

CPP 35: P7: Hydrogels and Elastomers

Time: Tuesday 14:00–16:00

Location: Poster C

CPP 35.1 Tue 14:00 Poster C

Demixing transition and molecular interactions in poly(N-isopropyl acrylamide) compared to its monomer — ●MORITZ FUTSCHER¹, MARTINE PHILIPP¹, PETER MÜLLER-BUSCHBAUM¹, and ALFONS SCHULTE² — ¹TU München, Physik-Department, LS Funktionelle Materialien, James-Franck-Str. 1, 85748 Garching — ²University of Central Florida, Department of Physics, The College of Optics & Photonics, Orlando, Florida 32817-2385, US

Temperature-sensitive hydrogels such as poly(N-isopropyl acrylamide) (PNIPAM) exhibit a coil to globule transition of the polymer chains with a lower critical solution temperature (LCST) near 32 °C. The cooperative dehydration of bound water molecules upon heating plays a significant role. The hydrogen bonding with the amide groups in the side chains has to be contrasted with the hydration interaction of the hydrophobic main chain hydrocarbons. Employing FTIR spectroscopy we probe molecular changes in the various chemical groups. PNIPAM and its monomer NIPAM are investigated at a concentration of 20 wt% in aqueous solution. We observe a nearly discontinuous shift of the peak frequencies and the intensities of vibrational bands (amide I, amide II, CH) in PNIPAM, while in NIPAM there is a continuous linear shift with temperature. The results are discussed with respect to hydration changes in the amide group and cooperative interactions with bound water along the backbone chain.

CPP 35.2 Tue 14:00 Poster C

The Formation and Swelling of Superabsorbent Networks: A Monte Carlo Study — ●MICHAEL LANG, ANDREAS JOHN, and JENS-UWE SOMMER — Leibniz-Institut für Polymerforschung Dresden e.V., Hohe Straße 6, 01069 Dresden, Germany

The free-radical polymerization was studied in aqueous acrylic acid solution in the presence of cross-linkers using the Bond Fluctuation Model (BFM). Network formation was analyzed for varying cross-linker reaction rates, cross-linker composition and number fraction, cross-linker functionality and time dependent initiator release. For all simulations we observe an auto-acceleration of reaction kinetics similar to the gel effect but independent of the degree of cross-linking. The weight distributions of chains that result from reactions of one radical and the number distribution of cross-linkable sites on these chains can be approximated by Poisson distributions. The weight fractions of the active material and gel, the average strand length within the active material, and the gel point are determined. The swelling behavior of neutralized networks seems to confirm the Flory-Rehner prediction for the equilibrium degree of swelling as function of the average strand length. However, a more detailed investigation reveals that this results from the fortuitous cancellation of corrections due to inactive material and entanglements for networks with a structure similar to our study. Thus, only the networks with a rather large active strand length agree with the Flory-Rehner model, while the networks with a short elastic strand length show an additional non-affine contribution to the equilibrium degree of swelling.

CPP 35.3 Tue 14:00 Poster C

Single and double networks from amphiphilic star block copolymers — ●XIAOHAN ZHANG¹, KONSTANTINOS KYRIAKOS¹, ELINA N. KITIRI², MARIA RIKKOU-KALOURKOTI², COSTAS PATRICKIOS², and CHRISTINE M. PAPADAKIS¹ — ¹TU München, Physik-Department, Soft Matter Physics Group, Garching — ²University of Cyprus, Nicosia, Cyprus

Amphiphilic conetworks comprise hydrophilic and hydrophobic chains

which microphase-separate when swollen with water. This way, a large amount of internal interfaces is created which is of interest for, among others, tissue engineering. To improve the mechanical strength, especially regarding compression, a second hydrophilic polymer network is introduced into these amphiphilic networks.

We investigate amphiphilic conetworks from various acrylic blocks which differ in composition, water solubility and mechanical properties. We have studied the structures of the single and the conetworks using small-angle X-ray scattering which reveals information about the microphase-separated morphology. We find that their degree of swelling in water as well as the underlying mesoscopic structures depend strongly on these characteristics.

CPP 35.4 Tue 14:00 Poster C

Light induced phase transitions in gold-microgel hybrids — ●MAREN LEHMANN, SARAH TURNER, LUCAS KUHRTS, and REGINE VON KLITZING — Stranki-Laboratory, Dept. of Chemistry, TU Berlin, Germany

Poly(N-isopropylacrylamide) (PNIPAM) microgels are one of the most studied soft materials. They respond to various external stimuli, which makes them attractive for biological applications, such as drug delivery and biosensing, as well as for catalysis or nanoreactors [1] [2]. Depending on their composition PNIPAM microgels respond to pH, ionic strength or solvent. By introducing metal nanoparticles they are able to react to a magnetic field or light. We incorporated gold nanoparticle into the microgel network in order to introduce a responsiveness to light of the plasmon resonance wavelength of the gold nanoparticles. The temperature dependent size of the microgel and the hybrids was measured by dynamic light scattering (DLS). The swelling and shrinking properties were investigated by DLS and temperature-controlled UV-Vis adsorption spectroscopy. The uptake of gold nanoparticles per microgel particle and their distribution within the microgel particles were studied with the transmission electron microscope.

[1] K. Gawlitza et al. Phys.Chem.Chem.Phys.15, 37 (2013). [2] M. Karg et al. Curr. Opin. Colloid Interface Sci 14, 6 (2009)

CPP 35.5 Tue 14:00 Poster C

Finite element analysis of filled elastomer networks responding to static external stress — ●SERGEJ BERDNIKOW and REINHARD HENTSCHEKE — Bergische Universität, 42279 Wuppertal, Germany

Technical elastomers acquire most of their mechanical strength through fillers forming spanning branched networks throughout the elastomer matrix. Depending on filler concentration and processing conditions the filler network may consist of fractal flocs, giving rise to the unique and often desirable mechanical properties of rubber materials. Here we present a finite-element based model of filler networks embedded in an elastic matrix subjected to a static external stress. It is calculated how the network responds to the rupture of highly loaded network junctions caused by the external forces. We compare quasi-fractal filler networks, i.e. filler networks possessing fractal structure below a certain length scale, which are often found in for instance tire tread materials, to random filler networks at otherwise identical conditions. We observe that the so called "occluded rubber" effect, which is present for the quasi-fractal networks, is destroyed upon random reordering of the filler. In addition, significant load redistribution during filler network damage can be seen when the filler structure is quasi-fractal. For random fillers this load redistribution is almost completely absent.