Graphitizing polyimide surfaces — Jhina Lazareva, Yuri Koval, M. Alam, Stefan Stromsdorfer, Slava Dremov, and Paul Muller — Physikalisches Institut III, Universität Erlangen-Nürnberg

Various polymers can be converted to conducting state by ion irradiation. Recently we demonstrated that irradiation with Ar+ ions of energies even as low as 150 eV is effective. In contrast to high-energy ion bombardment, low-energy ion irradiation transforms only a thin surface layer. Depending on the irradiation conditions, the conducting layer can be partly or completely graphitized. We present our experimental results of graphitization of polyimide by Ar+ ions with energies between 150 eV and 1000 eV. The surface of the irradiated polyimide was investigated by atomic force and scanning tunneling microscopy. The atomic structure of the irradiated polyimide surface confirms the graphitic nature of the conducting layer. Transport properties of the graphitized layers were studied in the temperature range between 4.2 and 300 K. For high resistive films, the conductivity is provided by variable-range hopping. At high electric fields, the conductivity of the graphitized polyimide can be described by a Poole-Frenkel model. At temperatures below 10 K, tunneling becomes the main process of ionization, and a crossover to Fowler-Nordheim emission was observed. For higher radiation fluences and higher process temperatures, the conductivity increased significantly and we observed semi-metallic behavior.

Reversible charge storage and modification of thin polymer films investigated by electrostatic force microscopy — Andreas Kleiner1, Othmar Marti1, Armin Kneil2, Bernd Gotsians2, and Urs Dürig2 — Institute of Experimental Physics, Ulm University, 89069 Ulm, Germany — IBM Research GmbH, Zurich Research Laboratory, 8803 Rüschlikon, Switzerland

Atomic force microscope (AFM) modes like force curve measurements, Pulsed Force Mode or intermittent contact techniques apply certain amounts of normal and lateral forces to the sample. In most cases this creates surface charges, similar to the macroscopic contact electrification of insulators. These charges can be observed by Kelvin Probe or Electric Force Microscopy (KPFM / EFM). The quantity of charge depends on parameters like contact time, applied force or scanning velocity. By adjusting the tip voltage during contact, the amount and polarity can be controlled and charges can be erased and overwritten without change in the polymer structure. High voltages between tip and sample lead to raised topographic features due to the large non-uniform electric field. The height of these structures reaches several nanometers, depending on tip shape and applied voltage, and is reversible. Long-term measurements of these surface charges on different polymers at various temperatures will lead to a better understanding of charge storage and transport mechanisms on thin films.

Assembly of diblock copolymers on patterned substrates: A “Single-Chain-in-Mean-Field-Simulation” study — Marcus Muller and Kostas Daoulas — Institut füer Theoretische Physik, Georg-August Universitaet, Goettingen

The directed assembly of diblock copolymers on patterned substrates is a way to create nanoscopically structured materials. We study the structure and kinetics of diblock copolymers on patterned substrates by simulating a large ensemble of independent chains in an external field. This external field depends on the density created by the ensemble of molecules and it is frequently updated as to mimic the instantaneous interactions of a molecule with its neighbors. This approximate, particle-based self-consistent field method allows to (i) incorporate arbitrary chain architecture (ii) includes fluctuations and (iii) the explicit propagation of the chain conformations in time permits us to study the kinetics of structure formation. The factors that control the accuracy of the method are quantitatively discussed [1] and the reconstruction of the soft morphology at substrate patterns that deviate from the periodic morphology of the diblock in the bulk allows to [2].

Demixing and dewetting in films of binary mixtures — Santiago Madruga and Uwe Thiele — Max Planck Institute for the Physics of Complex Systems, Noethnitzer Str. 38, 01187 Dresden

Thin polymer films are often used in advanced technological applications either as homogeneous coatings or as structured functional layers. Their stability and therefore potential usage is mostly determined by the wettability properties of the substrate and is rather well understood for single component liquids. However, in various applications the film consists of a binary mixture such as a polymer blend. Then the dynamics of the decomposition in the film and of dewetting of the film couple. This allows for new pathways of structuring like decomposition induced dewetting [1]. We complete the bulk description of the dynamics of a binary mixture (model-H) [2] with boundary conditions for the evolving free surface.

The model is used to analyse the spinodal decomposition of a film of a binary mixture. The composition gradients give rise to a solutal Marangoni effect that modifies the dynamics deeply. Linear results obtained with the full transport equations for (a) purely diffusive transport described by the Cahn-Hilliard equation and (b) diffusive and convective transport described by model-H between parallel plates are compared to the case of a free surface.


Molecular-dynamics simulations of thin films with a free surface — Simone Peter, Hendrik Meyer, and Joerg Baschnagel — Institut Cahrels Sadron, Strasbourg, France

We present results [1,2] from molecular-dynamics simulations for a model of non-entangled short polymer chains in a free standing and a supported film geometry. We investigate the influence of confinement on static and dynamic properties of the melt. We find that the relaxation at the surfaces is faster in comparison to the bulk. We perform a layer-resolution analysis of the dynamics and show that it is possible to associate a gradient in critical temperatures Tc(H) with the gradient in the relaxation dynamics. This finding is in qualitative agreement with experimental results on supported polystereene (PS) films [Ellison et al, Nat. Mater. 2, 695 (2003)].

Furthermore we show that the y-dependence of Tc(y) can be expressed in terms of the depression of Tc(h), the global Tc for a film of thickness h, if we assume that Tc(h) is the arithmetic mean of Tc(y) and parameterize the depression of Tc(h) by Tc(h)=Tc(1/1+40/h), a formula suggested by Herminghaus et al [Eur. Phys. J E 5, 531 (2001)] for the reduction of the glass transition temperature in supported PS films. We demonstrate the validity of this formula by comparing our simulation results to results from other simulations and experiments.

Investigation of Polymer Surfaces by Dynamic Force Spectroscopy — Jan-Erik Schmutz1,2 and Hendrik Holscher1,2 — CeNTECH, Heinenbergstr. 11, 48149 Münster — University of Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

The atomic force microscope (AFM) is often used in dynamic modes to enhance the resolution compared to the conventional contact mode. The tapping mode where the cantilever is oscillating with a fixed frequency near the sample surface is the standard mode used in air and liquids. With a slight modification of the excitation it is possible to gain more information about the sample surface. This so-called constant-excitation mode (CE-mode) enables the direct and continuous determination of conservative and dissipative tip-sample interactions [1]. Recently, we demonstrated the application of this technique to self-organizing DPPC films [2] which are frequently used as model systems.
Manipulation of smectic layers thickness in smectic elastomers by means of uniaxial stretching — VICTOR Aksenov1, MARTIN RÖSSELE2, RAFI STAN NARIUS3, and RUDOLF ZENTEL2 — 1Otto-von-Guericke-Universität Magdeburg, Institut für Experimentelle Physik, Universitätsplatz 2, D-39106 Magdeburg — 2Universität Mainz, Institut für Organische Chemie, Duesbergweg 10-14, D-55099 Mainz

The deformations of thin oriented films of smectic liquid crystal elastomers (LCE) have been studied on macroscopic and microscopic levels by small angle x-ray scattering (SAXS), optical reflectometry and polarized Fourier transform infrared (FTIR) spectroscopy [1, 2, 3]. The polymeric network couples the microscopic characteristics such as director orientation and order parameter to the macroscopic dimensions of LCEs. For the material investigated in this work, it has been found that during stretching of free standing films with smectic layers parallel to the film surface, the optical thickness of the sample changes [1]. Small angle x-ray scattering (SAXS) measurements revealed the compression of the smectic layers in the SmA and SmC* phases [1]. The deformation induced tilt measured by polarized FTIR spectroscopy [3] is too small to explain the compression of the smectic layers.


Orientation and structural changes upon uni- and biaxial drawing of polyamide 6 — HUSSEIN SHANAK1, KARL-HEINZ EISSES2, JAN LION1, PIETER LEIBENGUTH2, and ROLF FEHSTER1 — 1FR 7.2, Experimentalphysik, Universität des Saarlandes, Postfach 151505, 66041 Saarbrücken — 2Lehrstuhl für Funktionswerkstoffe, Universität des Saarlandes, Postfach 151505, 66041 Saarbrücken, Germany

The influence of drawing on orientation, crystallinity, structural properties and anisotropy of polyamide 6 films was investigated. The samples were uniaxially and biaxially stretched. Their crystallinity as well as size and orientation of the crystallites were evaluated using X-ray diffraction. The orientation was analyzed using pole figures and hermans functions. In case of uniaxial drawing, the crystallinity increases and the films show strong orientation with increasing drawing ratio. The orientation of the biaxially drawn films is high and it is inhomogeneous, depending on the position on the film. The structural data is correlated with dielectric anisotropy that was measured at microwave frequencies.