

## CPP 42: Gels, Polymer Networks and Elastomers III

Time: Thursday 15:00–16:45

Location: H 0106

CPP 42.1 Thu 15:00 H 0106

**SAXS analysis of electrically controlled drug release hydrogels for diabetes treatment** — •YINING SUN<sup>1</sup>, CLEMENT BLANCHET<sup>2</sup>, and MICHAEL GRADZIELSKI<sup>1</sup> — <sup>1</sup>Stranski-Laboratorium für Physikalische und Theoretische Chemie, Institut für Chemie, Technische Universität Berlin, Straße des 17. Juni 124, D-10623 Berlin, Germany — <sup>2</sup>European Molecular Biology Laboratory, Hamburg Outstation, Notkestrasse 85, 22603 Hamburg, Germany

Herein, we present the fabrication of conductive hydrogels that were prepared using quaternized chitosan grafted with polyaniline (QC-SPA), polyvinyl alcohol, and boronic acid. This hydrogel was dynamically crosslinked by boronate esters between alcohol and boronic acid and ionic interactions between chitosan and boronic acid. The modified QCSPA endows the good bulk conductivity of the hydrogel. We studied the crosslinking of this hydrogel by rheology and small angle scattering (SAXS and SANS), especially the effect of the QCSPA content. Besides, the passive diffusion and electro-triggered insulin release behavior are also studied by SAXS, to observe the relations between hydrogel structure and insulin release kinetics. The obtained results underline the importance of mesh size in the release procedure, which can be designed by varying hydrogel components. The resulting hydrogel demonstrates electrically triggered insulin release, aiming at localized and on-demand therapeutic delivery. The system shows high current tolerance, high drug loading capacity, and is effective in vitro drug release, which suggests a new method to advance diabetes treatment.

CPP 42.2 Thu 15:15 H 0106

**Striking a Delicate Balance: Mussel-Inspired P(NIPAM-co-Dopamine Methacrylamide) Microgels with Improved Mechanical and Adhesive Properties** — •SANDRA FORG and REGINE VON KLITZING — Soft Matter at Interfaces (SMI), Institute for Physics of Condensed Matter, Technical University of Darmstadt, Darmstadt, Germany

Marine organisms such as mussels have captured the interest of the scientific community due to their exceptional under-water adhesive capabilities and mechanical properties. The catechol-based dopamine methacrylamide (DMA) can serve as a synthetic replacement to mimic the mussel's properties. It has the ability to cross-link polymers.

When DMA is combined with the versatile microgels, systems that exhibit stimuli-responsiveness, mechanical durability, self-healing capabilities, and high surface adhesion can be created. This study offers a thorough exploration of mussel-inspired poly(N-isopropylacrylamide) (PNIPAM) microgels co-polymerised with DMA. These P(NIPAM-co-DMA) microgels adsorbed at the solid surface are characterised by atomic force microscopy (AFM). Their mechanical properties, as well as their adhesive properties were examined by using different probe shapes and sizes (tips vs. colloidal probes). One challenge in the design of mussel-inspired materials is optimising its adhesion while preserving toughness. DMA's cross-linking ability could counteract the adhesion of microgels to surfaces, adding complexity to the development process.

This research provides valuable insights into these novel microgels and establishes a robust foundation for potential future applications.

CPP 42.3 Thu 15:30 H 0106

**Exploring Hydration Mechanisms in Poly(N-isobutyramide) and its Isomer, Poly(N-isopropylacrylamide)** — •MORGAN P. LE DÜ<sup>1</sup>, JULIJA REITENBACH<sup>1</sup>, DAVID P. KOSBAHN<sup>1</sup>, LUKAS V. SPANIER<sup>1</sup>, CRISTIANE HENSCHER<sup>2</sup>, ANDRÉ LASCHEWSKY<sup>2</sup>, ROBERT CUBITT<sup>3</sup>, CHRISTINE M. PAPADAKIS<sup>4</sup>, and PETER MÜLLER-BUSCHBAUM<sup>1,5</sup> — <sup>1</sup>TUM School of Natural Sciences, Chair for Functional Materials, 85748 Garching, Germany — <sup>2</sup>Fraunhofer IAP, 14476 Potsdam, Germany — <sup>3</sup>IILL, 38000 Grenoble, France — <sup>4</sup>TUM School of Natural Sciences, Soft Matter Physics, 85748 Garching, Germany — <sup>5</sup>MLZ, TUM, 85748 Garching, Germany

Thermo-responsive polymers hold a prominent position due to the easy access to the temperature parameter. This study investigates Poly(N-isobutyramide) (PNVIBAM) and compares it with its structural isomer, Poly(N-isopropylacrylamide) (PNIPAM). PNVIBAM exhibits a slightly higher LCST than PNIPAM in aqueous solutions. This makes PNVIBAM particularly well-suited for applications requiring temperature sensitivity to the human body. We investigate the swelling behav-

ior of both polymers when used as thin films and exposed to high humidity conditions. Swelling characteristics are obtained via spectral reflectance and in situ FTIR is used to explore the hydration mechanisms in both polymers. Neutron reflectometry (NR) offers crucial insights into their equilibrium swollen state and water content. This research contributes to the understanding of PNVIBAM and PNIPAM properties regarding their hydrophilic behaviour.

CPP 42.4 Thu 15:45 H 0106

**Restricted mobility of Ni nanorods in agarose hydrogels** — •NILS BOUSSARD and ANDREAS TSCHÖPE — Universität des Saarlandes, Experimentalphysik, Campus E2 6, 66123 Saarbrücken

The three-dimensionally linked polymer network in an agarose hydrogel has large pore sizes in a range comparable to the typical length of Ni nanorods ( $\langle L \rangle = 100 - 600 \text{ nm}$ ). The liquid that fills the interstices of the network provides a medium for the movement of embedded particles and the aim of the present study was to investigate how the rotational motion of the magnetic nanorods in agarose hydrogels (0.3-1.0 wt.%) is constrained by the scaffold. To quantify the microstructure of the agarose hydrogels a correlation length  $\xi$  was obtained from spectrophotometric turbidity measurements. Due to a magnetic field during gel formation, the ferromagnetic nanorods could be aligned in parallel for the initial state and after switching off this field, the rods relaxed into a stationary orientation distribution. This state could be quantified via optical transmission measurements by an alignment parameter which correlated qualitatively with the ratio  $\langle L \rangle / \xi$ . For the combinations of nanorod length and agarose concentration of this study, the Ni nanorods showed the transition from nearly free mobility to fixation and a quantitative model was derived by adapting the Edwards tube model. The topological constraint on the rotational motion of the nanorods was approximated by a confining tube with a diameter proportional to the correlation length.

CPP 42.5 Thu 16:00 H 0106

**Deformation-Induced Structure and Temperature Evolution of Natural Rubber** — •ERIC EUCHLER<sup>1</sup>, KONRAD SCHNEIDER<sup>1</sup>, ANNA KATHARINA SAMBALE<sup>1</sup>, MATTHIAS SCHWARTZKOPF<sup>2</sup>, and SVEN WIESSNER<sup>1,3</sup> — <sup>1</sup>Leibniz-Institut für Polymerforschung, Dresden, Germany — <sup>2</sup>Deutsches Elektronen Synchrotron DESY, Hamburg Germany — <sup>3</sup>TUD Dresden University of Technology, Dresden, Germany

Natural Rubber (NR) vulcanizates show deformation-induced structure evolution, e.g. crystallization, explaining the outstanding mechanical performance in comparison to other elastomers. In this study, combined in situ experiments were realized by synchronizing wide-angle X-ray scattering (WAXS) and infrared (IR) thermography with the mechanical deformation of NR vulcanizates. Owing to the coupled methods, a unique database provides new insights into the mechanical behavior of NR, for example: (i) deformation-induced crystallization is primarily controlled by the mechanical stress; (ii) IR thermography allows to follow crystallization as a function of deformation; (iii) the onset of crystallization causes a rapid increase in temperature, however, only a slight increase in stress; (iv) deformation-induced crystallization shows a saturation plateau, which hardly changes with ongoing deformation; (v) surface temperatures show a certain fluctuation that may indicate a non-uniform crystallite distribution.

CPP 42.6 Thu 16:15 H 0106

**Mechanical and rheological properties at the surface of amphiphilic polymer conetworks** — •KEVIN HAGMANN<sup>1</sup>, NORA FRIBICZER<sup>2</sup>, SEBASTIAN SEIFFERT<sup>2</sup>, CAROLIN BUNK<sup>3</sup>, FRANK BÖHME<sup>3</sup>, and REGINE VON KLITZING<sup>1</sup> — <sup>1</sup>Institute for Condensed Matter Physics, Technische Universität Darmstadt, D-64289 Darmstadt — <sup>2</sup>Department of Chemistry, Johannes Gutenberg University Mainz, D-55128 Mainz — <sup>3</sup>Leibniz-Institut für Polymerforschung Dresden e.V., D-01069 Dresden

The underlying study focuses on the mechanics and rheology at the surface of amphiphilic polymer conetworks (ACNs). Two four-arm star-shaped polymer building blocks made up of tetra-poly(ethylene glycol) and tetra-poly( $\epsilon$ -caprolactone) form a 3-dimensional amphiphilic network, that serves as a model system for this study. First, the correlation between different synthesis strategies for gel films and their

resulting properties will be described. Secondly, the effect of solvents of different polarity on the swelling ability will be presented on different length scales. For this purpose, topology and near surface structure are studied with atomic force microscopy (AFM). We also put special emphasis on the determination of mechanical and rheological properties laterally and orthogonally to the gel surface by carrying out dynamic AFM indentation experiments. In order to evaluate heterogeneities, the mechanical and rheological behavior at the surface of the ACNs will be presented on various length scales (nm -  $\mu$ m). The study shows that the synthesis strategy has a strong effect on the gel structure and on nano/microrheological properties.

CPP 42.7 Thu 16:30 H 0106

**How chromophore labels shape the structure and dynamics of a peptide hydrogel** — •FREDERICK HEINZ<sup>1</sup>, BETTINA KELLER<sup>1</sup>, JONAS PROKSCH<sup>1</sup>, BEATHE KOKSCH<sup>1</sup>, ROBERT SCHMIDT<sup>2</sup>, and MICHAEL GRADZIELSKI<sup>2</sup> — <sup>1</sup>Freie Universität Berlin, Berlin, Germany — <sup>2</sup>Technische Universität Berlin, Berlin, Germany

Biocompatible and functionalizable hydrogels have a wide range of (po-

tential) medicinal applications. In contrast to conventional hydrogels formed by interconnected or interlocked polymer chains, self-assembled hydrogels form from small building blocks like short peptide chains. However, the hydrogelation process for these systems, especially those with very low polymer weight percentage ( $< 1$  wt%), is not well understood. This severely hinders the rational design of self-assembled hydrogels. In this study, we demonstrate the impact of an N-terminal chromophore label amino-benzoic acid on the self-assembly and rheology of hydrogel hFF03 (hydrogelating, fibril forming) using molecular dynamics simulations, which self-assembles into  $\alpha$ -helical coiled-coils. We find that the chromophore and even its specific regioisomers have a significant influence on the microscopic structure and dynamics of the self-assembled fibril, and on the macroscopic mechanical properties. Furthermore we find that the solvation shell fibrils by itself cannot explain the viscoelasticity of hFF03 hydrogels. Our atomistic model of the hFF03 fibril formation enables a more rational design of these hydrogels. In particular, altering the N-terminal chromophore emerges as a design strategy to tune the mechanic properties of these self-assembled peptide hydrogels.