CPP 2 Colloids and Nanoparticles

Time: Monday 10:00–12:30 Room: ZEU 160

CPP 2.1 Mon 10:00 ZEU 160

Self organization of micelles at solid-liquid interfaces — •Max Wolff[1,2], Marco Walz[3], Andreas Magerl[3], and Hartmut Zabel[1] — [1]Lehrstuhl für Festkörperphysik, Ruhr-Universität Bochum, Bochum, Germany — [2]Institut Laue-Langevin, Grenoble, France — [3]Lehrstuhl für Kristallographie und Strukturphysik, Universität Erlangen-Nürnberg, Erlangen, Germany

Self organizing systems are known to open new possibilities in nanopatterning of materials. One interesting aspect is the influence of a solid substrate on ordering in liquids. To gather in-situ non-destructive information on the not directly accessible solid-liquid interfaces is difficult. We have demonstrated that by taking advantage of the high penetration power of neutrons and combining neutron reflectivity (NR), off-specular scattering and near-surface small angle scattering (NS-SANS) three dimensional structural information from the μm down to nm regime becomes accessible.
We will demonstrate the importance of the properties of the solid-liquid interface, like the chemical termination, for the crystallization of three block polymer micelles. Aditionally we will present data exploring the crystallization process for varying temperatures in great detail. We find a hysteresis not only in the size and formation of crystallites but also in the structure formed during crystallization and reorientation with increasing and decreasing temperatures. The presented findings from the neutron scattering experiments will be correlated to rheological studies.

CPP 2.2 Mon 10:15 ZEU 160

Energetics of Self-organization of 2D colloids in free-standing smectic-C films — •Christian Bohley and Ralf Stannarius — Institut für Experimentelle Physik, Abteilung Nichtlineare Phänomene, Otto-von-Guericke-Universität Magdeburg, PF 4120, D-39016 Magdeburg

The formation of regular colloid patterns was shown experimentally for free smectic films at the transition from the smectic-C to the isotropic phase [1-3]. The self-organization of the isotropic droplets is caused by their mutual interaction, mediated by elastic distortions of the local liquid crystal (LC) director that are related to the anchoring conditions of the director at the droplet border. We describe analytically the energetics of a single droplet in the LC environment. A method of the complex analysis, the Conformal Mapping, is employed. Energetics of chain and grid patterns built from the isotropic colloids will be investigated numerically in order to explain the observed formations.

[1] C. Völtz, R. Stannarius, Phys. Rev. E 70, 061702 (2004) [2] C. Völtz, R. Stannarius, Phys. Rev. E 72, 011705 (2005) [3] R. Stannarius, C. Völtz, Phys. Rev. E 72, 032701 (2005)

CPP 2.3 Mon 10:30 ZEU 160

Detailed structural analysis of wet-chemically synthesized II-VI semiconductor nanoparticles — •Franziska Niederdraenk[1], Pawel Luczak[1], Andreas Stahl[1], Christian Kumpf[1], Reinhard Neder[2], and Eberhard Umbach[1] — [1]Experimentelle Physik II, Univ. Würzburg — [2]Inst. für Mineralogie und Kristallstrukturlehre, Univ. Würzburg

The determination of the detailed geometric structure of nanoparticles with diameters below 5 nm is of particular interest since these particles represent the transition regime between molecular and solid state physics. In principle, diffraction methods provide this information, but crystallographic analysis techniques, like the Rietveld refinement or a size determination with the Scherrer equation were developed for large particles (> 10 nm) and are not reliable any more below 5 nm.

To cope with this difficulty, we model the entire nanoparticle and use the Debye formula to calculate its powder diffraction pattern. This method allows us to directly determine intrinsic parameters which cannot be treated by most of the established crystallographic techniques, e.g. size-distributions, different shapes, stacking faults, strain, etc. The Debye formula has been embedded in an evolutionary algorithm, which enables an automatic refinement of the primary atomic model. Distributions of parameters are now considered, which are essential since they are likely to occur in wet-chemically synthesized particles. We present model calculations for ZnO, CdSe and CdSe/ZnS core-shell nanoparticles in the range of 2 - 10 nm and compare them with experimental data.

— 15 min. break —

CPP 2.4 Mon 11:00 ZEU 160

Janus particles at liquid/liquid interfaces — •Nicole Glaser, Alexander Böker, and Georg Krausch — Physikalische Chemie II, Universität Bayreuth, 95440 Bayreuth, Germany

Following recent theoretical predictions, we report on the first experiments on the interfacial assembly of so-called Janus nanoparticles, i.e. bifacial particles consisting of a gold and an iron oxide moiety, using pendant drop tensiometry. Our results show that the amphiphilicity derived from the Janus character of the particles leads to a significantly higher interfacial activity than observed for the respective homogeneous particles of the same size. This leads to a dramatic decrease in interfacial tension at the hexane-water interface during particle assembly. Furthermore, we demonstrate control over the interfacial activity by tuning the particle amphiphilicity via ligand exchange reactions.

CPP 2.5 Mon 11:15 ZEU 160

Mechanical properties of catanionic hollow faceted polyhedrons — •Nicolas Delorme[1], Monique Dubois[2], Thomas Zemb[3], and Andreas Fery[1] — [1]Max Planck Institute for Colloid and Interface Research, Potsdam, Germany — [2]SCM, CEA Saclay, Gif-sur-Yvette, France — [3]LCF, CNRS/CEA URA 331, Gif-sur-Yvette, France

Mixtures of cationic and anionic surfactants dispersed in water show a rich polymorphism depending on the mixing ratio. For an excess of the anionic component, hollow facetted polyhedrons are formed which have been subject to detailed structural studies in the past.While our aim in this study is to understand the impact of electrostatic interactions on the mechanics of the catanionics, our results are also relevant for studies on viruses or facetted vesicles which are mechanically analogous. In this purpose, Atomic Force Microscopy (AFM) is used to measure elastic properties and other surface interaction forces. After the immobilization of the polyhedrons onto a flat surface using polylelectrolytes of tailored charge density, combining force measurements and imaging allowed demonstrating the strong dependence between the stiffness and the shape of the facetted polyhedrons. We have demonstrated that compared to a supported lipid bilayer in the gel-state, the catanionic membrane is very rigid, showing an effective bending modulus of up to 450 kT. In order to understand the origin of the rigidity of the catanionic membrane, the evolution of the mechanical properties were investigated as function of pH and salt concentration, which are know to change the electrostatic contribution to the bending stiffness.

CPP 2.6 Mon 11:30 ZEU 160

Raman scattering on double-wall carbon nanotubes under high pressure — •Matthias Müller[1], Janina Maultzsch[1], Ferenc Simon[2], and Christian Thomsen[1] — [1]Inst. für Festkörperphysik, TU Berlin, 10623 Berlin — [2]Inst. für Materialphysik, Universität Wien, A-1090 Wien

We report resonant Raman scattering on double-wall carbon nanotubes. The effects of applied pressure up to several GPa on the radial breathing modes and the high energy modes are studied. We investigated either structures with ^{12}C or ^{13}C isotopes used for the production of the inner tube. From the radial breathing modes we can assign the chiral index of the tubes[1]. Pressure shielding by the outer tubes was suggested by Arvanitidis et al.[2]. Using the ^{12}C or ^{13}C tube samples, we assign the Raman signal to inner and outer tube. We can therefore distinguish the possibly different effect of pressure on either inner or outer tube.

[1] Telg et al., Phys. Rev. Lett. 93, 177401 (2004). [2] Arvanitidis et al., Phys. Rev. B 71, 125404 (2005).

CPP 2.7 Mon 11:45 ZEU 160

Resonant Raman spectroscopy on isolated single-walled carbon nanotubes — •Martin Fouquet, Hagen Telg, Janina Maultzsch, and Christian Thomsen — Institut für Festkörperphysik, Technische Universität Berlin, Germany

We performed resonant Raman measurements on isolated single-walled carbon nanotubes deposited on a silicon substrate. Varying the excitation energy, we collected intensity profiles of the radial breathing mode (RBM) and the high energy mode (HEM). From the RBM we assign the

chiral index of each observed tube. We then analyze the dependence of the HEM on excitation energy of the assigned tube. In particular we compare the HEM lineshape of metallic and semiconducting nanotubes.

CPP 2.8 Mon 12:00 ZEU 160

Lattice dynamics of two-dimensional colloidal crystals — •Pavel Dyshlovenko — Ulyanovsk State Technical University, 32 Severny Venets Street, Ulyanovsk 432027, Russia

Electrostatic interaction in two-dimensional colloidal crystals obeying the non-linear Poisson-Boltzmann equation is studied numerically. The force constants, which are the coefficients of the energy quadratic form of the crystal, are obtained for hexagonal and quadratic crystal lattices. The normal modes of oscillations and low frequency elastic properties of colloidal crystals are then calculated for a broad range of lattice constants and particles' parameters. Particular attention is given to many-particle effects in the crystals.

Significant discrepancy between the results of computer experiments and predictions of the harmonic crystal theory based on the idea of pair interaction was detected. The unified approach to quantitative estimation of many-particle effects and validity of the approximation of the nearest-neighbour interaction is proposed. It is shown that the contribution of many-particle interaction into the total electrostatic interaction in colloidal crystals is surprisingly significant for a broad range of crystal lattice constants and particles' sizes and charges.

CPP 2.9 Mon 12:15 ZEU 160

Fluctuation Forces between Colloids at Interfaces — •Hartwig Lehle[1,2], Martin Oettel[1,2], and Siegfried Dietrich[1,2] — [1]Max Planck Institut für Metallforschung, Heisenbergstraße 3, 70569 Stuttgart — [2]ITAP, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart

We calculate the thermal Casimir force between nanoscopic rotationally symmetric colloids trapped at a fluid interface. Due to the constraints imposed by the presence of the colloids on the interface the spectrum of the interface fluctuations (capillary waves) is modified, leading to a free energy depending on the geometrical arrangement of the system. For the case of two colloids and a simple capillary wave Hamiltonian, we calculate the partition function of the system in a functional integral approach, where the boundary conditions imposed by the colloids on the interface are incorporated by the use of auxiliary fields. Analytical results for small and large colloid separations are compared to numerical results for the full range of separations. We discuss the physically distinct cases of a pinned (Dirichlet boundary condition) and a fluctuating contact line. For small separations, the leading part of the divergent fluctuation force is calculated with Dirichlet b. c. Since the fluctuation force is independent on the surface tension and the precise shape of the colloids, we predict a strong tendency to coagulation even in arrangements when the vdW force is close to zero.