

CPP 14 Polymer Crystallization

Time: Wednesday 14:00–15:30

Room: ZEU Lich

CPP 14.1 Wed 14:00 ZEU Lich

Deformation and Fracture Mechanisms in Semicrystalline Polymers as revealed by Microfocus Synchrotron X-ray Scattering — ●NIKOLAOS ZAFEIROPOULOS¹, RICHARD DAVIES², CHRISTIAN RIEKEL², YONGFENG MEN³, JENS RIEGER³, and MANFRED STAMM¹ — ¹Leibniz-Institut für Polymerforschung Dresden, Hohe Strasse 6, 01069, Dresden — ²European Synchrotron Radiation Facility, BP 220, F-38043 Grenoble Cedex, France — ³BASF Aktiengesellschaft, Polymer Physics, 67056 Ludwigshafen, Germany

The fracture properties of polymers are one of the key parameters that define their service life and limit their applications. One of the most interesting and important questions is how the molecular architecture and the structure of polymers at nano-length scales influence their fracture properties. X-ray scattering is a powerful means of probing bulk structures at the nanometer scale. It can therefore provide a wealth of information relating to such structure-property relationships. In the present study, synchrotron radiation microfocus small and wide angle X-ray scattering is used to investigate the fracture mechanisms ahead of a crack tip in situ with the application of load, and the damage area ahead and around the crack tip post mortem, in isotactic polypropylene and high density polyethylene samples of different thermal histories. The results revealed that significant cavitation develops in the damage area at the plastically deformed region beyond the crack tip, and inside the damage zone rod and platelet-shaped cracks/voids are formed (as revealed by SAXS), accompanied by martensitic crystal transformations or the formation of a conformationally disordered phase (as revealed by WAXS).

CPP 14.2 Wed 14:15 ZEU Lich

What happens to entanglements during polymer crystallization? — ●HENDRIK MEYER — Institut Charles Sadron, CNRS UPR 22, 67083 Strasbourg, France

We developed a simplified polymer model which appeared to be very efficient for the study of polymer crystallization from the dense melt using molecular dynamics simulations [1]. Chain-folded lamellae were obtained starting from the isotropic melt with chains of $N=400$ monomers corresponding to 10-12 entanglement lengths. The thickness of the lamellae decreases with crystallization temperature as observed in experiments. We now reanalyzed the obtained configurations with a primitive path analysis [2] to quantify the entanglement length of the chains. We find that for fast crystallization, the entanglement length remains almost unchanged. For slower crystallization, in particular above the temperature where homogeneous nucleation of crystals was observed, some disentanglement occurs, and the entanglement length increases by about 50%. This means that the majority of entanglements is still present. They must be in the amorphous zones where the entanglement density thus increases.

[1] H. Meyer and F. Müller-Plathe, *J. Chem. Phys.* 115 (2001) 7807; *Macromolecules* 35 (2002) 1241.

[2] R. Everaers et. al., *Science* 304 (2004) 823.

CPP 14.3 Wed 14:30 ZEU Lich

Nanotomography of Semicrystalline Elastomeric Polypropylene — ●MECHTHILD DÖRING, NICOLAUS REHSE, CHRISTIAN DIETZ, SABINE SCHERDEL, and ROBERT MAGERLE — Chemische Physik, TU Chemnitz, D-09107 Chemnitz

Semicrystalline polymers contain nanometersized crystallites embedded in a matrix of amorphous material. The form and the arrangement of the crystallites determine the properties of the materials considerably. We use Nanotomography to image the three-dimensional structure of semicrystalline elastomeric polypropylene. The method is based on scanning probe microscopy imaging and subsequent etching of the sample surface layer by layer. Our aim is to automate the method as far as possible, to analyse different polymers, and to study the relations between structure and properties of the materials. Furthermore, the spatially complex structures are quantitatively characterized with modern image analysis techniques.

CPP 14.4 Wed 14:45 ZEU Lich

Thin Films of Crystalline Diblock Copolymers — ●C. PAPANAKIS¹, I. BOTIZ², G. REITER², and C. DARKO¹ — ¹Physik Department E13, Technische Universität München, James-Frank Str. 1, 85748 Garching — ²Institut de Chimie des Surfaces et Interfaces, CNRS, Mulhouse, France

In thin films of diblock copolymers having one crystallizing block, a number of surface structures have been observed, e.g. edge-on or flat-on lamellae with high persistence lengths, spirals and dendrites, allowing the structuring of organic surfaces on a large range of length scales. The crystallization growth process in thin films of lamellar poly(styrene-*b*-ethyleneoxide) diblock copolymer was followed by in-situ optical microscopy. Using grazing-incidence small-angle X-ray scattering (GISAXS) and grazing-incidence X-ray diffraction (GIXD), we investigate the orientation of the mesoscopic structures with respect to the substrate as well as the orientation of the crystalline chains with respect to lamellar interfaces. This information on the structure inside the film is compared to the surface texture obtained by atomic force microscopy with the focus on the effect of crystallization temperature.

CPP 14.5 Wed 15:00 ZEU Lich

Understanding polymer crystallization: a personal resumee — ●GERT STROBL — Institut für Physik, Albert-Ludwigs-Universität, 79104 Freiburg

New findings during the last decade have triggered a reconsideration of the foundations of polymer crystallization. The expansion of knowledge is due to the introduction of novel techniques - in-situ atomic force microscopy, high speed calorimetry, combination of standard techniques in simultaneous runs, or the use of new evaluation procedures in scattering experiments - which is demonstrated by a selection of important and clear-cut experimental results. The lecture points at some straightforward conclusions and presents a new thermodynamic scheme developed on the basis of the observations.

— 15 min. break —