CPP 1 Thin Films and Surfaces I

Time: Monday 09:30–12:15 Room: ZEU Lich

Invited Talk CPP 1.1 Mon 09:30 ZEU Lich

Polymer Thin Films and Mixed Brushes: Some Applications to Nanoscience — •Manfred Stamm — Leibniz Institute of Polymer Research Dresden, Germany

Polymers exhibit interesting properties that are used in the bulk, but can similarly provide interesting aspects with thin films. Crosslinked polymer networks thus can be highly swollen in solvents, and with a thin polymer bilayer film this effect may be utilized to produce nanotubes by scrolling of the film /1/, when the lower layer is swollen by the solvent while the upper layer is inert. The film can be patterned at the surface and the structure transferred to the inner surface of the tube formed. A fairly robust way of surface functionalization is the attachment of polymer chains to the surface by covalent bonding. At high grafting density a brush-like layer will be formed, and surface properties can be changed significantly. Utilizing mixed polymer brushes the surface properties can be switched between different states due to local phase segregation /2/, and it is even possible to switch between ultra-hydrophobic and ultra-hydrophilic behavior by introduction of an additional surface roughness. Mixed polymer brushes may be used for the control of protein adsorption or the separation of liquids by the effect of controlled surface interaction.

/1/ V. Luchnikov, M. Stamm, O. Sydorenko, Advanced Materials, 17, 1177-1182 (2005) /2/ L. Ionov, B. Zdyrko, A. Sidorenko, S. Minko, V. Klep, I. Luzinov, M. Stamm, Macromolecular Rapid Communications, 25, 360-365 (2004)

CPP 1.2 Mon 10:00 ZEU Lich

Thin Film Rupture: From Elastic Fracture to Viscous Fingering — •Sylvain Gabriele[1], Günter Reiter[2], and Pascal Damman[1] — [1]Université de Mons Hainaut Laboratoire de PhysicoChimie des Polymères Place du Parc, 20 B-7000 Mons — [2]Institut de Chimie des Surfaces Interfaces 15, rue Jean Starcky F-68057 Mulhouse

The stability of thin polymer films on top of a solid surface is of importance for numerous applications ranging from the lubrication to microlithographic resist films. When forced to cover a non-wettable substrate, thin liquid film could be unstable and dewet. We will focus on different geometries of dewetting (circular and planar) which exhibit a variety of artistic morphologies of instability. We report experimental observations that suggest that different viscoelastic instabilities are directly related to the dissipation mode: elastic or viscous. The first case of instability appears at the early stage of dewetting in the elastic regime and is related to stress dissipation by fracture propagation. The formation of cracks into the asymmetric rim can be interpreted as the instantaneous response of a circular dynamic elastic ring to an applied tangential stress. As a result, the fractures propagation forms a complex structure in a starry shape which provides a faster way to release the accumulated stress. After a characteristic time t2, rims show fluctuations in width and finally yield to an artistic finger-like pattern. The transversal instability of the rim is clearly reminiscent of the Rayleigh-Plateau instability. We argue that determining the onset of this rim instability represents a reliable way for measuring the disentanglement time of polymer which corresponds to the characteristic time t2.

CPP 1.3 Mon 10:15 ZEU Lich

Flow of a complex liquid near a solid interface: SPM studies — •Hendrik Hähl, Ludovic Marquant, Daniel Podzimek, Renate Fetzer, and Karin Jacobs — FR 7.2 Experimentalphysik - Weiche Materie, Universität des Saarlandes, D-66123 Saarbrücken

Dewetting of structured liquids is a very complex process. We investigate thin block-copolymer films composed of polystyrene-block-polyethylen/propylen (PS/EP) retracting from silanized silicon wafers. The equilibrium layer structure of the block-copolymer film vanishes in the presence of shear flow, giving way to a more complex structure. By tapping mode SPM, we can detect PS cylinders in a matrix of PEP. These cylinders are aligned parallel to the moving three-phase contact line. Additional to the free surface of the film, we are interested in the film behaviour near the solid substrate. We found a novel method to scan the microdomain structure of the block-copolymer film just at this interface with SPM resolution. The alignment of the cylinders we also found here gives evidence to a nonzero slippage velocity.

CPP 1.4 Mon 10:30 ZEU Lich

Pretransitional Wetting Structures at a Thermotropic Liquid Crystal/Water Interface — •Christian Bahr — Max Planck Institute for Dynamics and Self-Organization, Bunsenstr. 10, 37073 Göttingen

Recently, theoretical interest has emerged concerning colloidal interactions between spherical particles, which are suspended in the isotropic phase of nematic liquid crystals and are covered with a nematic wetting layer [1]. A corresponding experimental system could consist of an emulsion of water droplets in an isotropic liquid crystal. It is not known, however, if at isotropic liquid crystal/water interfaces nematic wetting layers exist or what properties they have. We present here an ellipsometric study of such an interface near the nematic – isotropic phase transition. Approaching the transition temperature T_{NI} from above, a nematic wetting layer appears at the interface if the water phase contains a surfactant inducing a homeotropic alignment of the nematic phase. On further approaching T_{NI}, the thickness of the nematic layer shows a pronounced increase and a possible logarithmic divergence at T_{NI}. The detailed behavior is significantly influenced by the concentration of the surfactant. The experimental results can be described by a mean-field model in which the surfactant concentration tunes the magnitude of an ordering interface potential.

[1] H. Stark, *Phys. Rev. E* **66**, 041705 (2002); J. Fukuda, H. Stark, H. Yokoyama, *Phys. Rev. E* **69**, 021714 (2004); M. Huber and H. Stark, *Europhys. Lett.* **69**, 135 (2005).

— 15 min. break —

CPP 1.5 Mon 11:00 ZEU Lich

Structural analysis of triblock / diblock copolymer blend films: A comparative GISAXS study of films obtained by spin-coating and solution casting — •V. Körstgens[1], M.M. Abul Kashem[1], S. Stüber[1], S.V. Roth[2], and P. Müller-Buschbaum[1] — [1]TU München, Physik-Department E13, James-Franck-Str. 1, D-85747 Garching, Germany — [2]HASYLAB at DESY, Notkestr. 85, D-22603 Hamburg, Germany

Films of styrene-isoprene-styrene (SIS) triblock copolymer blended with styrene-isoprene (SI) diblock copolymer and a naphtenic oil are investigated with grazing incidence small angle X-ray scattering (GISAXS). Polymer films were prepared from toluene solution on glass slides by two different procedures: On the one hand spin-coating technique was applied and on the other hand films were solution casted and dried. Both types of films differ markedly in thickness and structure. Moreover surface and bulk structures can be distinguished. Surface sensitive probes such as atomic force microscopy and optical imaging complement the scattering experiment.

CPP 1.6 Mon 11:15 ZEU Lich

Regular Nano-dot Patterns by Dewetting of Thin Organic Films — •Stephan Rath, Mark Heilig, and Helmut Port — 3. Phys. Inst. Universität Stuttgart

The dewetting of thin organic films UHV-deposited on He-cooled substrate is analyzed by optical and AFM microscopies. By controlled annealing to room temperature such films can be transformed into patterns of isolated droplets. The description of the dewetting process takes advantage of the close similarity to pattern formation and dynamics in thin polymer films (polystyrene). Typical dewetting stages are discerned: spinodal hole formation, inhomogeneous extension of the hole, transformation into droplets via fingering and Rayleigh instabilities followed by droplet coarsening.

Films of a fulgide derivative, deposited on quartz glass substrates in the thickness range between 2 and 22 nm, will be considered as example. On smooth substrate surfaces, however, only irregular pattern of droplets are formed. In order to achieve regular patterns which are of interest for applications in molecular electronics and photonics, structured substrates are used as templates. In this way regular patterns of nano-dots with variable sizes and lateral distances have been produced.

CPP 1.7 Mon 11:30 ZEU Lich

Deformation of polymer thin films on structured substrates — •Julien Leopoldes and Pascal Damman — Laboratoire de Physico-Chimie des Polymères, 20 Place du Parc, B7000 Mons

Polymer surface patterning is a crucial issue for many technological applications such as the manufacture of memory storage devices, catalyse, biomimetics or microfluidics. Various techniques are available, mainly based on lithography. It is however unanimously acknowledged that new routes toward the self-assembling of chemical and/or topographical patterns are urgently needed, to reduce the cost and accelerate the progress of the development of the micro and nano structuring processes. A most promising approach is the decomposition of thin films under the destabilizing influence of long range Wan der Waals forces, but the complex patterns obtained still render their technological value rather unclear. Moreover, the limited scales (100nm) on which Wan der Waals forces can be accounted for is actually a great limitation to a broad range of applications. Here we reveal other perspectives to achieve the control of the destabilisation of thin films, and henceforth the resulting surface properties. The films are adsorbed on chemically patterned substrates and the alteration of the film surface is initiated up to thicknesses corresponding to several microns.

CPP 1.8 Mon 11:45 ZEU Lich

Low-temperature structures of dipolar films — •Sabine H.L. Klapp — Stranski-Lab for Physical and Theoretical Chemistry, Sekr. C7, Technical University Berlin, Strasse des 17. Juni 115, 10623 Berlin — Institute for Theoretical Physics, Sekr. PN 7-1,Technical University Berlin, Hardenbergstrasse 36, 10623 Berlin

Recent theoretical and experimental research has demonstrated that fluids with dominant dipole-dipole interactions can display new, unexpected behavior such as self-assembly of the particles into dipolar chains, and crystallization into novel structures (1). In the present contribution we focus on the behavior of dipolar systems confined to thin films and in two spatial dimensions, a situation which is particularly important for colloidal systems with (ferro–)magnetic interactions and for thin magnetic films. Using lattice summations and density functional theory we analyze possible lattice structures as well as the fluid side of the phase diagram. We also present Monte Carlo data for thin dipolar fluid films with a thicknesses between one and two monolayers.

1) S. H. L. Klapp, J. Phys.: Condens. Matter **17**, R525 (2005).

CPP 1.9 Mon 12:00 ZEU Lich

Micro-focus GISAXS Investigation of Polymer Brushes — •Jochen S. Gutmann[1,2], Gina-Gabriela Bumbu[1], Markus Wolkenhauer[1], Yajun Cheng[1], and Rüdiger Berger[1] — [1]Max Planck Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz, Germany — [2]Institute for Physical Chemistry, Johannes Gutenberg University Mainz, Welderweg 11, D-55099 Mainz, Germany

Polymer brushes are selective coatings for micromechanical cantilever (MC) sensors, enabling the use of MC sensor technology in liquid environments. To prepare covalently grafted polymer layers on MC sensors, a poly(methyl methacrylate) (PMMA) brush layer was grown using a grafting-from ATRP synthesis [1]. The brush layer acts as a sensing layer when brought into contact with different solvents. In our experiments we have noticed that the deflection/stress of the PMMA covered MC after the first swelling systematically differs from the values before swelling. This behaviour may be assigned to a structural 'memory' of previous treatments, i.e. the solvent/non-solvent used and the drying procedure. We therefore focus on the influence of the solvent used for swelling on the morphology of the dried PMMA brushes. In order to investigate the lateral structure of the brush layer on the μm sized cantilevers, we used a micro-focus set-up for X-ray scattering under grazing incidence (μ-GISAXS), at the BW4 beam line.

[1] Bumbu G.-G., Kircher G., Wolkenhauer M., Berger R., Gutmann J.S., Macromol. Chem. Phys. 2004, 205 (13): 1713-1720