BP 13: Nanoparticles and Viruses

Time: Tuesday 14:00–16:30 Location: H45

Invited Talk BP 13.1 Tue 14:00 H45

Carbon nanotubes fluids: simple or complex? — •Matteo Pasquali — Department of Chemical & Biomolecular Engineernig, Department of Chemistry, Smalley Institute for Nanoscale Science and Technology, Rice University, Houston Texas, USA

At the single-molecule level, Single-Walled Carbon Nanotubes (SWNTs) have remarkable electrical and mechanical properties, more so than previously known polymer molecules or colloidal particles. Realizing these properties in applications requires understanding and controlling the behavior of SWNTs in dilute as well as concentrated fluid phases. Yet, SWNT liquids are almost considered an oxymoron because dispersing or dissolving SWNTs into fluid phases is exceedingly difficult.

In this talk, I will discuss how SWNTs can and should be viewed as hybrids between polymer molecules and colloidal particles. Even at low concentrations (few parts per million), SWNTs form complex fluid phases with intriguing properties. When stabilized properly, dilute SWNTs behave as Brownian rods. Their interaction can be mediated by polymers and surfactants to produce complex individual architectures, or to devise ways of making transparent conductive coatings. In superacids, SWNTs dissolve spontaneously. At high concentration, they form liquid crystals that can be spun into well-aligned, macroscopic fibers. Intriguingly, the self-assembly of SWNTs into liquid crystalline phases can be understood by hybridizing Onsager's theory for colloidal rods with Flory's theory for rod-like polymers.

BP 13.2 Tue 14:30 H45

Interactions of nanoparticles with serum albumin — •Lennart Treuel, Marcelina Malissek, Julia S. Gebauer, and Reinhard Zellner — Universität Duisburg-Essen, Essen, Germany

As nanoparticles (NPs) are of the same size scale as typical cellular components and proteins, such particles are suspected to evade the natural defences of the human organism and may lead to permanent cell damages. One major factor that may strongly influence the toxicity is the interaction of these NPs with proteins in body fluids and cells.

Circular dichroism (CD) spectroscopy is used to determine the interactions of serum albumin with a wide variety of NPs (Ag, Au, Polystyrene, ZnO etc.) in a size range between 5 nm and 100 nm. A multitude of different surface coatings (Citrate, TPPT, PVP etc.) has been used in these experiments in order to identify the key factors driving the NP / protein interaction process. From these measurements dissociation constants for different NP / protein systems have been derived. The results show a strong dependence of the interaction process on both NP material and surface coating. They further suggest a fundamental impact of the nature and persistence of the surface coating on the biological fate of the NP under consideration.

BP 13.3 Tue 14:45 H45

Electron microscopic analysis of particle uptake by lung macrophages in a murine allergic asthma model — •Christoph Wigge[1], Melanie Conrad[2], Holger Garn[2], Harald Renz[2], and Marianne Geiser[1] — [1]Institute of Anatomy, University of Bern, Switzerland — [2]Department of Clinical Chemistry and Molecular Diagnostics, Philipps University of Marburg, Germany

Efficient particle uptake by lung surface macrophages is essential for the clearance of particles deposited in the peripheral lungs. Thereby, uptake of nanoparticles is of special interest, since there is evidence from epidemiology for a toxicological role of such particles. We investigated particle uptake by cells obtained from bronchoalveolar lavage of mice with induced allergic inflammation in comparison to cells obtained from healthy animals. Cells cultured on porous filter inserts were exposed to microparticles (3-um fungal spores) and to nanoparticles (20-nm gold) for 2 and 4 hours, respectively, and then processed for conventional transmission electron microscopy and electron tomography. We found phagocytic uptake of microparticles by macrophages in all animals, as the vesicular membrane was tightly apposed to the particles. There was evidence for rather unintentional uptake of nanoparticles, which were found in large vesicles containing other material. Electron tomography allowed detailed spatial resolution of nanoparticles in vesicles. In allergic animals, nanoparticles were also found in eosinophils. Uptake of nanoparticles by other leukocytes may contribute to nanoparticle clearance from the inner surface of lungs in inflammation.

BP 13.4 Tue 15:00 H45

Single gold nanoparticles as optothermal tools in phospholipid membranes — Tom Pfeiffer, •Alexander S. Urban, Michael Fedoruk, Fernando Stefani, and Jochen Feldmann — Photonics and Optoelectronics Group, Physics Department and CeNS, Ludwig-Maximilians-Universität München, Amalienstr. 54, 80799 Munich, Germany

Metallic nanoparticles (NPs) can be efficiently heated by illuminating them at their plasmon resonances. In recent years, optical (plasmonic) heating of ensembles of NPs has found a number of applications including remote release [1], DNA-melting analysis [2] and even as a prospect for cancer therapy [3]. Recently, we have started the investigation and application of plasmonic heating of individual NPs, which enables unprecedented nanoscale thermal investigations. In particular, we have used the NPs to remotely (optically) induce and characterize reversible phase (gel-fluid) transitions of nanometric regions of a phospholipid membrane [4]. Furthermore, the control over the phase transition allowed us to guide the nanoparticles to specific locations on the membrane. Currently, we are investigating the possibility of manipulating transport across the membrane with optically heated NPs. It has been postulated that during the gel-fluid transition pores may open in the membrane due to phospholipid reordering. We test this possibility by studying the penetration of the membrane by nanoparticles and molecules of different sizes as a function of the optical heating of NPs bound to the membrane.

15 min. break

BP 13.5 Tue 15:30 H45

Excited state energy transfer between CdSe nanocrystals and the isolated phycobiliprotein antenna of A.marina — •Franz-Josef Schmitt[1], Vithiya Jeyasangar[1], Heinrich Südmeyer[1], Max Schoengen[1], Vladimir Paschenko[3], Hans Joachim Eichler[1], and Gernot Renger[2] — [1]Institute of Optics and Atomic Physics, Berlin Institute of Technology — [2]Max-Vollmer Laboratory for Biophysical Chemistry, Berlin Institute of Technology — [3]Lomonosov Moscow State University

A quantitative analysis of the interaction between semiconductor nanocrystals and isolated light harvesting complexes from photosynthetic organisms is of relevance for the development of biosensors with enhanced sensitivity. The present work describes results obtained on a hybrid system consisting of CdSe nanoparticles and rod shaped phycobiliproteine (PBP) antenna complexes from the cyanobacterium Acaryochloris marina. The CdSe core of the nanocrystals is covered with a ZnS shell and the surface is functionalised with anions of dihydrolipoic acid leading to electrostatic coupling to the PBPs. The measured time resolved and time integrated fluorescence spectra can be explained by a highly efficient excitation energy transfer from the nanocrystals to the PBP antenna with a time constant of about 200 ps at room temperature. At 0°C a decoupling of about 80 % of the CdSe crystals from the PBP antennae was observed. These results could be relevant for the design of switchable light harvesting systems or controlled fluorescence enhancement.

BP 13.6 Tue 15:45 H45

Nanostructured gold microelectrodes for extracellular recording — •Dorothea Brüggemann, Bernhard Wolfrum, Vanessa Maybeck, and Andreas Offenhäusser — CNI Center of Nanoelectronic Systems for Information Technology and Institute of Bio- and Nanosystems 2, Forschungszentrum Jülich

Electrophysiological activity of electrogenic cells is currently recorded with planar bioelectronic interfaces such as microelectrode arrays (MEAs). In this work, a novel concept of biocompatible nanostructured gold MEAs for extracellular signal recording is presented. MEAs were fabricated using clean room technologies, e.g. photolithography and metallization. Subsequently, they were modified with gold nanopillars of approximately 300 to 400 nm in height and 60 nm width. The nanostructuring process was carried out with a template-assisted approach using nanoporous aluminium oxide. Impedance spectroscopy

of the resulting nanostructures showed higher capacitances compared to planar gold. This confirmed the expected increase of the surface area via nanostructuring.

We used the nanostructured microelectrodes to record extracellular potentials from heart muscle cells (HL1), which were plated onto the chips. Good coupling between the HL1 cells and the nanostructured electrodes was observed. The resulting signal-to-noise ratio of nanopillar-MEAs was increased by a factor of 2 compared to planar MEAs. In future applications this nanopillar concept can be adopted for distinct interface materials and coupling to cellular and molecular sensing components.

BP 13.7 Tue 16:00 H45

Nsp7-Nsp8 Supercomplex Building of Fe-CoV — •Henning Seidel[1], Yibei Xiao[2], Rajesh Ponnusamy[2], Rolf Hilgenfeld[2], and Christian G. Hübner[1] — [1]Institute of Physics, Ratzeburger Allee 160, 23538 Lübeck, Germany — [2]Institute of Biochemistry, Ratzeburger Allee 160, 23538 Lübeck, Germany

Coronaviruses are enveloped positive-stranded RNA viruses. They possess the largest known RNA genome. Their RNA-dependent RNA-polymerase (RdRp) activity is supplied by the non-structural protein 12 (nsp12) [1]. For SARS-CoV, it was shown that coronaviruses also encode a second RdRp build from nsp7 and nsp8. This hexadecameric nsp7-nsp8 supercomplex is a hollow, cylinder-like structure assembled from eight copies of nsp8 and held together by eight nsp7 molecules [2]. We are aiming at understanding the assembly process and related conformational changes of the supercomplex for the related Feline Coronavirus. The structural and functional examination of the nsp7-nsp8 supercomplex building should help in understanding the replication and transcription mechanisms of Fe-CoV and other coronaviruses like SARS-CoV. In order to gain knowledge of the complex building, we apply methods of single molecule fluorescence, namely fluorescence correlation spectroscopy (FCS) and fluorescence resonance energy transfer (FRET).

[1] Imbert I. et al., The EMBO Journal, Vol 25, 4933-4942 (2006)
[2] Zhai Y. et al., Nature Structural and Molecular Biology, Vol 12, No 11, 980-986 (2005)

BP 13.8 Tue 16:15 H45

Swelling and softening of the CCMV plant virus capsid in response to pH shifts — •Bodo D. Wilts[1], Iwan A.T. Schaap[1], Chris C. Broomell[2], Charles M. Knobler[3], and Christoph F. Schmidt[1] — [1]III. Physikalisches Institut, Georg-August-Universität Göttingen, Germany — [2]Center for Bio-Inspired Nanomaterials, Montana State University, Bozeman, MT, USA — [3]Department of Chemistry and Biochemistry, UCLA, Los Angeles, CA, USA

Previous research on cowpea chlorotic mottle viruses (CCMV) has revealed a swelling transition and a softening of the protein capsid in response to a pH increase. In this study, we have performed nanoindentation experiments using an atomic force microscope and tested the shell response from low (4.8) up to high pH (7.5) in the absence of divalent ions. We could, for the first time, study the elastic behavior of the swollen virions. Indentations were performed in the reversible linear regime with indentation forces up to 200 pN. The results show a gradual swelling transition of the RNA-filled capsids preceded by a softening of the shell as a function of pH. Control measurements with the empty capsid and a salt-stable mutant revealed that the softening is not directly coupled to the swelling of the protein shells. Instead we hypothesize that the softening of the CCMV virions is triggered by pH-dependent opening of bonds within the protein shell which may be necessary, but not sufficient for swelling.