacial tension and reduce the roughness of interfaces significantly. We also study the case in which orientation of cell division depends on cell shape and the case in which cell division rate is affected by cell area pressure. These two mechanisms have negligible contribution to the interfacial tension, however the interface roughness is significantly reduced when combined with a local increase of cell bond tension at the interface. In the case where cells are elongated by external shear stress, the interfacial tension is changed slightly, while there is a strong effect straightening the interface.

BP 17.39 Wed 17:30 Poster A

Critical behaviour and axis defining symmetry breaking in Hydra embryonic development — •Heike Dobicki[1], Andrea Gamba[2], Mario Nicodemi[3], Albrecht Ott[1], Aravind Pasula[1], Mathias Sander[1], and Jordi Soriano[4] — [1]Biol. Experimentalphysik, Univ. d. Saarlandes — [2]Politecnico di Torino and CNISM — [3]Dip.to di Science Fisiche, Universitá di Napoli "Federico II" — [4]Dept. d'ECM, Facultat de Física, Univ. de Barcelona

Axis-determination plays a pivotal role in embryogenesis, development and tissue regeneration. Before axis locking, animal embryos usually go through a phase, which features a fluid-filled cavity, surrounded by a sphere of cells, called a blastula. Hydra vulgaris, a fresh-water cnidarian, has a radial symmetry with a head-to-foot axis. It can reproduce

either sexually or asexually by budding. The hydra regeneration process starts with a spherical shape similar to a blastula in embryonic development. The cell sphere actively oscillates until it establishes the head-to-foot axis and subsequently develops into a complete animal. We have observed a self-similar distribution of the ks1-gene on the cell sphere at the symmetry breaking moment. We suggest that the main features of hydra axis establishment can be inferred from the limited communication ability of the cells. A numerical simulation based on a fluctuating cell state, which spreads between neighboring cells only, reproduces all of the observed experimental data well. Besides the critical state that occurs at the axis locking moment, this also includes a bistable distribution of the axis orientation by a weak temperature gradient.

BP 17.40 Wed 17:30 Poster A

Impact of Temperature on Cell Nuclei Integrity in the Optical Stretcher — •Enrico Warmt, Tobias Kiessling, Anatol Fritsch, Roland Stange, and Josef Käs — University of Leipzig, Faculty of Physics and Earth Sciences, Institute of Experimental Physics I, Soft Matter Physics Division, Linnéstraße 5, 04103, Leipzig, Germany

The deformation of cells in Optical Stretcher experiments is considered to be caused exclusively by the deformation of the cellular cytoskeleton. However, the visual appearance of certain cell types during the stretching process implicates events taking place in the cell organelles, especially the cell nucleus. To obtain a more detailed view into the cell we dyed the nucleus in different cell lines and stretched many cells to examine the behavior of the nucleus. At a certain laser power, we observe an abrupt restructuring of the nucleus of MCF-7 cells. This restructuring is irreversible and does not occur during a second stretch of the same cell. Interestingly, the intensity of the restructuring differs between cell lines in a highly reproducible way: While MCF-7 and HMEC show a significant restructuring, less or even no restructuring is observed on MDA-MB-231, MDA-MB-436 and MCF-10A cells. By controlling the ambient temperature, we show that restructuring is triggered by a laser-induced increase in temperature during measurement. The underlying physical processes and the origin of the variations among cell lines has to be clarified.

BP 17.41 Wed 17:30 Poster A

Synchrotron-based functional imaging of prostate tissue samples — •Andrea Matschulat[1], Georgi Graschew[2], Anton Serdyukov[1], Arne Hoehl[1], Ralph Müller[1], and Gerhard Ulm[1] — [1]Physikalisch-Technische Bundesanstalt (PTB), Abbestr. 2-12, 10587 Berlin, Germany — [2]ECRC Campus Buch, Max-Delbrück-Centre of Molecular Medicine, Lindenberger Weg 80, 13125 Berlin, Germany

In our contribution we focus on the sensitive biochemical and functional imaging of human tissue samples with the help of synchrotron-based FTIR-microspectroscopy. FTIR-microspectroscopy is an optical non-invasive technique and has proven to be a fast diagnostic readout tool for multiplexed analysis of biomolecules, mainly in the biomedical field. Measurements were performed at the Metrology Light Source (MLS) of the PTB, an unique low-energy electron storage ring that provides broad-band synchrotron radiation. In our systematic approach we studied the MIR signatures of human benign and malign prostate tissue samples in the spectral range from 900 cm^{-1} to 3900 cm^{-1} under implementation of brilliant synchrotron radiation and globar source in the reflection mode. For a reliable clinical diagnosis with respect to distinct localization of benign and malign tissue areas, a sensitive detection of tissue samples with/without biomarkers is very important. Additionally, spectral quality, i.e., high S/N-ratios in spectral datasets and their correction by Mie scattering algorithms are needed. We will discuss the results of Mie-corrected MIR signatures of prostate tissues and evaluate their classification by multivariate statistics.

BP 17.42 Wed 17:30 Poster A

Biofilm Formation on Microstructured Components — •Jennifer Marx[1], Christine Müller[1], Christin Schlegel[3], Kai Muffler[3], Guido Schüler[2], Michael Walk[2], Jan C. Aurich[2], Roland Ulber[3] und Christiane Ziegler[1] — [1]Department of Physics and Research Center OPTIMAS — [2]Institute of Manufacturing Technology and Production Systems — [3]Institute of Bioprocess Engineering

As soon as a biological molecule, for example bacteria, gets in contact with a surface, they adsorb to the surface. As result a biofilm is established. Especially in bioreactors the bacteria are used to gain for example pharmaceutical products. In this work micro milled titanium compared to native titanium is used as substrate for the biofilms. The biofilm establishment, the morphology of the bacteria and the adhesion of the cells is investigated by a combination of fluorescence microscopy and scanning force as well as scanning electron microscopy (SFM, SEM) as a reference method. The fluorescence dyes show the genetic material in the bacteria in combination with the extracellular matrix and in addition the discrimination between live and dead cells in the biofilm. An almost living biofilm can be observed on natural titanium. The calibration of optical microscopy and SFM allows the detailed imaging of the cells. On natural titanium a multi-layered biofilm with a fusion of colloidal cells to chains is observed. The SEM approves this observation. and provides an insight into detailed structures of the biofilm. On microstructured titanium a biofilm in the microstructures was observed.