CPP 51: Hydrogels and Microgels

Time: Wednesday 15:00–17:00 Location: C 264

CPP 51.1 Wed 15:00 C 264

On the generation of stimuli-responsive HEMA-co-DEAEMA hydrogels by using Cold Atmospheric-Pressure Plasma Polymerization — •Ihsan Amin[1], Felipe Vicente de Paula Kodaira[1,2], Monique Levien[1], Rogério Pinto Mota[2], Klaus-Dieter Weltmann[1], and Katja Fricke[1] — [1]Junior Research Group Biosensing Surfaces, Leibniz Institute for Plasma Science and Technology, INP Greifswald e.V., Felix-Hausdorff-Strasse 2, 17489 Gerifswald, Germany — [2]São Paulo State University (Unesp), School of engineering, Guaratinguetá, SP, Brazil

A simple and fast fabrication of stimuli-responsive hydrogels from (hydroxyethyl)methacrylate-co-2-(diethylamino)ethyl methacrylate by cold atmospheric plasma polymerization (CAPP) is reported. The influence of input power and different volume ratios on the coating's properties have been investigated to clarify their effect on the stability and swelling behavior of the hydrogels. The plasma-polymerized hydrogels retain the functionality of both monomers and their functional groups, as measured by FTIR and XPS. Hydrogel films generated at a HEMA/DEAEMA volume ratio of 1:1 demonstrate good stability and a high swelling ratio in water at pH 7, and a lower swelling ratio at pH 10 and pH 4, respectively. Due to the simplicity and cost efficiency of CAPP, combined with the excellent properties of the plasma polymerized hydrogels, these coatings are suitable for biomedical applications such as biosensors, implants, and cell adhesion-promoted coatings where long-term stability of the surface properties is required.

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Foams stabilized by PNIPAM microgels — •Matthias Kühnhammer and Regine von Klitzing — Technical University of Darmstadt, Department of Physics, Soft Matter at Interfaces, 64287 Darmstadt, Germany

Cross-linked, short-chained poly-N-isopropylacrylamide (NIPAM) polymers, also referred to as microgels, have attracted much attention during the last years and were studied with various techniques and in the context of multiple possible applications. Since these microgels are responsive to external stimuli like temperature, materials made from them can be considered 'smart' materials. A prominent example are thermo-responsive emulsions stabilized by microgel particles adsorbed at the water-oil interface. In these systems the emulsion stability can be controlled by changing the temperature [1,2].

In this contribution we report on our experiments with aqueous foams, which are stabilized by PNIPAM microgel particles. We present how microgel properties like size, cross-linking density and particle concentration can influence properties of macroscopic foams prepared with them. In addition we attempt to link the differences in foamability and foam stability to the properties of the different microgels in solution.
[1] B. Brugger, B. Rosen, W. Richtering, Langmuir, (2008), p. 12202. [2] V. Schmitt, V. Ravaine, Curr. Opin.Colloid Interface Sci. (2013), p. 532.

CPP 51.3 Wed 15:30 C 264

Studying properties of microgels: from fuzzy to core-shell model — •Elena Minina[1,2], Sofia Kantorovich[1,2], and Christos Likos[1] — [1]University of Vienna, Vienna, Austria — [2]Ural Federal University, Ekaterinburg, Russian Federation

Microgels are spherical colloidal particles consisting of the polymer network. Due to their nature, microgels are able to swell and shrink as a response to their external environment. This ability makes them promising materials for many applications including drug delivery and design of artificial muscles. The desire to control microgels, therefore, has motivated studying their properties.

In this work, we study microgels properties by means of molecular dynamics computer simulations. To this aim, we developed coarse-grained models of fuzzy and core-shell microgels based on the bead-spring model and random cross-linking procedure. Our models capture the swelling behaviour of microgels that we verified by embedding microgels in solvents of different quality. To examine structural properties of microgels, we focus on the polymer network analysis and density profiles of microgels of different size and with various fraction of homogeneously distributed cross-linkers inside the core and on the shell for core-shell microgels.

CPP 51.4 Wed 15:45 C 264

Anomalous Dynamics of Concentrated Silica-PNIPAm Microgels — •Lara Frenzel[1,2], Felix Lehmkühler[1,2], Irina Lokteva[1,2], Michael Sprung[1], and Gerhard Grübel[1,2] — [1]DESY, Notkestr. 85, 22607 Hamburg — [2]The Hamburg Centre for Ultrafast Imaging, Luruper Chaussee 149, 22761 Hamburg

Poly(N-isopropylacrylamide) (PNIPAm) cross-linked microgels show a coil-to-globule transition in water at a lower critical solution temperature (LCST) around 32°C, below which the particles collapse drastically. With this volume phase transition PNIPAm is applicable in both technical as well as medical fields. It furthermore became a frequently studied system in soft matter research as a model system to probe the specific phase behavior of soft colloids. Via x-ray photon correlation spectroscopy (XPCS) we investigate the change of structure and dynamics of highly concentrated PNIPAm core-shell microgels around the LCST. Here we will present our work on particles with radii of 80-200 nm, whereby we investigated the dynamics and interaction of the highly concentrated colloids as a function of temperature. Upon heating from room temperature to 45°C we found three dynamical regimes: First, the relaxation time decreases linearly while the shell shrinks. Second, around the LCST at 32°C the relaxation time decreases rapidly until it (third) jumps around 38°C more than three orders of magnitude. This effect was determined as a function of concentration between 6 and 30 wt% and is not present in dilute systems. Furthermore, both the structural and the dynamical behavior were found to be reversible upon cooling down the system after heating.

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Combining reaction ensemble Monte-Carlo simulations with Molecular Dynamics to probe the electrophoretic mobility of weak polyelectrolytes — •David Sean and Christian Holm — Institute for Computational Physics, University of Stuttgart, Stuttgart, Germany

Monomers in strong polyacids become negatively charged due to a strong chemical drive bringing them towards a deprotonated state. In weak polyelectrolytes however, the chemical drive is weak and monomer ionization often change between its (negatively charged) dissociated state and a (neutral) associated state. The reaction ensemble Monte-Carlo (RxMC) method allows to efficiently sample configurational states of weak polyelectrolytes under chemical equilibrium in order to obtain static properties. However, this method is inappropriate probe dynamical properties like diffusion and electrophoretic mobility. In order to probe for dynamical properties, we turn to Molecular Dynamics (MD) with hydrodynamic interactions using the Lattice Boltzmann method. With the chemical equilibrium results obtained from the RxMC simulations, MD simulations are used to integrate in time the trajectories polyelectrolytes under the influence of a driving field. Static and dynamic properties of a coarse-grained microgel model in salty conditions are reported using this methodology. We report and discuss upon a surprisingly weak dependence of the mobility as a function of the total nanogel charge.

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Modelling of shock wave dynamics in ferrogels — •Segun Goh, Andreas M. Menzel, and Hartmut Löwen — Institut für Theoretische Physik II: Weiche Materie, Heinrich-Heine-Universität Düsseldorf, D-40225 Düsseldorf, Germany

Ferrogels are smart soft materials, consisting of a gel network and embedded magnetic particles. Novel phenomena, such as the response of elasticity to external magnetic fields, emerge consequently. Due to the difficulties in describing the touching/separating processes of magnetic particles, however, the dynamics of ferrogels remain largely unveiled. In this study, we consider a one dimensional chain consisting of magnetic dipoles and springs between them as a simple model for ferrogels. To probe the dynamics theoretically, we investigate a continuum limit of the double-well type potential governing the system and the corresponding equation of motion. It is then revealed that a type of spinodal decomposition underlies the touching/separating dynamics of the magnetic particles. We further elucidate the formation of touching/separating particle clusters as well as the migration of interfaces in terms of shock solutions. Comparisons of the continuum theory with the particle-resolved simulation are also given. We expect that these

results will provide insight into understanding the dynamics of more realistic models with randomness in parameters and time-dependent magnetic fields.

15 min. break

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Alternative acrylamides for microgel synthesis — •Yvonne Hertle[1], Jörn Lessmeier[1], Johanna Grote[2], Lars Wiehemeier[1], Tilman Kottke[1], Sergej Kakorin[1], and Thomas Hellweg[1] — [1]Physical and Biophysical Chemistry, Bielefeld University, Bielefeld, Germany — [2]Inorganic and Structural Chemistry, University Bielefeld, Bielefeld, Germany

Microgels made of poly(N-isoproplyacrylamide) (pNiPAM) are one of the most frequently used and studied polymer based systems in the field of soft matter. Due the LCST (lower critical solution temperature) of pNiPAM in water at about 32°C, microgels made of this polymer are suitable candidates for a wide variety of applications like nanoparticle and drug carriers, sensors, nanoactuators, chemical separation media or biochemical applications as cell culture media.

Since the monomer NiPAM and its relative N-isoproplymethacrylamide (NiPMAM) are commercially available, other homologous acrylamides need to be synthesized. Therefore, the Schotten-Baumann reaction published by Hirano et al. for the synthesis of N-n-propylacylamide (NnPAM) is well suited [1]. Based on this we established a synthesis route to obtain a wide variety of acrylamide monomers. From these homopolymer microgels and different copolymer particles have then been prepared via a conventional precipitation polymerization with surfactant and characterized with respect to their phase transition behaviour, particle size and composition.

[1] B. Wedel, Y. Hertle, O. Wrede, J. Bookhold and T. Hellweg, Polymers, 8, 2016, 162.