BP 66: Biomaterials and Biopolymers III (Joint Session BP/CPP/MM)

Joint session with CPP and MM organized by BP.

Time: Thursday 15:00–16:15 Location: H45

BP 66.1 Thu 15:00 H45

Contribution of Biofilm Matrix Components to Physical Material Properties of Bacterial Biofilms — •Sara Kesel, Stefan Grumbein, Ina Gümperlein, Anna-Kristina Marel, Marwa Tallawi, Oliver Lieleg, and Madeleine Opitz — Center for NanoScience, Faculty of Physics, Ludwig-Maximilians-Universität München, Munich, Germany

Bacteria can be protected from antibiotics, chemicals and mechanical stresses by a self-produced matrix, the so called biofilm. As biofilms can grow on various surfaces such as medical implants, this poses a big problem in health care and industry. Biofilm matrices can thereby consist of different extracellular substances (EPS) such as polysaccharides, proteins, lipids and nucleic acid. Understanding of the individual contributions to the above described resistances by the different biofilm matrix components is therefore necessary, in order to prevent and fight biofilm growth. In particular, it is important to understand at what stage of biofilm formation the observed resistances are developed. In this study, different stages of biofilm growth (attachment of single cells, microcolony growth, as well as mature biofilms) were investigated using several techniques such as e.g. cantilever arrays, time-lapse microscopy and atomic force microscopy. The attachment of single bacteria onto solid surfaces and further physical material properties of two B. subtilis wild-type strains that differ in their biofilm matrix composition were analyzed. Furthermore, using several mutant strains the impact of specific biofilm matrix elements on the observed biofilm properties was quantitatively analyzed.

BP 66.2 Thu 15:15 H45

Multiple bio-functionalization in 3D-scaffolds for cell manipulation realized by orthogonal (photo)chemistry — •Vincent Hahn[1], Benjamin Richter[2], Tanja Claus[3,4], Guillaume Delaittre[3,5], Christopher Barner-Kowollik[3,4], Martin Wegener[1,6], and Martin Bastmeyer[2] — [1]Institute of Applied Physics, Karlsruhe Institute of Technology (KIT) — [2]Zoological Institute and Institute for Functional Interfaces, KIT — [3]Institute for Chemical Technology and Polymer Chemistry, KIT — [4]Institute for Biological Interfaces, KIT — [5]Institute for Toxicology and Genetics, KIT — [6]Institute of Nanotechnology, KIT

In recent years, we have applied Direct Laser Writing to fabricate 3D-microscaffolds for culturing cells in a well-defined environment and investigated cellular responses, e.g., contractility, adhesion and shape.

By sequential writing of different photoresists, patterned scaffolds are realized. They consist of protein-binding polymers next to regions containing light-activatable monomers in a non-protein binding background. Upon light-activation we were able to biotinylate specific regions in the passivating backbone. When incubated with a protein solution, proteins adsorb only onto protein-binding polymer areas. The biotin-linker is subsequently addressed by using avidin and any other biotinylated protein of choice. This technique has been successfully applied to fabricate scaffolds functionalized with two different adhesion proteins that selectively direct cell adhesion.

Such scaffolds might prove useful for applications in tissue engineering and stem cell differentiation.

BP 66.3 Thu 15:30 H45

Different protein adsorption rates on different grain orientations in hydroxyapatite — •Thomas Faidt, Jörg Schmauch, Michael Deckarm, Samuel Grandthyll, Frank Müller, and Karin Jacobs — Saarland University, Dept. of Experimental Physics, 66041 Saarbruecken

As a model system for tooth enamel, hydroxyapatite (HAP) pellets with a density of $> 97\%$ of the theoretical crystallographic density of HAP have been produced by compacting and sintering commercially available HAP powder. Atomic force microscopy (AFM) combined with electron backscatter diffraction (EBSD) measurements reveal the smoothness and the crystal orientation of the HAP grains on the surface of the pellets. On these surfaces, single molecule BSA adsorption experiments are performed in a microfluidic setup and reveal that different grain orientations provoke different adsorption rates. These findings open a pathway to control protein adsorption.

BP 66.4 Thu 15:45 H45

Studying Biomineralization with ultrathin silica sheets grown at the air-water interface. — •Helmut Lutz[1], Vance Jaeger[2], Rüdiger Berger[1], Mischa Bonn[1], Jim Pfaendtner[2], and Tobias Weidner[1] — [1]Max Planck Institute for Polymer Research Ackermannweg 10, Mainz 55128, Germany — [2]Chemical Engineering University of Washington 105 Benson Hall, Seattle, WA 98195-1750, USA

Inspired by diatom silification we used amphiphilic peptides consisting of leucine and lysine (LK peptides) to investigate biomineralization at surfaces. Depending on hydrophobic periodicity, these peptides adopt alpha helical or beta sheet structures at the air-water interface. Upon addition of a silica precursor we obtained surface-tailored peptide-silica hybrid films with a thickness of ~4 nm. We probed film composition and interactions between peptides and silica at early stages of biomineralization by means of surface sensitive techniques, such as sum frequency generation (SFG) and X-ray photoelectron spectroscopy (XPS). Electron and atomic force microscopy show similarities of the film fine structure and the surface of in-solution silica precipitates. Experimental findings were complemented with molecular dynamics simulations. We believe that our results provide insights into the biomineralization of structured films, which might prove useful in materials design and surface engineering.

H. Lutz, V. Jaeger, R. Berger, M. Bonn, J. Pfaendtner, T. Weidner, Advanced Materials Interfaces 2015, 2, n/a. J. E. Baio, A. Zane, V. Jaeger, A. M. Roehrich, H. Lutz, J. Pfaendtner, G. P. Drobny, T. Weidner, Journal of the American Chemical Society 2014, 136, 15134.

BP 66.5 Thu 16:00 H45

AFM force spectroscopy with S. aureus and Strep. mutans to reveal biopolymer binding properties — •Friederike Nolle[1], Nicolas Thewes[1], Christian Spengler[1], Kordula Schellnhuber[1], Peter Loskill[1], Alexander Thewes[2], Ludger Santen[2], and Karin Jacobs[1] — [1]Saarland University, Dept. of Experimental Physics, 66041 Saarbruecken — [2]Saarland University, Dept. of Theoretical Physics, 66041 Saarbruecken

The adhesion of pathogenic bacteria is a crucial step in the development of implant-related infections. The adhesion of bacteria is mediated by biopolymers, the properties of which we are able to characterize by AFM force spectroscopy, where the probe is a single bacterium. To deepen the understanding, we combine the AFM studies with computer simulations [1]. For bacteria (Staphylococcus aureus) in contact with hydrophobic surfaces, thermally fluctuating cell wall proteins of different stiffness attach to the surface via short range forces and subsequently * due to entropic forces * pull the bacterial cell into close contact. That way, S. aureus is able to substantially increase its interaction range for contact initiation. Bacteria like Streptococcus mutans also attach to hydrophilic surfaces (e.g. titanium or hydroxyapatite) in the presence or absence of other biomolecules (proteins, enzymes). Our study reveals the importance of specific parameters (e.g. roughness) and proposes that fluctuations in protein density and structure are much more relevant than the exact form of the binding potential.

[1] N. Thewes, P. Loskill, P. Jung, H. Peisker, M. Bischoff, M. Herrmann, K. Jacobs, Soft Matter 2015, 11, 8913-8919