Shear-induced crystallization precursors

For many years nucleation and growth as a stepwise process has dominated discussions about polymer crystallization under quiescent conditions [1]. In contrast to this view a multi-stage process [2] or a spinodal-assisted crystallization process [3-5] has been recently proposed. These ideas have in common that crystallization of polymers is preceded by ordered precursors. In recent years this point has been subjected to an important and still open debate [6, 7]. In the case of shear-induced crystallization so-called shish-kebab structures occur, in which oriented molecules serve as precursor of primary nucleation and form the shish [8, 9]. Further knowledge about the mechanism of the early stages of shear-induced crystallization is of great importance not only for our fundamental understanding of polymer crystallization, but also for the industrial processing of polymers.

The structural and morphological evolution of shear-induced crystallization precursors can be spatially resolved by simultaneous small- and wide-angle X-ray microdiffraction [10]. The sample can be scanned through the beam along a line with μm-range steps (Fig. 1). A small X-ray beam divergence (less than about 0.2×0.2 $mrad^2$) allows recording both the WAXS and SAXS signals together in the same patter [11]. This would allow one to perform innovatively accurate data analysis.

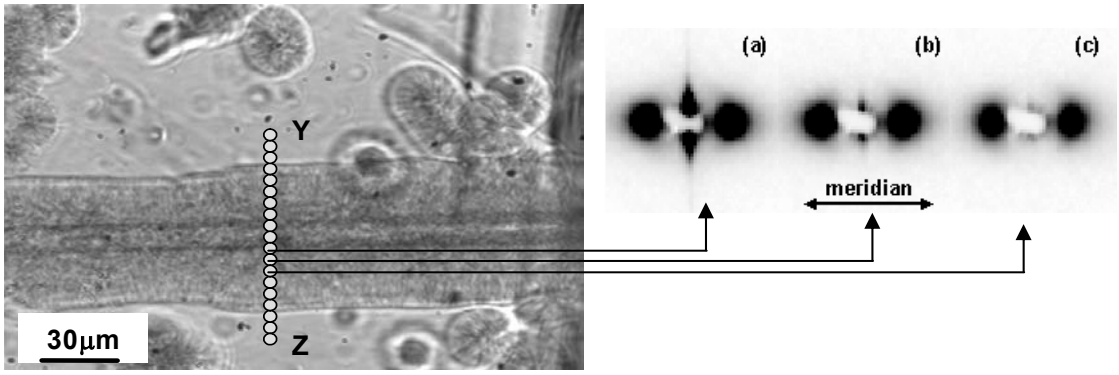

Fig. 1 Optical micrograph of a perturbed semicrystalline i-PS sample, showing schematically a linear raster-scan with 5 μm raster-increment through the perturbed zone (line YZ). A transcrystalline layer surrounding the fiber all along its length is clearly detected. Both an equatorial streak (shish) and a very well define two-lobe meridian (kebab) are observed in the SAXS patterns on the right. The meridian lobes do not change appreciably throughout the transcrystalline layer, while the equatorial streak rapidly vanishes with increasing the distance from the fiber surface [10].

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