CPP 25: Focus: Functional Polymer Hybrids II

Time: Tuesday 14:00–16:00 Location: H51

Invited Talk CPP 25.1 Tue 14:00 H51

Plasmonic heating brings dynamic control of microgel shape and locomotion — •Ahmed Mourran, Hang Zhang, and Martin Moeller — DWI-Leibniz Institute for Interactive Materials, and Textile and Macromolecular chemistry, RWTH Aachen University Germany

Hydrogel actuation involves reversible swelling/shrinkage of the polymer network. However, the volume change of hydrogel is a slow diffusion-controlled process with a strong dependence on size. For this reason, hydrogels materials hardly allow instant control of their shape, making it difficult to develop fast and soft actuators. To overcome this limitation, we have combined non-equilibrium inhomogeneous swelling/shrinkage and anisometric microgel geometry to achieve large and fast bending deformations. An essential finding of this work is the generation of non-reciprocal actuation, i.e., each cycle consists of a forward and a distinct reverse movement, thereby creating the thrust needed to propel the hydrogel microswimmer in water. A body shape deformation is triggered by the photothermal heating of gold nanorods embedded in a temperature sensitive microgel. Absorption of high-intensity laser light by the plasmonic nanoparticles allows rapid heating and makes it possible to achieve fast dynamics. We will show that dynamic control of shape through plasmonics heating represents an exciting avenue in the development of photo-thermo-mechanical actuator or maneuverable soft microswimmers.

CPP 25.2 Tue 14:30 H51

Gold nanoparticles as local hot spots in thermoresponsive microgels — •Maren Lehmann, Weronika Nasiłowska, Tim Möller, Stefan Wellert, and Regine von Klitzing — Applied Physical Chemistry, TU Berlin, Berlin, Germany

Sensoric ultrathin coatings have a high impact in basic research and for technical applications. A promising combination is of metal particles embedded in a polymer matrix. The metal particles can interact with external fields (e.g. light, magnetic field) and the polymer matrix can be sensitive to outer stimuli like temperature, pH or ionic strength. Here, we present a hybrid system of thermosensitive poly(N-isopropylacrylamide) (PNIPAM, LCST: 32°C) microgels and Au nanoparticles (Au NP). The incorporation of Au NP into the PNIPAM microgel influences the optical properties of the microgels via plasmon coupling during their volume phase transition [1] [2]. In order to study the effect of hot spots, we coupled a second laser for plasmon excitation into our dynamic light scattering (DLS) set-up. The loading density of the Au NP within the microgels was optimized for our purpose. The plasmon excitation of Au NP results in local heating providing enough heat to induce a reduction in the microgel size. Depending on the uptake of Au NP the induced size change also varies and the apparent internal temperature within the gel can be determined.

1. Lange, H. et al. Langmuir, 2012, 28, 8862
2. Gawlitza, K. et al. Phys. Chem. Chem.Phys., 2013, 15, 15623

CPP 25.3 Tue 14:45 H51

Thermal Transport in Colloidal Crystals and Assemblies — Fabian A. Nutz[1], Pia Ruckdeschel[1], Alexandra Philipp[1], Tobias Kemnitzer[2], Jürgen Senker[2], and •Markus Retsch[1] — [1]Physical Chemistry - Polymer Systems, University of Bayreuth, 95447 Bayreuth, Germany — [2]Inorganic Chemistry III, University of Bayreuth, 95447 Bayreuth, Germany

We will present our latest results on thermal transport phenomena in colloidal materials, which are structured on length scales that bridge 10 nm up to 1 um. We will particularly introduce two examples of so-called colloidal crystals, which comprise either monodisperse polystyrene particles, composite core/shell spheres, or hollow silica capsules. While being entirely amorphous on a local scale, colloidal crystals feature opalescent colors due to their highly crystalline order on a couple of 100 nm. Such systems are well suited to investigate fundamental structural changes on an individual particle level and their influence on the effective thermal conductivity of the colloidal superstructure. We demonstrate the influence of microporosity and interfacial adhesion to the thermal transport in silica hollow spheres.[1] Polymer colloidal crystals are insensitive to their surrounding atmosphere but exhibit a strong hysteresis upon film formation.[2] [1] P. Ruckdeschel, et al., Nanoscale, 2015, 7, 10059 [2] F. A. Nutz, et al., J. Coll. Interf. Sci., 2015, 457, 96

15 min. break

CPP 25.4 Tue 15:15 H51

Network topology in magnetic gels studied by simulating the cross-linking process — •Rudolf Weeber and Christian Holm — Institut Fuer Computerphysik, Universitaet Stuttgart, Allmandring 3, 70569 Stuttgart

Ferrogels are hydrogels into which magnetic nanoparticles are immersed. Thereby,they combine elastic properties with the ability to react to external magnetic fields, which makes them candidates for applications such as drug delivery and actuation. One aspect of ferrogels, which is expected to have a large influence on their properties, is the topology of the polymer network forming the gel. This is, however, difficult to access experimentally. We therefore study the question using computer simulations. In the contribution, we present simulations of the cross-linking process of a magnetic gel, and we examine, how the resulting gel changes, depending on the conditions during cross-linking.

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structure and dynamics of nanocomposite hydrogels based on HEUR polymers and coated magnetite nanoparticles. — •Antonella Campanella[1], Olaf Holderer[1], Konstantinos Raftopoulos[2], Peter Müller-Buschbaum[2], and Henrich Frielinghaus[1] — [1]JCNS@FRMII, Lichtenbergstrasse 1, 85747 Garching, Germany — [2]Technische Universität München, Physik-Department, LS Funktionelle Materialien, James-Franck-Strasse 1, 85748 Garching, Germany

Magnetic nanoparticles as component in the nanocomposite hydrogel formulation lead to a wide variety of applications, e.g. cancer treatment, separation devices, electromagnetic waves absorbers. The structure and the dynamics of nanocomposite hydrogels based on HEUR (hydrophobically modified ethoxylated urethanes) polymers and coated magnetite magnetite nanoparticles are investigated with small angle neutron scattering (SANS) and with dielectric relaxation spectroscopy (DRS) in combination with neutron spin echo (NSE), respectively. The embedding of the magnetite nanoparticles in the HEUR polymer network leads to i) an increase of the domain spacing of the polymer network, i.e. the distance between the hydrophobic domains composed of the alkyl ends of the HEUR polymer and ii) a partial suppression of the segmental motion of the middle polar block of the HEUR polymer.

CPP 25.6 Tue 15:45 H51

Multiresponsive PNIPAM Microgels Doped with Magnetic Nanoparticles — •Marcus U. Witt[1], Sebastian Backes[1], Eric Roeben[2], Birgit Fischer[3], Annette M. Schmidt[2], and Regine v. Klitzing[1] — [1]Technische Universität Berlin, Institut für Chemie, Stranski Laboratorien, Straße des 17. Juni 124, 10623 Berlin — [2]Universität zu Köln, Institut für Physikalische Chemie, Luxemburger Straße 116, 50939 Köln Gebäude 322 — [3]Universität Hamburg, Institut für Physikalische Chemie, Grindelallee 117, 20146 Hamburg

N-isopropylacrylamide (NIPAM) based microgels exhibit a volume phase transition temperature (VPTT) at approximately 32°C. This VPTT leads to a reversible swelling and shrinking in water due to changes in temperature. There are several co-monomers which can be added to achieve additional responsive parameters such as pH or the ionic strength. To make the gels responsive to an external magnetic field we incubated magnetic nanoparticles (MNP) in the gel structure (ferrogel). In the present study different synthesis strategies are applied for the fabrication of homogenous and heterogeneous microgels. The effect of MNP loading due to the internal structure is studied. The investigation governs the thermoresponsive behavior of the ferrogel, the distribution of the MNP inside the gel matrix and the response to a static magnetic field in bulk and at a solid surface.