CPP 97: Nanostructures, Nanostructuring and Nanosized Soft Matter

Time: Thursday 15:00–17:00 Location: ZEU 255

Invited Talk CPP 97.1 Thu 15:00 ZEU 255

Grain coarsening dynamics in cylinder-forming block copolymer thin films — •Michele Perego — CNR-IMM, Unit of Agrate Brianza, Italy

The all-organic polystyrene-block-poly (methyl methacrylate) (PS-b-PMMA) block-copolymer (BCP) thin films have been widely investigated for advanced lithographic applications, due to the possibility to promote perpendicular orientation of the nanodomains by easy neutralization of the surface with the appropriate random copolymer. In this BCP system, the Flory-Huggins parameter X is weakly dependent on T and, consequently, the segregation strength XN can be modulated by simply changing the degree of polymerization N. In this respect, thin films of cylinder forming PS-b-PMMA represent a perfect test system for fundamental investigations on the evolution of ordering in two-dimensional hexagonal lattices. In this talk, we will revise our experimental studies about the grain coarsening process in PS-b-PMMA thin films with different N. The evolution of the correlation length as a function of time follows a power law with a specific growth exponent for each value of N. The exponential decay of the growth exponent as a function of N is perfectly consistent with a diffusion limited mechanism of the grain coarsening process. Interestingly for very small N, growth exponent value 1/2 suggests that the lateral ordering process is guided by a curvature limited mechanism.

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Gold cluster growth/formation on zwitterionic thin block copolymer coatings — •Apostolos Vagias[1], Simon J. Schaper[2], Christina Geiger[2], Lucas P. Kreuzer[2], Wei Chen[2], Suzhe Liang[2], Marc Gensch[2,3], Pallavi Pandit[3], Matthias Schwartzkopf[3], Stephan V. Roth[3], Jonas Drewes[4], Niko Carstens[4], Thomas Strunskus[4], Franz Faupel[4], Andre Laschewsky[5,6], and Peter Müller-Buschbaum[1,2] — [1]Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, Lichtenberstr.1, 85748 Garching, Germany — [2]Technische Universität München, Physik-Department, Lehrstuhl für Funktionelle Materialien, James-Franck-Str. 1, 85748 Garching — [3]DESY, Notkestr. 85, 22607 Hamburg — [4]CAU zu Kiel, Institut für Materialwissenschaft, LS Materialverbunde, Kaiserstr. 2, 24143 Kiel — [5]Institut für Chemie, Universität Potsdam, Karl-Liebknechtstr. 24-25, 14476 Potsdam-Golm, Germany — [6]Fraunhofer Institute for Applied Polymer Research IAP, Geiselbergstr. 69, 14476 Potsdam-Golm, Germany

Zwitterionic polymer (e.g. polysulfobetaines) films, serve as excellent antifouling coatings. Polymer-metal nanocomposites hold tremendous potential for plasmonics and organic catalysis. Sputtered gold can exhibit wetting selectivity with different affinities for each constituent of block copolymer films. Correlating gold growth and affinity to given polymer constituent remains elusive. By in-situ microfocus GISAXS (μGISAXS) we present the evolution of nanostructural gold growth on thin (<100 nm) films of zwitterionic copolymers and respective homopolymer films, commenting on metal selectivities during sputtering.

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A new polymorph in triglyceride nanoparticles prepared by antisolvent precipitation — •Isabel Schuldes[1], Dennis M. Noll[1], Klaus Götz[1,2], and Tobias Unruh[1,2] — [1]Institute for Crystallography and Structural Physics, Universitaet Erlangen-Nuernberg, Erlangen, Germany — [2]Interdisciplinary Center for Nanostructured Films, Universitaet Erlangen-Nuernberg, Erlangen, Germany

Antisolvent precipitation (AP) is a low-cost bottom-up method for the preparation of nanoparticles, e.g. for pharmaceutical applications. We report small (~ 25 nm in diameter) triglyceride (tripalmitin, trimyristin) nanoparticle dispersions prepared by AP, which exhibit unexpected structural characteristics: differential scanning calorimetry (DSC) and wide-angle X-ray scattering (WAXS) measurements show an uncommon melting behaviour and an untypical crystalline phase. The presence of said untypical phase has been reported in triglyceride nanosuspensions previously, but has not been studied as it represented only a minor fraction of the dispersion [1]. In contrast, we have observed that in dispersions prepared by AP this phase is predominant. Small-angle X-ray and neutron scattering (SAXS, SANS) measurements further revealed an interfacial structure of the liquid triglyceride nanoparticles. Such structure was recently suggested to be a general feature among small nanoparticles prepared by AP [2] and might play a role in the formation of the observed untypical phase. Our findings may help to tailor triglyceride nanoparticles for application as drug delivery systems. [1] H. Bunjes et al., Langmuir, 2000, 16, 5234. [2] I. Schuldes et al., Langmuir, 2019, 35 (42), 13578.

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Sputter deposition of Ag on nanostructured PMMA-b-P3HT copolymer thin films — •Marc Gensch[1,2], Matthias Schwartzkopf[1], Simon J. Schaper[2], Lucas P. Kreuzer[2], Nian Li[2], Jonas Drewes[3], Oleksandr Polonskyi[3], Thomas Strunskus[3], Franz Faupel[3], Peter Müller-Buschbaum[2,4], and Stephan V. Roth[1,5] — [1]DESY, Photon Science, Notkestr. 85, D-22607 Hamburg, Germany — [2]TUM, Physik-Department, LS Funktionelle Materialien, James-Franck-Str. 1, D-85748 Garching, Germany — [3]MaWi, Christian Albrechts-Universität zu Kiel, Kaiserstr.2, D-24143 Kiel, Germany — [4]Heinz Maier-Leibniz Zentrum (MLZ), TUM, Lichtenbergstraße 1, D-85748 Garching, Germany — [5]KTH, Teknikringen 56-58, SE-100 44 Stockholm

Nanostructured polymer-metal-composite films demonstrate great perspectives for optoelectronic applications, e.g. as sensors or photovoltaics. To enhance properties of such devices the metal cluster self-assembly process needs to be understood. We studied the silver cluster morphology during the growth on PMMA-b-P3HT by grazing incidence small-angle X-ray scattering (GISAXS), as well as the crystallinity of the metal film formation with grazing incidence wide-angle X-ray scattering (GIWAXS) in situ during sputter deposition. The scattering experiments were combined with surface differential reflectance spectroscopy (SDRS). Our study reveals the selective wetting of silver on the polymer blocks and the influence of the template on the percolation behavior of the silver layer, which was measured by resistivity measurements during the sputter deposition.

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Colloidal self-assembly route towards efficient designing of nanophotonic architectures — •Swagato Sarkar[1,2], Joby Joseph[1], and Tobias A.F. König[2,3] — [1]Dept. of Physics, Indian Institute of Technology Delhi, New Delhi-110016, India — [2]Leibniz-Institut für Polymerforschung Dresden e.V., Institute of Physical Chemistry and Polymer Physics, Hohe Str. 6, 01069 Dresden, Germany — [3]Technical University of Dresden, Physical Chemistry, 01062 Dresden, Germany

For many photonic applications, it is important to confine light of a specific wavelength at a certain volume of interest at low losses. So far, it is only possible to use the polarized light perpendicular to the solid grid lines to excite waveguide plasmon polaritons in a waveguide supported hybrid structure. In this contribution, we use a plasmonic grating fabricated by colloidal self-assembly [König, Fery et al. Adv. Optical Mater. 2018, 1800564] and an ultrathin injection layer to guide the resonant modes selectively.[Sarkar, Joseph, König ACS Appl. Mater. Interfaces 2019, 11, 14, 13752-13760] We use gold nanoparticles self-assembled in a linear template on a titanium dioxide (TiO2) layer to study the dispersion relation with conventional UV-vis-NIR spectroscopic methods. Compared to metallic grids, the experimentally observed (supported by simulation) range of hybridized guided-modes can now be extended to modes along the nanoparticle chain lines. With future applications in energy conversion and optical filters employing these cost-efficient and up-scalable directed self-assembly methods, we discuss its direct application in refractive index sensing.

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Surface Lattice Resonances in the Visible Optical Range by Soft Lithography Templates and Directed Self-Assembly. — •Vaibhav Gupta[1], Andreas Fery[1,2], and Tobias a.f. König[1,2] — [1]Leibniz-Institut für Polymerforschung Dresden e. V., Hohe Straße 6, D-01069 Dresden, Germany — [2]Physical Chemistry, Technical University of Dresden, 01062 Dresden, Germany

We demonstrate a novel approach towards mechanically tunable, cost-efficient and low-loss plasmonic nanostructures, whose pronounced optical anisotropy upon mechanical deformation can be detected by naked eye.1 Soft interference lithography and template-assisted colloidal self-assembly are used to fabricate a stretchable macroscopic

periodic square lattice of gold nanoparticles. Surface scanning methods reveal a full coverage of the array. The high structural quality results in a narrow bandwidth surface lattice resonance with a line width of 25. Stretching of the system results in reversible transition from the square lattice to a rectangular symmetry and corresponds to pronounced changes in the optical properties of the ensemble. We show the hybrid nature of the optical response using angle dependent UV-vis spectroscopy and numerical simulations. Based on these findings and our colloidal metasurface concept.2 We discuss potential applications as strain sensor and mechanically tunable filters.

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Nanoparticle Contaminations on the Skin - Can They be Removed? — •Jonas Schubert[1,2] and Max Schnepf[1,2] — [1]Functional Colloidal Materials, Leibniz Institute of Polymer Research Dresden, 01069 Dresden, Germany — [2]Physical Chemistry of Polymer Materials, Technische Universität Dresden, D-01062 Dresden, Germany

Nanoparticles (NPs) are used now for centuries and more and more they find their way into applications and products on the market. As the usage of nanoparticles is increasing, also accidental release of NPs is now an important issue for a safe work environment. We found that after a skin contact with quantum dot particles, these NPs are barely to remove by applying soap or other typical decontamination agents. From literature we know that some of the NPs can penetrate the skin and are then potentially be harmful for human health.[1] In this contribution, we present a gel that allows a complete removal of NPs from the skin. This marks a first step towards safe handling of nanomaterials, especially since this point is not yet covered by up-to-date occupational safety guidelines. The presented gel displays therefore an important step for the sustainable and safe use of nanomaterials.

[1] Nafisi, S.; Maibach, H. I., Chapter 3 - Skin penetration of nanoparticles. In Emerging Nanotechnologies in Immunology, Shegokar, R.; Souto, E. B., Eds. Elsevier: Boston, 2018; pp 47-88.