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On nanostructured dispersions and toughness of semi-crystalline polymers.[1]

LUDWIK LEIBLER, Matière Molle et Chimie (UMR 7167 CNRS/ESPCI), Ecole Supérieure de Physique et Chimie Industrielles, 75005 Paris

In the past 50 years, great research efforts have been devoted to increase toughness of plastics. Today, impact strength of millions of tons of plastics used in all sorts of applications relies upon dispersing rubber particles in semi-crystalline polymers (polyolefins, polyamides or polyesters). Yet, the underlying mechanisms controlling such toughening are controversial. Based on a large body of literature and some simple observations, we propose a theory of toughening that explains the existence of an often evoked critical distance between rubber particles which controls the brittle-to-tough transition and predicts how it depends on size and concentration of particles. Our model predicts the brittle-to- tough transition temperature and emphasizes the role of crystal organization and orientation of matrix. Adding rubber particles induces a substantial loss in stiffness. We report how to obtain super-tough polymers and avoid such softening by using nanostructured dispersions of block- copolymers. We show that block copolymers having a three-dimensional co-continuous structure are particularly attractive as they disperse in a polymer matrix very differently from a lamellar one. In particular, droplet coalescence is much less pronounced for the co-continuous structure. Our observations arise interesting general questions about break-up and coalescence of structured fluid droplets. With Laurent Corté.

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