

CPP 53: Responsive and Adaptive Systems II

Time: Friday 11:30–13:00

Location: H 0107

Invited Talk

CPP 53.1 Fri 11:30 H 0107

A hierarchical fabrication strategy for multi-responsive actuators with structural reconfiguration-assisted self-healing ability — ●QING CHEN — Laboratory for High Performance Ceramics, Empa, Swiss Federal Laboratories for Materials Science and Technology, Überlandstrasse 129, 8600 Dübendorf, Switzerland

The prospects of endowing stimuli-responsive materials with various life-like behaviors are promoting the development of intelligent robotic and electronic systems. However, it is extremely challenging to incorporate stimuli-responsive actuating and healing ability into one single material system. Herein, we describe a general design strategy of a humidity-responsive thin film composed of conducting polymer composites through physically crosslinking and hydrogen bonding supramolecular network. Owing to the dynamic nature of hydrogen bonding at an elevated humidity, the thin film exhibits rapid actuating and efficient healing performance at the structural, mechanical and functional levels. Moreover, through a combined analytical approach, we proposed a structural model for the reconfiguration of the thin film at multi-length scales when being exposed to elevated humidity levels. Based on the humidity-responsive structural configurations, the film presents tunable mechanical, electrical and actuating properties, and demonstrate its great potential as intelligent soft robots such as artificial muscles.

CPP 53.2 Fri 12:00 H 0107

Dynamic Behavior of Poly(*N*-isopropylmethacrylamide) in Water/Methanol Mixtures — CHIA-HSIN KO¹, PATRICK WASTIAN¹, DIRK SCHANZENBACH², ANDRÉ LASCHEWSKY^{2,3}, PETER MÜLLER-BUSCHBAUM¹, and ●CHRISTINE M. PAPADAKIS¹ — ¹TUM School of Natural Sciences, Technical University of Munich, Garching, Germany — ²Universität Potsdam, Institut für Chemie, Potsdam-Golm, Germany — ³Fraunhofer-Institut für Angewandte Polymerforschung, Potsdam-Golm

The thermoresponsive polymer poly(*N*-isopropylmethacrylamide) (PNIPMAM) features peculiar structural behavior [1]. Here, we investigate the dynamics of PNIPMAM in aqueous solution and in water/methanol mixtures in the one-phase region. Using dynamic light scattering, we observe two diffusive dynamic modes in a wide range of temperatures and polymer concentrations, which reflect local and large-scale dynamics. The scaling behavior of the dynamic correlation length of the fast mode deviates strongly from mean-field predictions, which may be related to the presence of the large-scale inhomogeneities, assigned to the enhanced hydrophobic effect. In water/methanol mixtures, the slow mode is strongly reduced, and the scaling exponent features non-monotonous behavior. Thus, the hydrophobic interactions result in complex behavior.

1. C.-H. Ko, C. M. Papadakis et al., *Macromolecules* **2020**, *53*, 6816.

CPP 53.3 Fri 12:15 H 0107

Local direction of opto-mechanical stress in azobenzene containing polymers during surface relief grating formation — ●SARAH LOEBNER¹, BHARTI YADAV², NINO LOMADZE¹, NINA TVERDOKHLEB², HENDRIK DONNER³, MARINA SAPHIANNIKOVA², and SVETLANA SANTER¹ — ¹Universität Potsdam, Potsdam, Germany — ²Leibniz Institute of Polymer Research Dresden, Dresden, Germany — ³CADFEM GmbH, Chemnitz, Germany

Here we unravel how the photo-induced deformation of azobenzene containing polymers relates to the local direction of opto-mechanical stresses generated during irradiation with interference patterns (IPs). We can substantiate the modeling approach in [1], that these deformations arise from the re-orientation of rigid backbone segments along the light polarization direction. In experiments we inscribe surface relief grating in pre-elongated photosensitive colloids of few microme-

ters using different IPs. The deformation of the colloidal particles is studied in-situ, whereby the local variation of the polymer topography is assigned to the local distribution of electrical field vector for all IPs. Orientation approach correctly predicts local variations of the main axis of light-induced stress in each interference pattern for both initially isotropic and highly oriented materials. With this work, we suggest that the orientation approach implements a self-sufficient and convincing mechanism to describe photo-induced deformation in azobenzene containing polymer films that does not require auxiliary assumptions.

[1] Yadav, B. et al., *J. Phys. Chem. B* 2019, *123*, 3337-3347.

CPP 53.4 Fri 12:30 H 0107

Electroactive nanoporous silicon-polypyrrole hybrids in aqueous electrolytes: An in-situ high-resolution X-ray diffraction study — ●MANUEL BRINKER^{1,2} and PATRICK HUBER^{1,2,3} — ¹Institut für Material- und Röntgenphysik, Technische Universität Hamburg, Denickestraße 15, 21073 Hamburg, Deutschland — ²Deutsches Elektronen-Synchrotron DESY, Center for X-Ray and Nano Science CXNS, 22607 Hamburg, Deutschland — ³Center for Hybrid Nanostructures CHyN, Universität Hamburg, 22607 Hamburg, Deutschland

A hybrid material of the electroactive polymer polypyrrole filled within the scaffold structure of the porous semiconductor porous silicon is exhibiting a reversible straining by control of an applied potential in an electrolyte solution. Anions from the electrolyte solution are inserted into or extracted from the polymer if it is polarized by an applied potential. This process is accompanied by an expansion or contraction of the polymer, which means a change of its geometrical dimensions. This process is directed by the confinement of the silicon nanopores. The swelling of the polymer impacts the mono-crystalline lattice in the porous silicon pore walls. Thus, it is possible to perform a highly resolved investigation of the reversible straining by means of an in-situ X-ray diffraction study that determines the lattice parameter inside the pore wall. [1]

[1] Manuel Brinker, Marc Thelen, Manfred May, Dagmar Rings, Tobias Krekeler, Pirmin Lakner, Thomas F. Keller, Florian Bertram, Norbert Huber, and Patrick Huber(2022). *Physical Review Materials*, *6*(11), 116002.

CPP 53.5 Fri 12:45 H 0107

Self-assembled photonic pigments from bottlebrush block copolymers — ●RUITING LI¹, ZHEN WANG², RICHARD PARKER², and SILVIA VIGNOLINI^{1,2} — ¹Department of Sustainable and Bio-inspired Materials, Max-Planck Institute of Colloids and Interfaces, Potsdam, 14476, Germany — ²Yusuf Hamied Department of Chemistry, University of Cambridge, Lensfield Road, Cambridge, CB2 1EW, UK

Bottlebrush block copolymers (BBCPs) have emerged as a versatile material for constructing photonic materials. In contrast to alternative photonic materials, BBCPs offers several distinct advantages, including: rapid assembly kinetics, ordering over macroscopic dimensions, and the capacity to accommodate substantial functionality.

In this talk we will introduce a robust strategy for the fabrication of hierarchical photonic pigments via the confined self-assembly of BBCPs within emulsified microdroplets. By optimising the BBCP composition and the emulsification conditions, we demonstrate that microparticles with a well-resolved concentric lamellar structure can be formed. The fundamental optical response (i.e. colour) is determined via the BBCP molecular weight, however we will show that by exploiting new macromonomers it is possible to produce "photonic pigments" that are mechanochromic, unlocking potential application as ultrasensitive pressure sensors.