

CPP 39: POSTERS Colloids and Liquids

Time: Thursday 17:00–19:30

Location: P3

CPP 39.1 Thu 17:00 P3

Magnetfeldabhängige optische Transmission kolloidaler Suspensionen aus Nickelnanostäbchen — ●ALEKSEJ LAPTEV, ANDREAS TSCHÖPE und RAINER BIRNINGER — Technische Physik, Universität des Saarlandes, Saarbrücken, Germany

Kolloidale Suspensionen aus Nickelnanostäbchen wurden mit Hilfe eines dreistufigen Syntheseverfahrens präpariert. Im ersten Schritt wurden durch anodische Oxidation von Aluminiumfolien Template erzeugt, die lineare Porenstrukturen mit einem Durchmesser von etwa 9 nm enthielten. Im zweiten Schritt wurden die Porenkanäle durch AC-Abscheidung mit Nickel befüllt, wobei die Fülllänge je nach Abscheidendauer zwischen 30 und 100 nm variierte. Im letzten Syntheseschritt wurden die Nickelnanostäbchen durch Auflösen der Aluminiumoxidschicht freigelegt und zu einer stabilen wässrigen Suspension weiterverarbeitet. An diesen Nanostäbchen wurden Messungen der optischen Transmission in äußeren Magnetfeldern bis 35 mT durchgeführt. Insbesondere wurde die Abhängigkeit der Transmission von der relativen Orientierung zwischen Magnetfeld und Lichtpolarisation sowie die Feldabhängigkeit der Extinktion und die Relaxation der Partikelorientierung nach Abschalten des Feldes untersucht. Die Messergebnisse zeigen eine gute Übereinstimmung mit einem Modell, das die Anisotropie der Absorption und die Orientierungsverteilung der magnetischen Stäbchen im Magnetfeld berücksichtigt.

CPP 39.2 Thu 17:00 P3

The volume phase transition of thermoresponsive core-shell microgels investigated by small angle neutron scattering — ●MATTHIAS KARG¹, STEFAN WELLERT², YVONNE HERTLE³, and THOMAS HELLEWEG³ — ¹TU Berlin, Germany — ²Helmholtz-Zentrum Berlin, Germany — ³Universität Bayreuth, Germany

Organic/inorganic hybrids attracted much interest within the last decade, since they can combine the properties of both components. Such composites can benefit e.g. from the thermoresponsive character of a polymer component and optical, catalytic or magnetic properties stemming from the inorganic material. Of special interest are hybrids with a core-shell structure, because they have a well-defined topology and hence are interesting for different physical investigations and applications like photonic materials.

We present here responsive core-shell microgels, with silica nanoparticles of different sizes as cores. Imaging techniques were used to study the structure of these hybrids regarding their core-shell topology. The volume phase transition (VPT) of the polymer shell was studied by dynamic light scattering and, focussing on the local length-scale, by small angle neutron scattering (SANS). SANS allowed to determine the correlation length of the polymer network. The scaling behavior of the correlation length was studied by SANS measurements in the vicinity of the VPT temperature. By contrast matching experiments the core size and polydispersity was investigated in-situ[1].

[1] M. Karg, S. Wellert, I. Pastoriza-Santos, A. Lapp, L. M. Liz-Marzán, T. Hellweg, *Phys. Chem. Chem. Phys.*, 2008, 10, 6708-6716

CPP 39.3 Thu 17:00 P3

Novel charge-induced protein interactions in solution studied by SAXS/SANS — ●FAJUN ZHANG¹, LUCA IANESELLI¹, MAXIMILIAN W. A. SKODA², ROBERT M. J. JACOBS³, OLIVER KOHLBACHER⁴, SOPHIE WEGGLER⁵, ANDREAS HILDEBRANDT⁵, and FRANK SCHREIBER¹ — ¹Institut für Angewandte Physik, Universität Tübingen, 72076 Tübingen, Germany — ²ISIS, Rutherford Appleton Laboratory, UK — ³CRL, University of Oxford, UK — ⁴Zentrum für Bioinformatik Tübingen, Tübingen — ⁵Zentrum für Bioinformatik Saar, Saarbrücken

Proteins can be considered as very complex *colloids*. Their interactions in solution challenge our understanding from conventional colloidal science. Using a model protein, BSA, we have studied the influence of ionic strength and the nature of salt on protein interactions by SAS. For simple salts, protein interactions can be described using a theoretical model based on a screened Coulomb potential [1]. By using multivalent counterions, a novel reentrant condensation behavior is observed, which is caused by short-ranged electrostatic interactions between ions and acidic residues, mechanistically different from the case of DNA. A short-ranged attraction arises between counterion-bound proteins in the reentrant regime. Monte Carlo simulations and zeta-potential measurements under these strong electrostatic coupling con-

ditions support an effective inversion of charge on surface side chains through binding of the multivalent counterions [2]. These observations provide a new way for tuning protein interactions in solution. [1] F. Zhang, et al., *J. Phys. Chem. B*, 2007, 111, 251. [2] F. Zhang, et al., *Phys. Rev. Lett.* 2008, 101, 148101.

CPP 39.4 Thu 17:00 P3

Frequency dependent deformation of liquid crystal droplets in an external electric field — ●GÜNTER K. AUERNHAMMER, JINYU ZHAO, and DORIS VOLLMER — Max-Planck-Institut für Polymerforschung, Ackermannweg 10, 55128 Mainz

Nematic drops suspended in the isotropic phase of the same substance were subjected to alternating electrical fields of varying frequency. The system was carefully kept in the isotropic-nematic coexistence region, which was broadened due to small amounts of non-mesogenic additives. Whereas the droplets remained spherical at low (order of 10 Hz) and high frequencies (in the kHz range), at intermediate frequencies, we observed a marked flattening of the droplet in the plane perpendicular to the applied field. The deformation of the liquid crystal droplets occurred both in substances with positive and negative dielectric anisotropy. We show that this frequency dependent deformation can be modeled with a combination of the leaky dielectric model and screening of the applied electric field due to the finite conductivity.

CPP 39.5 Thu 17:00 P3

A Simple and Robust Solver for the Poisson-Boltzmann Equation — MANUEL BAPTISTA, ●ROMAN SCHMITZ, and BURKHARD DUENWEG — Max-Planck-Institut für Polymerforschung, Mainz

A variational approach is used to develop a robust numerical procedure for solving the nonlinear Poisson-Boltzmann equation. Following Maggs et al., we construct an appropriate constrained free energy functional, such that its Euler-Lagrange equations are equivalent to the Poisson-Boltzmann equation. We then develop, implement, and test an algorithm for its numerical minimization, which is quite simple and unconditionally stable. The analytic solution for planar geometry is used for validation. Furthermore, some results are presented for a charged colloidal sphere surrounded by counterions. — See also arXiv:0810.0490v1

CPP 39.6 Thu 17:00 P3

Synthesis, characterization and cellular uptake of aminofunctionalized fluoresceine-labeled silica nanospheres — ●QI GAO¹, CHRISTINA GRAF¹, CYNTHIA KEMBUAN¹, FIORENZA RANCAN², STEFEN TROPPENS², SABRINA HADAM², ANNIKA VOGT², and ECKART RÜHL¹ — ¹Institut für Chemie und Biochemie, Freie Universität Berlin, Takustr. 3, 14195 Berlin — ²Department of Dermatology and Allergy, Charité - Universitätsmedizin Berlin, Charitéplatz 1, 10117

The understanding of the uptake mechanism of silica nanoparticles (NPs) by human cells is important for the development of NPs as novel therapeutic and diagnostic agents. Luminescent silica NPs are promising labeling reagents for various biomedical applications. We investigated the biological properties of 3-aminopropyltrimethylsilane (APS) functionalized and fluoresceine (FITC) labeled silica nanospheres. Nearly monodisperse FITC dye-labeled silica nanospheres with diameters of 30 - 300 nm are prepared by several modifications of the Stober process. Surface functionalization of APS allows us to adjust the zeta potential of these nanospheres from highly negative to positive (-55 mV to +45 mV). Size and zeta potential of the NPs were characterized by transmission electron microscopy and dynamic light scattering. A positive zeta potential enhances the interaction of the nanoparticles with the negatively charged cell surface and hence, the cellular uptake. Toxicity experiments indicate that these FITC dye-labeled silica NPs are not toxic to human cells. Research on the uptake of the NPs to cells, especially human skin cells, is currently in progress.

CPP 39.7 Thu 17:00 P3

Studying mechanical microcontacts of fine particles with the quartz crystal microbalance — ●EWA ILSKA, MICHAEL KAPPL, and HANS-JÜRGEN BUTT — Max-Planck-Institut für Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

Micromechanical contacts are an important issue in a wide variety of applications. Although their significance is acknowledged and mi-

compliance is widely studied e.g. in pharmaceutical or electronics industry, fundamental knowledge is still limited. Within this work, we attempt to understand and describe the physics behind particles and polymer surface contacts. We apply therefore the quartz crystal microbalance (QCM) technique, supported by particles video tracking and atomic force microscopy (AFM) imaging of contact zones. Glass particles of several diameters were deposited onto a thick polystyrene film, which was spin-coated onto the QCM surface. The shift of the resonance frequency f_0 of the QCM signal depends in a complex manner on the mass loading but also on the coupling strength between surface and particles. Addition of small particles leads to a decrease of resonance frequency due to the added mass. Addition of larger particles leads to an f_0 increase, further enhanced by oscillation amplitude. After annealing, amplitude increase and particle detachment are found to strongly influence the resonance behaviour. These striking differences can be explained by the different coupling of particles to the PS film. This is also supported by AFM images of the contact zones after particle removal.

CPP 39.8 Thu 17:00 P3

Pt- and FePt- nanoparticles on the basis of emulsion techniques — ●ACHIM MANZKE¹, STEFAN WIEDEMANN¹, FABIAN ENDERLE¹, ALFRED PLETTL¹, PAUL ZIEMANN¹, EYK SCHREIBER², ULRICH ZIENER², KATHARINA LANDFESTER², JOHANNES BISKUPEK³, and UTE KAISER³ — ¹Institut für Festkörperphysik, Universität Ulm, D-89069 Ulm — ²Institut für Organische Chemie III, Universität Ulm, D-89069 Ulm — ³Materialwissenschaftliche Elektronenmikroskopie, Universität Ulm, D-89069 Ulm

Metal-precursor loaded colloidal polystyrene (PS) particles in aqueous solution are produced by an emulsion and miniemulsion technique, respectively [1]. We will report on colloids loaded with Pt- as well as with Fe- and Pt- complexes. After deposition of a hexagonally ordered monolayer of PS spheres on top of a silicon substrate, optimized plasma and temper sequences are applied to obtain metallic nanoparticles which still exhibit the original lateral order. The metal content within a colloid defines the size of the final particle, which could be varied between 6 and 14 nm, so far. The interparticle distance is determined by the diameter of the starting PS- particles and was varied between 80 and 250 nm. EDX- and ICP-OES- measurements were carried out to investigate the chemical composition of the colloids. For example, a ratio of Fe : Pt = 1 could be achieved with the miniemulsion technique. HRTEM- images demonstrate the crystalline structure of the Pt- and FePt- nanoparticles.

[1] A. Manzke et al. Adv. Mater. 19, 1337 (2007)

CPP 39.9 Thu 17:00 P3

Phase behaviour studies of novel smart microgels based on copolymers of NIPAM and N-substituted acrylamides — ●YVONNE HERTLE, CHRISTOPH HASENÖHRL, and THOMAS HELLWEG — Universität Bayreuth, Physikalische Chemie I, Universitätsstr. 30, 95447 Bayreuth, Germany

Microgels made of N-isopropyl-acrylamide (NIPAM) are the most studied water-swellable microgel systems with a lower critical solution temperature (LCST) of $\sim 32^\circ\text{C}$ in water. This thermoresponsive behaviour can be strongly influenced by co-polymerisation with other organic comonomers. In this contribution thermoresponsive copolymer microgel networks made of N-isopropyl-acrylamide and other N-substituted acrylamides are presented. We use scattering techniques as light and neutron scattering to study the phase transition behaviour and the shape of the microgel particles in the swollen state. For characterisation of the particle shape in the totally collapsed state and their size distribution imaging methods such as transmission and scanning electron microscopy (TEM, SEM) are suitable.

CPP 39.10 Thu 17:00 P3

Investigating fluctuation and dissipation of optically trapped colloids — ●OLAF UEBERSCHÄR, CHRISTOF GUTSCHE, JÖRG REINMUTH, and FRIEDRICH KREMER — Universität Leipzig, Germany

Fluctuation and dissipation as the dominant mechanisms behind the well-observable Brownian motion of micron-sized particles are investigated and quantified on a single molecule level by means of optical tweezers technique. Using an outstandingly fast optical diffraction image analysis routine with a sampling frequency of 10 kHz combined with an automated data acquisition loop, we deduce the size of the colloid under study and the temperature of the heat bath interacting with it. Comparing blank and DNA-grafted colloids (DNA properties: molecular weight of 2800 base pairs, contour length of approximately

400 nm), the underlying mechanisms of dissipation are analyzed on a single colloid level. Bridging experiment and theory, we have adapted an experiment first carried out by Wang et al. in 2002 [1] in which the first experimental evidence for the validity of the fluctuation theorem (FT) was given. We find quantitative agreement with the FT being widely considered as the system-size and timescale independent generalization of the second law of thermodynamics. Eventually, we compare entropy production and consumption rates of blank and grafted colloids.

References: [1]G.M. Wang, E.M. Sevick, E. Mittag, D. J. Searles, and D. J. Evans, Phys. Rev. Lett. 89, 050601 (2002).

CPP 39.11 Thu 17:00 P3

Critical Casimir Forces in Colloidal Suspensions on Chemically Patterned Surfaces — ●OLGA ZVYAGOLSKAYA, FLORIAN SOYKA, DOMINIK VOGT, CHRISTOPHER HERTLEIN, LAURENT HELDEN, and CLEMENS BECHINGER — Universität Stuttgart, 2. Physikalisches Institut, Pfaffenwaldring 57, 70569 Stuttgart

We investigate the behavior of colloidal particles immersed in a binary liquid mixture of water and 2,6-lutidine in the presence of a chemically patterned substrate. Close to the critical point of the mixture, the particles are subjected to critical Casimir interactions with the force acting between the surfaces of the particles as well as between the particle and the wall. The strength and sign of these interactions depend on the surface properties and the mixture's temperature. Between equally coated surfaces an attractive force arises, a repulsive force occurs between contrarily coated surfaces. Chemically patterned substrates are created by first coating the substrate with a layer of one adsorption preference which is then locally removed creating a pattern of an opposite adsorption preference [1]. In addition to a variation of the substrate properties we can also modify the particle's surface properties by adsorption of thiols with different terminal groups. Due to the interplay of lateral and vertical critical Casimir forces, we observed very different colloidal structures.

[1] Critical Casimir forces in colloidal suspensions on chemically patterned surfaces F. Soyka et al. Phys. Rev. Lett., 101, 208301 (2008)

CPP 39.12 Thu 17:00 P3

Wetting properties of sugar surfactant based microemulsions at solid surfaces — ●STEFAN WELLERT¹, RALF STEHLE², CHRISTOPH SCHULREICH², MATTHIAS KARG², ANDRE RICHARDT³, and THOMAS HELLWEG² — ¹Helmholtz-Zentrum Berlin f. Energie und Materialien, Glienicke Str. 100, D-14109 Berlin — ²Physikalische Chemie I, Universität Bayreuth Universitätsstr. 30, D-95447 Bayreuth — ³WIS f. ABC Schutztechnol. Münster, Humboldtstr.1 D-29623 Münster

Compared to many standard products, surfactants containing sugar components and fatty acids are advantageous with respect to applications where environmental compatibility or human health is important. In this context very often microemulsions are used to overcome solubilization problems also in the presence of various solid surfaces. For example, cleaning and extraction applications in sensitive environments like human skin or interior technical equipment can benefit from the green and soft performance of sugar surfactant based microemulsions. Although the interaction between the microemulsion and the surface is essential for the desired functionality, only a few works attributed to this can be found in the literature. In this contribution we discuss the wetting properties of sugar surfactant based microemulsions on surfaces of different hydrophobicity. In the microemulsion systems under investigation Pentanol and sugar surfactants were used to form the interface between water and oils of different polarity. The wetting properties in terms of contact angles were investigated with droplet and bicontinuous microemulsions at different oil-water ratios at hydrophilic, -phobic and partially hydrophobic surfaces.

CPP 39.13 Thu 17:00 P3

Shear stable colloidal crystals. — ROY GOLDBERG, JOSE MARQUEZ HUESO, ANA BARREIRA FONTECHA, and ●HANS JOACHIM SCHÖPE — Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudinger Weg 7, 55099 Mainz, Deutschland

Colloidal crystals show interesting optical properties with potential application as new types of optical gratings or optical filters. For these applications it is necessary to prepare rigid and robust opaline materials where the crystalline order of the particles is maintained and can not be disturbed by thermal or mechanical forces. We here present several methods producing shear stable colloidal crystals and discuss their advantages and disadvantages. We present colloidal crystals with bcc, fcc and exotic crystal structure and characterize their optical proper-

ties. José Marqués-Hueso and Hans Joachim Schöpe, *Progr. Colloid. Polym. Sci.* 134, 48*56 (2008) A. Barreira Fontecha, H. J. Schöpe, *Phys. Rev. E* 77, Art. No. 061401(2008). R. Goldberg and H. J. Schöpe, *Chem. Mat.* 19, 6095-6100 (2007).

CPP 39.14 Thu 17:00 P3

Transport in micromodel porous media visualized by colloidal particles — ●YUJIE LI^{1,2}, MARIA ZVYAGOLSKAYA¹, and CLEMENS BECHINGER^{1,2} — ¹2. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — ²Max-Planck-Institut für Metallforschung, Heisenbergstrasse 3, 70569 Stuttgart,

Porous structures are found extensively in nature from soils/rocks to biological tissues. Transport properties of molecules and particles in porous media are of significant interest for environmental remediation, drug delivery, oil recovery, composite material reinforcement, and chemical reactors.

In our work, transport processes in pore scale are modelled and visualized by colloidal solutions flowing through 2D micromodels, which were designed with different spatial statistic properties. Reynolds number and Péclet number were varied in two orders of magnitude. The influences of the ratio of particle/structure sizes were studied as well. We analyzed particle trajectories by taking into account both coherent and incoherent particle movement. Streamlines of the flow field were reconstructed from the coherent part of particle velocities. Interesting phenomenon like bifurcation of the flow pathway, slowing-down, and trapping of particles at stagnant parts in the flow field were observed and could be attributed to the incoherent movement.

CPP 39.15 Thu 17:00 P3

Soft X-ray induced modifications & quantitative Analysis of PVA-based Microballoons (MBs) — ●BIRGIT GRAF-ZEILER¹, GEORGE TZVETKOV¹, PAULO FERNANDES², ANDREAS FERY³, and RAINER FINK¹ — ¹Universität Erlangen, Physikal. Chemie II, Erlangen — ²MPI for Colloids & Interfaces, Potsdam — ³Universität Bayreuth, Physikal. Chemie II, Bayreuth

We describe the characterization of poly(vinyl alcohol) (PVA) based gas-filled MBs in water using scanning transmission X-ray microscopy (STXM)[1]. The PolLux-STXM (SLS) combines NEXAFS with high-resolution microscopy, thus providing high chemical sensitivity and spatial resolutions <40 nm. The different absorption contrast below and above the O K-edge can provide unique information on the interior of the MBs. Soft x-ray illumination leads to the shrinking of the MBs. Nearly no change in the shell thickness can be verified, but the degradation of the PVA network and formation of carbonyl- and carboxyl-containing species could be detected. Based on existing theoretical models the radial transmittance profiles were evaluated[2]. These models are based on an ideal system of perfectly spherical MBs where the density gradient of the stabilizing shell and the finite beam width of the focused X-ray beam are taken into account. We have recently extended the existing models in order to explore the chemical composition of the stabilizing shell in greater detail with particular emphasis to quantify the gradient of water within the shell. Funded by the BMBF, project 05KS7WE1. [1]Tzvetkov et al., *Soft Matter*, 2008, 4, 510. [2]Fernandes et al., *Langmuir*, 2008, 24, 13677.

CPP 39.16 Thu 17:00 P3

Modifications in torsional resonance spectroscopy of charged sphere colloids — ●ALEXANDER REINMÜLLER, NINA LORENZ, LUCAS CHANCHETTI, THOMAS TODD, HANS-JOACHIM SCHÖPE, and THOMAS PALBERG — Institut für Physik der Universität Mainz, Staudingerweg 7, D-55099 Mainz, Germany

Morphological changes in colloidal crystals may have strong effects on the elastic properties of the corresponding solids. A modified experimental setup for measuring the shear moduli of torsionally oscillating charged sphere colloidal crystals by light scattering [1] [2] is presented: On the detection side a frequency analyzer is used instead of the conventional lock-in-amplifier. On the excitation side a white noise generator can be used instead of a simple sine generator. A comparison with the older method shows the following advantages: The measurement times can be reduced, structural changes can be controlled more precisely and coupling of resonance modes can be observed. Particular attention is paid to keeping the excitation amplitude small enough to leave the sample uninfluenced during thermal annealing.

[1] E. Dubois-Violette et al., *J. Physique* 41 (1980) 369-376

[2] H. J. Schöpe, T. Palberg, *J. of Colloid and Interface Science* 234, 149-161 (2001)

CPP 39.17 Thu 17:00 P3

Synthesis, characterization and cellular uptake of aminofunctionalized fluoresceine-labeled silica nanospheres — ●QI GAO¹, CHRISTINA GRAF¹, CYNTHIA KEMBUAN¹, FIORENZA RANCAN², STEFEN TROPPENS², SABRINA HADAM², ANNIKA VOGT², and ECKART RÜHL¹ — ¹Institut für Chemie und Biochemie, Freie Universität Berlin, Takustr. 3, 14195 Berlin — ²Department of Dermatology and Allergy, Charité-Universitätsmedizin Berlin, Charitéplatz 1, 10117 Berlin

The understanding of the uptake mechanism of silica nanoparticles (NPs) by human cells is important for the development of NPs as novel therapeutic and diagnostic agents. Luminescent silica NPs are promising labeling reagents for various biomedical applications. We investigated the biological properties of 3-aminopropyltrimethylsilane (APS) functionalized and fluoresceine (FITC) labeled silica nanospheres. Nearly monodisperse FITC dye-labeled silica nanospheres with diameters of 30 - 300 nm are prepared by several modifications of the Stöber process. Surface functionalization by APS allows us to adjust the zeta potential of these nanospheres from highly negative to positive (-55 mV to +45 mV). Size and zeta potential of the NPs were characterized by transmission electron microscopy and dynamic light scattering. A positive zeta potential enhances the interaction of the nanoparticles with the negatively charged cell surface and hence, the cellular uptake. Toxicity experiments indicate that these FITC dye-labeled silica NPs are not toxic to human cells. Research on the uptake of the NPs to cells, especially human skin cells, is currently in progress.

CPP 39.18 Thu 17:00 P3

Modeling effective single-particle dynamics by the harmonic chain method — ●JÖRG R. SILBERMANN, MICHAEL MELLE, and MARTIN SCHOEN — Stranski-Laboratorium für Physikalische und Theoretische Chemie, Technische Universität Berlin, D-10623 Germany

We consider the dynamics of a single tagged particle in a Lennard-Jones (LJ) system. Based on the equivalent harmonic chain method introduced by Adelman [1] a coarse grained description of the full many body system is generated. In this description the influence of the 'bath' surrounding the tagged particle is captured by means of a N -atom nearest neighbour harmonic chain. This chain is completely defined by a set of Einstein frequencies $\{\omega_{en}^2\}$ and coupling constants $\{\omega_{en}^2\}$ that can be determined from the memory function $M(t)$ linked to the velocity autocorrelation function (VACF) of the tagged particle in the LJ system [2]. In our work we assume $M(t)$ to be Gaussian. While this ansatz completely neglects long-time collective effects, $M(t)$ is then completely defined by static properties of the full LJ system that can be easily obtained from short Molecular Dynamics simulation runs. We study the influence of chain-length N on the dynamics of the tagged particle. Moreover, we investigate systematically the impact of the specific thermodynamic conditions (i.e., temperature and density) on the performance of our approach.

[1] S. A. Adelman, *J. Chem. Phys.* 71, 4471 (1979).

[2] M. Berkowitz, C. L. Brooks III, and S. A. Adelman, *J. Chem. Phys.* 72, 3889 (1980).

CPP 39.19 Thu 17:00 P3

Colloidal particles in microchannels — CHRISTIAN KLIX and ●CHRISTIAN KREUTER — Universität Konstanz

Transport behavior of interacting particles through narrow constrictions is of high importance for many processes, e. g. for the size selectivity in ion channels. Due to the fact that these systems are very complex, only hypotheses of the underlying physics can be made. Experimentally easily accessible model systems can reveal the processes governing such phenomena. Over the last years colloidal systems have become a standard approach to model and simulate real systems. In our experiments, we use either superparamagnetic particles or particles with metallic caps. These latter particles can exhibit permanent magnetic dipole moments. We investigate the transport behavior of such interacting particles, gravitationally driven through narrow channels defined by optical lithography. Various potential shapes can be defined by crossings of channels or by channels with structured walls. Furthermore, we modify the transport behavior through realisation of barriers perpendicular to the particle flow.

CPP 39.20 Thu 17:00 P3

Controlled optical heating of single metal nanoparticles in an optical trap — ●SPAS NEDEV, ROMY RADÜNZ, and FRANK CICHOS — Molecular Nanophotonics Group, Institute of Experimental Physics I, University Leipzig, Linnéstraße 5, 04103 Leipzig

Recently a technique called photothermal correlation spectroscopy has been developed by our group. This technique is based on a heterodyne photothermal detection of gold nanoparticles, where a laser heats a particle periodically and a probe laser detects the light scattered by the refractive index gradient caused by the local temperature field around the particle. If these particles are suspended in a liquid and freely diffusing, the heating will cause an enhanced Brownian motion in a local viscosity and temperature field. Within this study we are trying to disentangle all different contributions to the mobility of the particle by trapping gold nanoparticles in an optical tweezer and heating them in a controlled way with a second laser at the plasmon resonance. The positional fluctuations of the particle are studied as a function of the heating laser intensity to yield an effective trap stiffness due to the modified temperatures and viscosities. As a result of these experiments we hope to shine light on hot particle diffusion as well as on thermal boundary resistances between the nanoparticle and the liquid.

CPP 39.21 Thu 17:00 P3

Integral equations study of the depletion interaction between large colloids and a planar wall — MARTIN OETTEL and VITALIE BOTAN — Johannes-Gutenberg-Universität Mainz, Mainz, Germany

The integral equation theory, which is based on the full set of coupled inhomogeneous Ornstein-Zernike integral equations, has been developed for studying the depletion forces in colloidal suspensions containing a binary mixture of spheres close to a planar wall. Recent simulations pointed to a lack of sufficient theoretical understanding of the depletion force in hard systems with large asymmetry [1]. Our investigations of the wall-sphere depletion force in a purely hard system seem to be in good agreement with the recent Monte-Carlo simulation and density functional studies as well as predictions from morphological theory [2], which offers better insight into the regime of large asymmetry. The hard-sphere model captures the essence of the depletion phenomenon and can be mimicked experimentally by suitable choices of colloidal solutions [3]. However, a quantitative comparison between theory and experiment only appears possible if residual interactions are taken into account. We discuss the influence of effective electrostatic interactions among both species and the wall as well as the effect of gravity and tweezer forces in a model TIRM setup [4].

- [1] A. R. Herring et al., Phys. Rev. Lett. 97 (2006), 148302.
- [2] P.-M. König et al., Phys. Rev. Lett. 93 (2004), 160601.
- [3] A. D. Dinsmore et al., Phys. Rev. Lett. 80 (1998), 409.
- [4] D. Kleshchanok et al., J. Phys.: Cond. Matter 20 (2008), 073101.

CPP 39.22 Thu 17:00 P3

Aggregation of cationic surfactants with different counterions in the presence of poly(methacrylic acid) — DAN F. ANGHEL, SHUJI SAITO, ALINA IOVESCU, ADRIANA BARAN, and GABRIELA STINGA — Department of Colloids, "Ilie Murgulescu" Institute of Physical Chemistry, Spl. Independentei 202, Bucharest, Romania

Counterion effect of a cationic surfactant upon its interaction with poly(methacrylic acid) (PMA) was investigated and compared with the analogous in poly(acrylic acid) (PAA) systems. Decylammonium (DeA⁺) with different counterions (Cl⁻, SCN⁻, acetate (Ac⁻) and butyrate (Bu⁻) were employed. The interaction critical points, determined from surface tension measurements, indicated the concentrations at which primary and secondary aggregates were formed. For each counterion, T1 with PMA was higher than the respective T1 with PAA. In aqueous solution, PMA was compactly coiled up forming hydrophobic microdomains (HMD) in the chain. The surfactants were first bound to the HMD, and at T1 the free ones cooperatively formed primary aggregates on the other parts of PMA. Different from PAA systems, T1 with PMA was the sum of the surfactant amount bound to HMD and the ordinary cac. For both polymers, T1 raised in the order DeA-Ac < DeA-Bu < DeA-Cl < DeA-SCN, which was opposite to the order of the respective critical micellar concentration (cmc). The formation of hierarchical polymer-surfactant super-structures was highly influenced by the cationic surfactant concentration and counterion nature and by the polymer hydrophobic character.

CPP 39.23 Thu 17:00 P3

Flux Forward Sampling Study of Homogeneous Nucleation in Hard Spheres — DOROTA NIEDZIALEK and TANJA SCHILLING — Johannes-Gutenberg University of Mainz, Germany

As nucleation is an activated process, its study requires special rare event simulation techniques. We applied Flux Forward Sampling to a simple model problem: crystallization of hard spheres. We present results on the morphology of the crystalline aggregates and an estimate

of the nucleation rate. We compare our results to a phase field model and to previous simulations which were based on umbrella sampling, and hence required an preliminary guess of the reaction coordinate.

CPP 39.24 Thu 17:00 P3

Quadratic electroclinic effect in bent-core liquid crystals — STEPHAN STERN, ALEXEY EREMIN, and RALF STANNARIUS — Otto-von-Guericke-Universität Magdeburg, Universitätsplatz 2, D-39106 Magdeburg

We report an electric-field induced SmA-SmC transition in a liquid crystal formed by achiral bent molecules. The steric moment of such molecules is too small to spontaneously induce the phases characteristic to the bent-core mesogens. On the other hand, its contribution to the thermodynamical properties of the mesophases make it possible to induce tilt and polar order by the action of the external electric field. This effect is unique for bent mesogens and its physical nature differs from an electroclinic effect observed in the SmA* phase of chiral liquid crystals.

CPP 39.25 Thu 17:00 P3

Step-Emulsification Microfluidics for the Generation of Spherical Mesoporous Silica Particles — VENKATACHALAM CHOKKALINGAM¹, BORIS WEIDENHOF², WILHELM MAIER², STEPHAN HERMINGHAUS¹, and RALF SEEMANN^{1,3} — ¹Max Planck Institute for Dynamics and Self-Organization, Goettingen 37073, Germany — ²Technical Chemistry, Saarland University, Saarbruecken 66123, Germany. — ³Experimental Physics, Saarland University, Saarbrücken 66123, Germany

We explore two phase microfluidics for complex chemical reactions. By dispersing different reagents into droplets and subsequently merging the droplets containing the different reagents, we realize chemical reactions, which are neither possible in single phase microfluidics, nor in droplet based microfluidics if the reagents are already mixed before being dispersed into droplets. We explore this explicitly for the production of porous silica particles from sol-gel chemistry. Regular pairs of aqueous droplets containing tetramethoxysilane (TMOS) and ammonia, respectively, are formed. The sol-gel reaction is started by merging the individual droplets using either electrocoalescence or a geometrical constriction. The concentration of the solutions is adjusted such, that the gel is fully developed when the coalesced droplets are collected outside of the microfluidic device for subsequent drying and heat treatment. The resulting silica particles have a diameter of a few micrometers, only. Further BET surface area analysis yields the chemical properties of the silica particles obtained. Particles obtained have a pore radius of about 4.5 nm and a surface area of about 600 sq.m/g.

CPP 39.26 Thu 17:00 P3

Directed Growth of Metal Organic Frameworks — FLORIAN WIELAND¹, MICHAEL PAULUS¹, CHRISTIAN STERNEMANN¹, FLORIAN EVERS¹, OSAMA SHEKHAN², HUI WANG², METIN TOLAN¹, and CHRISTOF WÖLL² — ¹Fakultät Physik/Delta, TU Dortmund, D-44221 Dortmund, Germany — ²Ruhr-Universität Bochum, Physikalische Chemie I, D-44780 Bochum Germany

Metal organic frameworks (MOFs) are a new class of advanced materials which may be used for various applications. In contrast to the usual synthesis protocol a new approach for the synthesis of MOFs was developed in order to investigate the dynamics and the process of the structural formation. Thin films of the MOF [Cu₃BTC₂(H₂O)_n] (HKUST-1) are grown by layer-by-layer deposition on top of functionalized organic surfaces which serve as a two dimensional nucleation site [1]. The samples were investigated by x-ray diffraction at the synchrotron source DELTA. Two dimensional scattering patterns were obtained giving information about the structural order of the films. Comparing x-ray diffraction data of the corresponding bulk material with our data we find that layers of HKUST-1 grow in different preferred directions depending on the functional group of the self-assembled monolayer. The structural behavior under temperature load was investigated up to a temperature of 250°C. The data shows a change of the HKUST-1 orientation.

- [1] O. Shekhan et al, J.AM.CHEM.SOC. 2007,129,15118-15119

CPP 39.27 Thu 17:00 P3

Adhesion Properties of Polymer Microbubbles studied by AFM and RICM — MELANIE PRETZL, PAULO FERNANDES, and ANDREAS FERY — Universitätsstraße 30, Universität Bayreuth

Air filled polymer microbubbles are interesting devices for medical ap-

plications, they can be used as ultrasound contrast agents and for local drug delivery [1]. To improve their diagnostic and therapeutic properties it is important to understand and control their interactions with the surrounding tissue.

We investigated the adhesion properties of these novel medical devices in detail with a colloidal probe-AFM set up, that was used in combination with an inverted optical microscope. The optical microscope was used during the measurements in the RICM mode, reflection interference contrast microscopy mode. This technique enabled us to determine the change in the contact area between individual microbubbles and test substrate in dependence on varying applied external forces [2]. First results indicate that the increase of the contact area with rising external forces is also dependent on the microbubble size, the shell thickness and the air/water content of the particles. We analyzed the system also in terms of temperatures and pH.

[1]*F. Cavalieri, I. Finelli, M. Tortora, P. Mozetic, E. Chiessi, F. Polizio, T. Brismar, G. Paradossi, Chemistry of Materials 2008, 20, (10), 3254-3258.

[2]*Dubreuil, F.; Elsner, N.; Fery, A., European Physical Journal E 2003, 12, (2), 215-221.

CPP 39.28 Thu 17:00 P3

Investigations of the Molecular Structure of Bent-Core Liquid Crystals by NMR — ●GÜNTER HEMPEL — Martin-Luther-Universität, Institut für Physik, D-06099 Halle, Germany

Liquid crystals consisting of molecules with bent cores exhibit an interesting phase behaviour. For example, ferroelectricity is observed even if the molecules are achiral. The phase structure depends strongly on the geometry of the molecules, particularly on the angle by which the mesogenic core is bent. Because of absence of long-range periodicity, a non-scattering method was needed for estimating the structure directly in the nematic phase.

In our NMR experiments, the dipolar coupling among nuclear spins was explored. For monitoring the 1H - 13C interaction we applied the cross-polarization procedure. It relies on the exchange of polarization between 1H and 13C spin systems which can take place as oscillation. Its frequency is proportional to the dipolar coupling. Furthermore the interaction among the 1H spins was investigated by means of the decay of the proton magnetic resonance signal (WISE experiment). In both cases a two-dimensional Fourier transformation was performed which gives two frequency axes: One related to chemical-shift scale, the other related to the interaction frequency scale. The interaction between two magnetic moments depend on the angle between the connection line and the magnetic field. At this way it was possible to calculate intramolecular angles from the coupling constants.

CPP 39.29 Thu 17:00 P3

Tetrahydrofuran clathrate hydrate formation studied by x-ray Raman scattering — ●HEIKO CONRAD¹, FELIX LEHMKÜHLER¹, CHRISTIAN STERNEMANN¹, ARTO SAKKO², OMD FEROUGH¹, LAURA SIMONELLI³, SIMO HUOTARI³, DIETMAR PASCHEK⁴, KEIJO HÄMÄLÄINEN², and METIN TOLAN¹ — ¹TU Dortmund, Fak. Physik/DELTA, Dortmund, Germany — ²Div. Mat. Ph., Dep. of Physics, U Helsinki, Finland — ³ESRF, Grenoble, France — ⁴Rensselaer Polytechnic Institute, Troy, NY, USA

The formation of clathrate hydrates in the system water-Tetrahydrofuran (THF) was studied by means of non-resonant x-ray Raman scattering (XRS). Hydrates are ice-like inclusion compounds where guest molecules are embedded in water nano-cages. A possible future application of hydrates is the storage of gases, in particular H_2 in THF hydrate for fuel cells. Therefore, a detailed knowledge of the hydrate formation process is important.

XRS is an energy loss spectroscopy which allows to measure light element x-ray absorption using hard x-rays. In the dipole limit XRS directly corresponds to x-ray absorption spectroscopy (XAS). XRS spectra are sensitive to possible hydrate precursors in a supercooled state and thus yield unique information about the hydrate formation process. X-ray Raman spectra of the oxygen K-edge were measured of the hydrate, of a supercooled liquid THF/water mixture, and of a mixture at a temperature above the region of hydrate stability. The measurements were compared with DFT calculations employing local structures obtained from molecular dynamics simulation snapshots.

CPP 39.30 Thu 17:00 P3

Stability of free flying liquid films — ●PASCAL FRANK, JOHANNES BONEBERG, and PAUL LEIDERER — Universität Konstanz, Deutschland

A 10 ns laser pulse is used to rapidly heat the surface of a silicon

substrate, where a thin (100-500nm) liquid film is deposited on top. The subsequent phase transition of the first ten nanometers at the interface leads to desorption and acceleration of this film. Ns-time resolved reflectometry allows to determine the actual position of the free flying liquid film. The measurements show that under ambient conditions the flight is parabolic and the film returns to the substrate after some hundred nanoseconds as the accelerating pressure rapidly decreases below the ambient pressure with increasing distance to the substrate. The maximal distance of the film is up to a few micrometers. The liquid remains stable during the time of flight of several hundred nanoseconds. If the exciting laser pulse is modulated via laser interference with periods exceeding thermal conduction length during the pulse, the film thickness can be modulated as well. Investigation of the diffraction provides insights to the stability of this modulation and the whole film.

CPP 39.31 Thu 17:00 P3

Changes of the Near-Surface Chemical Composition of the [EMIM]Tf₂N Room Temperature Ionic Liquid under the Influence of Irradiation — ●ANGELA KEPPLER¹, MARCEL MARSCHESKI², MARCEL HIMMERLICH¹, SYED IMAD-UDDIN AHMED¹, JUERGEN A. SCHAEFER¹, EVGENIJ PACHOMOW², WOLFGANG MAUS-FRIEDRICH², OLIVER HÖFFT³, FRANK ENDRES³, and STEFAN KRISCHOK¹ — ¹Institut für Physik and Institut für Mikro- und Nanotechnologien, TU Ilmenau, P.O. Box 100565, 98684 Ilmenau, Germany — ²Institut für Physik und Physikalische Technologien, TU Clausthal, Leibnizstr. 4, 38678 Clausthal-Zellerfeld, Germany — ³Institut für Mechanische Verfahrenstechnik, TU Clausthal, Robert-Koch-Str. 42, 38678 Clausthal-Zellerfeld, Germany

In some applications room temperature Ionic Liquids (RT-ILs) are exposed to different kinds of irradiation. Using the low vapour pressures of RT-ILs, we studied the influence of irradiation on the surface properties under UHV conditions by photoelectron spectroscopy and Metastable Induced Electron Spectroscopy. We present the effect of irradiation by electrons and photons with energies ranging from a few eV to several keV on the surface composition of [EMIM]Tf₂N and its valence band structure. Our results indicate a strong reduction of the carbon content during keV-electron irradiation as well as other compositional changes. The changes of the film composition are correlated with changes in the valence band structure as a function of irradiation energy. X-ray irradiation with high exposures cause also variations in chemical composition of the [EMIM]Tf₂N.

CPP 39.32 Thu 17:00 P3

The Fréedericksz transition in thermoreversible nematic liquid-crystal gels — ●FLORIAN HEYM¹, ACHIM SACK¹, WOLFGANG SCHÖPF¹, INGO REHBERG¹, ROBIN PETTAU², and HANS WERNER SCHMIDT² — ¹Experimentalphysik V, Universität Bayreuth — ²Makromolekulare Chemie I, Universität Bayreuth

Liquid crystals like '5CB' are often gellified in order to increase the relaxation speed and to influence the liquid crystals' orientation and mechanical properties. As a gelator we use new ABA triblockcopolymers with a midblock containing Cyanobiphenyl. The properties of these nematic liquid-crystal gels are investigated and compared with ordinary nematics and nematics gellified by low molecular weight organogelators. We measure the dependency of the relaxation time of the Fréedericksz transition on the sample thickness using polarisation microscopy.

CPP 39.33 Thu 17:00 P3

Time-resolved optical measurement of director dynamics in electroconvection — ●STEPHAN MESSLINGER, ACHIM SACK, WOLFGANG SCHÖPF, and INGO REHBERG — Experimentalphysik V, Universität Bayreuth, Bayreuth, Germany

We investigate the time-dependent behavior of electroconvective patterns in liquid crystal cells [1-3] with a shadowgraph setup. Time resolution is achieved by a stroboscopic illumination [4], phase-locked to the periodic driving voltage applied to the cell. By varying the illumination phase relative to the driving voltage, the temporal modulation of the electroconvective patterns can be visualized. We present a harmonic analysis of the temporal behaviour near the convection onset, both in the dielectric and in the conductive regime.

[1] I. Rehberg, B. L. Winkler, M. de la Torre Juárez, S. Rasenat and W. Schöpf, *Adv. Solid State Phys.* **29**, 35 (1989).

[2] P. G. de Gennes and J. Prost, *The Physics of Liquid Crystals* (Clarendon Press, Oxford, 1993).

[3] A. Buka and L. Kramer, *Pattern Formation in Liquid Crystals*

(Springer, New York, 1996).

[4] U. Schneider, M. de la Torre Juárez, W. Zimmermann and I. Rehberg, *Phys. Rev. A* **46**, 1009, (1992).

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Planar and curved electrolytic liquid-liquid interfaces —

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The interfacial tension of a liquid-liquid interface in the presence of microscopic ions is studied for the cases of planar as well as curved interfaces. Unequal partitioning of the ions between the two liquid phases is identified as the mechanism dominating the planar interfacial tension at low ionic strengths. Several scaling regimes of the curved interfacial tension are found which allows, e.g., to assess the range of validity of low-curvature expansions.