# BP 19: Biosensors and Biofunctionalized Systems

Time: Wednesday 15:30–17:15 Location: H43

BP 19.1 Wed 15:30 H43

**Dependence of DNA/Dendrimer Nanoscale Structures on pH and Composition** — •Rolf Dootz and Thomas Pfohl — MPI for Dynamics and Self-Organization, Bunsenstraße 10, 37073 Göttingen

DNA condensation by nanoscale objects represents the process by which the genetic information is packed and protected. Moreover, using artificial nanoscale 3D structures leads to novel DNA-containing nanostructures which exhibit great potential not only as genetic but also as generic materials possessing many valuable functional and material properties. However, a profound knowledge of the manifold DNA organization factors is still missing. Here, the self-assembly behavior of DNA and PAMAM dendrimers generation 6 (P6) is studied as a function of the overall complex composition and the pH of the solution, which is known to affect the dendritic structure and charge significantly. The complexation is found to result in DNA condensation through which the dendrimer-bound DNA chains are aggregated significantly to form ordered structures. At low pH values, a liquid crystalline phase is formed which shows a weak dependence of the complex composition. At high pH values, increasing the dendrimer fraction first results in a condensed nematic phase in which the locally oriented DNA chains do not exhibit a coherent positional order. Subsequently, the condensed DNA structure transforms into a long-range ordered dual lattice phase which has not been described previously. To rule out the nature of the observed phases, the evolution of the interaction between P6 and DNA is studied accomplishing hydrodynamic focussing experiments in crossed microchannel devices.

BP 19.2 Wed 15:45 H43

**Development of a Biosensor Device Comprising Functionalized Silicon-On-Insulator (SOI) Structures for the Specific Detection of Proteins** — •Bernhard Wunderlich, Petra Neff, and Andreas Bausch — Lehrstuhl für Biophysik E22, TU München, 85747 Garching, Germany

Recently, a new Silicon-on-Insulator (SOI) based thin film resistor for chemical and biological sensor applications was introduced. Its response against pH changes and variations of the salt concentration was measured and compared to the theoretical predictions. It has been shown that this sensor is highly sensitive to variations of the surface potential evoked by the adsorption of small amounts of charged molecules.

We use this sensor device for the label-free detection of proteins. The passivation of the native silicon oxide surface by either physical adsorption of proteins or covalent binding of silane is presented. Different strategies for further functionalizations of the sensor surface with molecules for biomolecular recognition have been evaluated, including the deposition of lipid monolayers with incorporated metal chelate lipids and covalent immobilization of antibodies onto the sensor. Results of the specific detection of proteins by affinity reactions are discussed and compared to the results obtained from fluorescence and ellipsometry measurements.

As the device is based on standard semiconductor technologies, the SOI-based biosensor is well suited for parallelization needed in high throughput applications. We present a sensor device including several sensitive areas suitable for parallel and differential detection.

BP 19.3 Wed 16:00 H43

**Impact of Peptide Structure on Semiconductor Binding** — •Stefan Schnabel[1], Simon Mitternacht[2], Michael Bachmann[1,2], Anders Irbäck[2], and Wolfhard Janke[1] — [1]Institut für Theoretische Physik, University of Leipzig — [2]Complex Systems Division, Lund University. Sweden

We applied simulated tempering and multicanonical Monte Carlo methods to an all-atom protein model to investigate the thermodynamical behavior of four selected peptides, each consisting of 12 residues, in aqueous solution. By recent experiments it is known that all of the four peptides tend to bind well at a GaAs surface, while only one shows good adhesion to Si. In the simulations we also observed a structural anomaly for this peptide. Since this difference is not induced by a different amino acid content, we conjecture that structural properties play an important role in the adhesion process and propose further experiments to verify this hypothesis.

BP 19.4 Wed 16:15 H43

**Chemical Grafting of Biphenyl Self-Assembled Monolayers on Diamond for the Electro-Addressing of Proteins** — •Simon Lud[1], Florian Spirkl[1], Marin Steenackers[2], Rainer Jordan[2], Paola Bruno[3], Dieter M. Gruen[3], Stefan Neppl[4], Peter Feulner[4], Jose A. Garrido[1], and Martin Stutzmann[1] — [1]Walter Schottky Institut, Technische Universität München — [2]Lehrstuhl für Makromolekulare Stoffe, Technische Universität München — [3]Materials Science Department, Argonne National Laboratory — [4]Physics Department E20, Technische Universität München

We have explored the formation of self-assembled monolayers (SAMs) of 4'-nitro-1,1-biphenyl-4-diazonium tetrafluoroborate (NBD) onto ultrananocrystalline diamond (UNCD) thin films. In contrast to the established method to modify diamond and diamond like substrates by electrografting, the SAM was formed from the saturated solution of NBD in acetonitrile by spontaneous chemical grafting. Atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), cyclic voltammetry (CV), and near edge X-ray absorption fine structure spectroscopy (NEXAFS) have been used to verify the direct covalent attachment of the 4'-nitro-1,1-biphenyl (NB) SAM on the diamond substrate via stable C-C bonds. The results confirm the presence of a very stable, homogeneous, and dense monolayer. Quantitative analysis by XPS, NEXAFS, and CV has confirmed the presence of a densely packed monomolecular layer with a grafting density of 4.5-5.3 x $10^{-10}$mol/cm$^2$, equivqalent to a nominal area of 31-37 Å$^2$/molecule.

BP 19.5 Wed 16:30 H43

**Desorption of Spider Silk Proteins from Surfaces with an AFM studied by Molecular Dynamics** — •Dominik Horinek and Roland Netz — Physik Department, Technische Universität München, 85748 Garching

Protein adsorption is important in many biological phenomena like biomineralization or cardiovascular diseases. This adsorption is governed by electrostatic forces, and by nonelectrostatic dispersion and hydrophobic forces. Recently, it was discovered that polymer adsorption is dominated by nonelectrostatic contributions even for charged substrates. We present classical molecular dynamics simulations of protein adsorption, which account for electrostatics, dispersion, and hydrophobic forces.

Spider silk proteins, which do not form secondary structure in solution, are good model compounds for computer simulation studies of protein-surface interactions. We study the desorption of spider silk proteins from hydrophobic and hydrophilic surfaces with an AFM with different pulling rates. On hydrophobic surfaces, we show that equilibrium desorption forces can be calculated by molecular dynamics, whereas thermal equilibrium is not reached when pulling off a hydrophilic surface.

We compare our modeling results with recent AFM experiments. The equilibrium desorption forces are analyzed in the context of hydrophobic and van der Waals forces, which are important for phenomena like protein folding. We also discuss friction effects, which are seen for fast pulling rates.

BP 19.6 Wed 16:45 H43

**Membrane-Grafted Hyaluronan Films: a Well-Defined Model of Glycoconjugate Cell Coats** — •Ralf Richter and Joachim Spatz — Heidelberg University & MPI for Metals Research (Stuttgart)

Many cells endow themselves with a carbohydrate-rich pericellular coat, which is particular in many respects. It is amazingly thick (up to several micrometers), extremely hydrated, self-assembled and highly dynamic. These coats play a crucial role in the general protection of the cell, act as a mediator in the communication with its environment, and are vital in structuring its surrounding. A prominent example of such an intriguing self-organized edifice is the hyaluronan-rich coat around chondrocytes. The elucidation of the self-organization and functional properties of these coats constitutes a considerable challenge, due to the complex dynamics of the living cell and due to the coat's highly hydrated nature.

We have developed simplified models of the pericellular coat that are confined on solid supports. Such confinement makes them amenable to investigations with a wide range of biophysical characterization techniques. The end-grafting of hyaluronan (HA) on a solid-supported

lipid membrane is an example of a bottom-up approach, with which we create well-controlled models with tuneable complexity that mimic various aspects of the pericellular coat. We present novel experimental approaches to characterize the formation kinetics, thickness, mechanical properties and permeability of hyaluronan-based films. Ultimately, we expect to gain novel information about the relationship between the coat's composition, supramolecular structure and biological function.

BP 19.7 Wed 17:00 H43

**Spatially and temporally varying magnetic, biocompatible substrates for induction of cell differentiation** — •Juliane Issle, Martin Loichen, and Uwe Hartmann — Institute of Experimental Physics, University of Saarland, 66123 Saarbruecken, Germany

The main goal of the here presented work is to develop a method to induce (stem-) cell differentiation by means of surface-cell interaction. The setup consists of three parts: the biomolecules, magnetic beads as carriers for the biomolecules and a magnetic carrier substrate.

Magnetic nanobeads of an average diameter of 250 nm are commercially available with different surface groups, like carboxylic or amino groups. The magnetic core consists of 20 nm magnetite crystals kept together by means of a dextran matrix. Magnetization curves show that they are superparamagnetic. Cell type specific biomolecules can be covalently bound to the reactive surface groups of the nanobeads. As magnetic carrier substrates out-of-plane magnetized garnet films with particular domain structure are used as they appeared to be biocompatible. The domain structure can be changed using perpendicular or parallel external magnetic fields. As long as the set up is kept in liquid environment (cell culture medium) the nanobeads can follow the domain changes, once they are deposited onto the domain walls.

This opens the opportunity to change the structure of the substrate in vitro and to investigate the influence of topographical as well as chemical substrate changes on cell growth and differentiation. The physical properties of the described setup are analyzed mainly by AFM and MFM, fluorescence microscopy, magnetometry and SEM.