CPP 15: Poster: Functional Polymer Hybrids

Time: Monday 18:15–21:00 Location: Poster B2

CPP 15.1 Mon 18:15 Poster B2

Nanostructured hybrid block copolymer electrolytes as a membrane for lithium-ion microbatteries — •Maximilian Kaeppel, Ezzeldin Metwalli, and Peter Müller-Buschbaum — TU München, Physik-Department, LS Funktionelle Materialien, 85748 Garching, Germany

Solid-state polymer electrolyte membranes are promising alternatives to liquid electrolytes for energy storage related applications. A key challenge is to achieve a highly ionic conductive membrane that maintains both, high-modulus and chemical stability. The structure and conductivity of hybrid polymer electrolyte membranes composed of polystyrene-block-polyethylene oxide diblock copolymer (PS-b-PEO), lithium salt and ionic liquid (IL) were investigated. The PEO crystallization during the solution-casting of thin solid-state membranes was observed. The PEO crystallization is inhibited by increasing the doping level of both Li ions and IL. The high-modulus PS domains of the nanostructured hybrid membranes offers mechanical stability, while both the Li-containing PEO and IL enable the requisite high ionic conductivity. An optimized functional morphology of the hybrid membrane is achieved by enabling highly interpenetration hard PS and soft PEO/IL domains. The conductivity enhancement correlation with the evolved morphologies is proved.

CPP 15.2 Mon 18:15 Poster B2

Morphology of block copolymer electrolytes for rechargeable lithium batteries — •Bernhard Springer, Ezzeldin Metwalli, and Peter Müller-Buschbaum — TU München, Physik-Department, LS Funktionelle Materialien, 85748 Garching, Germany

Block copolymers (BC) electrolytes have been recently investigated as solid-state membranes for lithium-ion batteries. Nanostructured BC electrolyte contains both, the ionic conducting as well as the high-tensile polymer domains, enabling both, high ionic conductivity and improved mechanical stability. Since the diffusion path of the lithium-ions only follows the percolation path of the ionic conducting domain, the morphology of the BC electrolyte is an essential parameter. Theoretical studies have recently reported that the BC electrolyte phase diagrams significantly deviate from the conventional BC phase diagrams due to electrostatic interactions between polar chains and alkali metal-ions. The morphology of polylauryl methacrylate-block-polymethacrylic acid (PLMA-b-PMAA) BC electrolyte with three different ionic block volume fractions was investigated using SEM and SAXS. In the current study, morphological deviation compared with that of the conventional BC phase diagrams in consistent with the theoretical studies is experimentally proved. Conductivity measurements of the Li-ions containing BC hybrid films were examined for different morphologies using impedance spectroscopy.

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Hybrid Based Thermoelectrica — •Anjani Kumar Maurya, Nitin Saxena, and Peter Müller- Buschbaum — TU München, Physik-Department, LS Funktionelle Materialien, 85748 Garching, Germany

High-efficiency thermoelectric (TE) materials are an important materials system for power generation that can directly convert thermal waste heat into electrical energy which plays a key role in our current challenge to develop alternative energy technologies to reduce our dependence on fossil fuels and to reduce greenhouse gas emissions. The power conversion efficiency of TE materials for TE generators is proportional to the so-called figure of merit ZT. Organic materials, such as polymers, are attractive thermoelectrics due to their low thermal conductivity, but face similar challenges in optimization as their inorganic counterparts. Inorganic hybrid composites, present a unique opportunity to optimize ZT via molecular and interfacial design in ways not possible in more classical systems. We investigate novel organic-inorganic hybrid materials for thermoelectric applications. The goal is to realize efficient low temperature ($T < 100°C$) thermoelectric hybrid thin films. We attempt to improve the figure of merit ZT, by combining nanostructured inorganic materials with the electrically conducting polymer blend PEDOT:PSS.

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Polymer metal composite: direct patterning by E-beam lithography — •Parisa Bakhtiarpour[1], Annina Steinbach[2], Stefan Jenisch[2], Steffen Strehle[2], Othmar Marti[1], and Masoud Amirkhani[1] — [1]Institute of Experimental Physics, University of Ulm, 89069 Ulm, Germany — [2]Institute of Electron Devices and Circuits, University of Ulm, 89069 Ulm, Germany

Ionic polymer metal composites (IPMCs) have a wide range of applications as artificial muscle in robotic and micro robotics. To metalize ionic polymers such as Nafion, chemical reduction and electroless plating are common methods, but without the possibility to control the metal penetration into the polymer. The modality and depth of penetration have an important role in IPMC function, especially in micrometer sample size. To study the position and geometry of metal layer and their effect on performance, using a manageable method for metal electrodes fabrication is essential. In this work, E-beam has been used to pattern the polymer surface in desired shape with high value of accuracy and control. Physical methods like coating and sputtering can be applied after pattern process to cover the electrode area. We investigate various parameters for pattern formation and stable coating.

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Template-assisted self-assembly of anisotropic plasmonic nanocuboids employing wrinkle-structured substrates — •Patrick T. Probst[1], Moritz Tebbe[2], Tobias A. F. König[1], and Andreas Fery[1] — [1]Institute of Physical Chemistry and Polymer Physics, Leibniz Institute of Polymer Research (IPF), Hohe Str. 6, Dresden, Germany — [2]Dept. of Physical Chemistry II, University of Bayreuth, Universitätsstr. 30, 95447 Bayreuth, Germany

Tailored inter-particle coupling and substrate-supported plasmonic coupling effects are a prerequisite to generate electric and magnetic modes in colloidal optical metamaterials. Wrinkle-assisted self-assembly allows for the cost-effective construction of linear plasmonic arrays on macroscopic areas.[*Soft Matter* **2007**, *3*, 1530; *Farad. Discuss.* **2015**, *181*, 243] By multi-printing and selective transfer of assembled particle lines of defined morphology and periodicity, more complex structures are feasible.[*Langmuir* **2012**, *28*, 16745] Line spacing is determined by the template, whereas inter-particle spacing can be modified by a soft, polymeric spacer to tune the collective optical response. Thus, for the first time, we arrive at ensembles which show a clear signature of nanophotonic features in conventional UV/Vis/NIR spectroscopy homogenously over macroscopic areas, in accordance with electrodynamic simulations (GMMT, FDTD).[*Nano Lett.* **2014**, *14*, 6863] We present recent results in expansion of this assembly approach to anisotropic plasmonic nanocuboids and its perspectives toward metamaterial effects and concepts for light management.[*Mater. Today* **2014**, *18*, 185]

CPP 15.6 Mon 18:15 Poster B2

Mechanically tunable plasmon ruler by exploiting macroscopic colloidal line grating — •Anja Maria Steiner[1], Christoph Hanske[2], Tobias A.F. König[1], and Andreas Fery[1] — [1]Institute of Physical Chemistry and Polymer Physics, Leibniz Institute of Polymer Research (IPF), Hohe Str. 6, 01069 Dresden — [2]Dept. of Physical Chemistry 2, University of Bayreuth, Universitätsstr. 30, 95440 Bayreuth

Large-scale, template-assisted assemblies of plasmonic gold nanospheres[1] transferred to low-modulus, high-elongation elastomeric substrates (PDMS) represent a novel class of tunable optical systems. We present a tunable optical system with the ability to reversibly shift the plasmonic key resonance by mechanical deformation. This strain-dependent plasmonic response is observed with conventional UV/vis/NIR spectroscopy and is correlated to *in-situ* scanning probe microscoy measurements.

In strong agreement with finite-difference time-domain (FDTD) simulations the tunable optical response can be distinguished into two effects: First, the plasmonic resonance shift depending on the inter-particle distance within the lines (plasmon ruler). Second, the line-to-line coupling, which becomes dominant at a certain distance (grating effects).

Overall, controlling the optical response upon mechanical deformation gives the opportunity for mechano-optically active systems and soft optical sensors.

[1] Christoph Hanske *et al.*, Nano Lett., **2014**, 14, 6863-6871

CPP 15.7 Mon 18:15 Poster B2

Tailored Plasmonic Particle Arrays for Systematic Dark Field Spectroscopy — •Yannic Brasse[1], Tobias A. F. König[1], Matthias Karg[2], and Andreas Fery[1] — [1]Physical Chemistry and Polymer Physics, Leibniz Institute of Polymer Research (IPF), Hohe Str. 6, 01069 Dresden, Germany — [2]Physical Chemistry I, University of Bayreuth, Universitaetsstr. 30, 95440 Bayreuth, Germany

This work describes the fabrication of spaced plasmonic particle arrays for systematic dark field investigation. The major advantage of those substrates is the possibility of "high" throughput single particle spectroscopy in combination with the accessibility towards post-modifications. The concept is based on directed assembly of Poly(N-isopropylacrylamide) coated plasmonic colloids on micro contact printed polyelectrolyte multilayer films. Arrays of gold core particles were overgrown with gold and studied via dark field microscopy and spectroscopy. The presented method is highly suited for efficient screening of optical properties and catalytic reactions on the single particle level (M.B. Müller, ACS Nano, 2014, 8, 9410).

CPP 15.8 Mon 18:15 Poster B2

A Comparative Study of Photoinduced Deformation in Azobenzene Containing Polymer Films — •Sarah Loebner, Nataraja Sekhar Yadavalli, and Svetlana Santer — Institute of Physics and Astronomy, University of Potsdam, Germany

Here we report on light induced structuring and deformation of three photosensitive polymers differing in their glass transition temperature. To inscribe surface relief gratings, the polymer films were irradiated with interference pattern of different polarization: intensity interference pattern (IIP) and polarization interference pattern (PIP). The irradiation was conducted in-situ while simultaneously acquiring the topography change with AFM. The polymers show comparable kinetic of topography change and maximally attainable grating height under irradiation with IIP. The illumination with PIP results in larger grating height for all three polymers, but more pronounce topography change was found for the polymers of larger glass transition temperature.
We have also performed experiments where a rectangular piece of polymer film was cut out of the film using AFM lithography and irradiated with homogeneous light of linear polarization. For all three polymers we have found that the rectangular piece elongates along the electrical field vector and contracts in perpendicular direction.