

DS 35: Nanostructured block copolymer films (SYSA 8)

Time: Thursday 17:00–18:30

Location: H 2032

Invited Talk

DS 35.1 Thu 17:00 H 2032

Nanostructure and transport in regioregular polythiophenes and their block copolymers — RUI ZHANG¹, BO LI¹, JESSICA R. COOPER¹, MIHAELA IOVU¹, GENEVEVIE SAUVE¹, DAVID N. LAMBETH¹, DETLEF-M. SMILGIES², RICHARD D. McCULLOUGH¹, and •TOMASZ KOWALEWSKI¹ — ¹Department of Chemistry, Carnegie Mellon University, 4400 Fifth Avenue, Pittsburgh, PA 15213 — ²Cornell University, Ithaca, NY, USA

This presentation will describe the results of combined atomic force microscopy (AFM) and grazing incidence small and wide angle x-ray scattering (GISAXS/GIWAXS) studies of narrow polydispersity regioregular poly(alkylthiophenes) (PATs) and their block copolymers. Well-defined PATs were shown to have a high tendency to form nanofibrillar structures with the nanofibril widths closely related to the contour lengths of polymer molecules. Moreover, carrier mobilities in field effect transistors fabricated from PATs exhibiting nanofibrillar morphologies exhibited exponential dependence on nanofibril width. The significance of this relationship as well as the morphology of block copolymers of PATs with immiscible segments and its impact on transport properties will be also discussed.

DS 35.2 Thu 17:30 H 2032

Morphological control in organic electronic devices using semiconductor block copolymers — •SVEN HÜTTNER^{1,2}, MICHAEL SOMMER², ULLRICH STEINER¹, and MUKUNDAN THELAKKAT² — ¹Cavendish Laboratory, University of Cambridge, UK — ²Angewandte Funktionspolymere, Universität Bayreuth, Germany

Morphology plays a key role in organic electronic devices. In organic solar cells, for example, one important parameter is the creation of a large donor-acceptor interface for efficient charge separation while providing charge transport pathways to the respective electrodes at the same time. We address this issue by combining the concept of block copolymer self-assembly with functional polymers providing light absorption, hole transport and electron transport.

The presented block copolymer consists of an electron conducting block which is featured by a perylene bisimide derivative and a second block which is either featured by polystyrene or a hole conducting block such as polymerized triphenylamine derivatives. By applying different annealing methods, like the controlled exposure to solvent vapour, we can achieve highly ordered, self-assembled nanostructures of the two components with some tens of nanometers in scale. This is decisive for polymer photovoltaic devices.

Furthermore we have investigated these novel perylene bisimide based block copolymers and homopolymers in organic field effect transistors. The material shows excellent n-type properties with electron mobilities in the order of $10^3 \frac{cm^2}{Vs}$ and threshold voltages as low as 5V could be achieved.

DS 35.3 Thu 17:45 H 2032

Creating nano-structured films from self-encapsulated inorganic-organic hybrid materials — J. PERLICH¹, M. MEMESA², J.S. GUTMANN², and •P. MÜLLER-BUSCHBAUM¹ — ¹TU München, Physik-Department LS E13, James-Franck-Str. 1, D-85748 Garching (Germany) — ²MPI for Polymer Research, Ackermannweg 10, D-55128 Mainz (Germany)

Inorganic-organic hybrid materials are used in many technological areas. Nano-structured films of these materials are of special interest for photo-voltaic applications. Based on a sol-gel process and an amphiphilic diblock copolymer matrix metal oxide nano-structures are created. These nano-structures are transferred into thin films and result in highly ordered hybrid films. Key parameters with respect to structural control are the type of diblock copolymer and the detailed preparation conditions. After thin film preparation a calcinations pro-

cess is added. Moreover the impact of plasma etching is investigated. We focus on the example of poly(styrene)-b-poly(ethylenoxide), P(S-b-EO), for the preparation of the TiO₂ nano-composite films, a system which exhibits optical properties for photo-voltaic applications. Nano-structures on simple Si substrates are compared with structures obtained on ITO-covered glass surfaces. Experimentally the investigation is based on grazing incidence small angle x-ray scattering (GISAXS) in combination with scanning probe microscopy (SPM) and scanning electron microscopy (SEM). Each step of the complex preparation process is monitored with these techniques allowing for a high degree of control.

DS 35.4 Thu 18:00 H 2032

Thin films of diblock copolymers having one crystalline block — •CHARLES DARKO¹, IOAN BOTIZ², GÜNTER REITER², DAG W. BREIBY³, JENS W. ANDREASEN⁴, DETLEF-M. SMILGIES⁵, STEPHAN V. ROTH⁶, and CHRISTINE M. PAPADAKIS¹ — ¹Physikdepartment E13, TU München — ²ICSI, CNRS, Mulhouse, France — ³Norwegian University of Science and Technology, Trondheim, Norway — ⁴Risø National Laboratory, Denmark — ⁵Cornell University, Ithaca, USA — ⁶HASYLAB at DESY, Hamburg

In thin films of symmetric poly(styrene-b-ethyleneoxide) (PS-b-PEO) diblock copolymers, the surface morphologies obtained are strongly influenced by the internal structural rearrangement within the films which are associated with different mechanisms of crystal growth of PEO. With grazing incidence small and wide angle X-ray scattering, we obtained information about the mesoscopic structures as well as the crystallite orientations within the thin films. We observed lamellae parallel to the substrate in all films, but the internal structure and the degree of preferred orientation depends strongly on crystallization temperature: When crystallized at 25°C, the c-axis is oriented at approximately 35° with respect to the film normal with a broad distribution. At a crystallization temperature of 50°C, the c-axis becomes perfectly perpendicular to the substrate/film interface. The lamellar repeat distances increase with crystallization temperature. The information on the inner structures is compared to the surface textures measured by optical and atomic-force microscopy (AFM).

DS 35.5 Thu 18:15 H 2032

Temperature dependent X-ray diffraction studies of low and high molecular weight Poly(3-hexylthiophene) P3HT fractions — •SIDDHARTH JOSHI¹, SOUREN GRIGORIAN¹, ULLRICH PIETSCH¹, PATRICK PINGEL², ACHMAD ZEN², MICHAEL FORSTER³, and ULLRICH SCHERF³ — ¹Festkörperphysik, Universität Siegen, Walter Flex strasse 3, D-57068, Siegen, Germany. — ²Institut für Physik, Universität Potsdam, Am Neuen Palais 10, D-14469, Potsdam, Germany. — ³Macromolecular Chemistry, Bergische Universität Wuppertal, Gauss-strasse 20, D-42119 Wuppertal, Germany.

GI-XRD in-plane and out-of-plane studies were performed in order to understand the crystallinity, the molecular orientation and the nanoscale morphology of a low-(LMW) and a high molecular weight (HMW) fractions of Poly(3-hexylthiophene) thin films along normal as well as parallel to substrate. Thickness dependence structural ordering has been also investigated for both fractions. At the same time we also correlated thickness dependence of structural ordering with corresponding electrical measurements for both fractions. LMW films are mainly amorphous and contain randomly oriented nano-crystallites with the best match for a monoclinic unit cell. For LMW material, the crystallites were preferentially orientation along the surface normal when the size of crystallites become in the order of film thickness i.e. ~ 20 nm. For HMW fraction we found an increase of lamellar ordering at about 60 K below the melting point of the material. Depending on substrate used (OTS, HMDS or SiO₂) one can see a clear difference in the crystal orientation and packing at the interface region.