Influence of nanoscale morphology on the micro- and macro-mechanical behaviour of polymers and polymer composites

Volker Altstädt, Jan Sandler, Department of Polymer Engineering, University of Bayreuth, Germany

ABSTRACT

In general polymers are toughened by rubber particles or reinforced by fibres with dimensions in the micro-scale. The lateral dimensions of the toughening or reinforcing agent are typically in the size range of a plastic deformation zone ahead of a sharp crack tip. With blockcopolymers but also with nanoplatelets or nano fibres the morphological features are in the nano-scale and therefore fare below the dimensions of a crazefibril or a shear zone observed by fracture mechanical experiments. Therefore the influence of morphological features in the nanoscale on the micro- and macro-mechanical behavior of polymers and polymer composites has to be explored and understood to tailor made the properties of these materials.

Based on investigations with ABC-Triblockcopolymers showing a knitting pattern morphology, PPO/SAN blends compatibilized by ABC-Triblockcopolymers showing a raspberry morphology and Polyamid reinforced with nano dispersed layered silicate the influence of nanascale morphology on properties will be discussed. In addition Poly(ether ether ketone) nanocomposites containing vapour-grown carbon nanofibres (CNF) were produced using standard polymer processing techniques. The addition of CNFs results in a higher melt strength at 360 °C. Electron microscopy confirmed the homogeneous dispersion and alignment of nanofibres. Evaluation of the mechanical and fracture mechanical properties revealed a linear increase in tensile stiffness and strength with nanofibre loading fractions up to 15 wt% while matrix ductility was maintained up to 10 wt%. An interpretation of the composite performance by short-fibre theory resulted in rather low intrinsic stiffness properties of the vapour-grown CNF.