

Structural Evolution in Block Copolymer Solids, Melts and Gels by Deformation at Controlled Temperatures

Y. Cohen, M. Brinkmann, C. Osuji, E. Thomas (Massachusetts Institute of Technology), and M. Capel (ANL)

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Introduction: Highly ordered, near-single-crystal lamellar films of a triblock copolymer (polystyrene-polybutadiene-polystyrene, PS/PB/PS) were used to study the deformation mechanism of a structure of alternating glassy-rubbery layers at elevated temperatures. SAXS was performed in-situ using a specially prepared stretching apparatus.

Methods and Materials: Highly oriented films of the triblock copolymer were prepared by roll casting from cumene solutions, followed by thermal annealing to remove solvent and improve order. Films were mounted in the stretcher and deformed by uniaxial tensile stress perpendicular to the layers at various temperatures.

Results: At ambient temperature, the constraints on the rubbery layers due to covalent bonding to the glassy layers at the interface do not allow any significant dilation of the layer spacing. The results indicate that the yield point in the mechanical response does not correspond to critical undulation instability. Rather, the low strain behavior is dominated by tilting of layers in the vicinity of defects. Deformation of the block copolymer melt above the T_g of the PS causes the layers to dilate affinely with the macroscopic elongation. The stability of dilated layers with respect to tilting can be explained by a model, which considers the dominating influence of interfacial tension. The undulation instability is observed only during deformation at about the T_g of PS, in which the system can be described as alternating viscoelastic/rubbery layers.

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References:

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