Shear-induced texture and shear-induced phase transitions observed in block copolymer melts and networks

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Publication date:
2004

Document Version
Publisher's PDF, also known as Version of record

Shear-Induced Texture and Shear-Induced Phase Transitions observed in Block Copolymer Melts and Networks:

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Combined studies of small-angle scattering and oscillatory shear instrumentation are effective tools for studying structure and real-time dynamics of soft matter materials. Applying well-controlled large-amplitude oscillatory shear can be used to effectively control the texture of soft matter materials in the ordered states[1]. An example is the unique control one may have on the lamellae orientations in LAM-ordered, symmetric diblock copolymers. Another example is the body-centered-cubic phase which shows remarkably related shear dependent texture: Detailed crystallographic studies show that both intermediate-amplitude oscillatory shear and large-amplitude oscillatory shear lead to twin structures with {112} planes sharing neighboring twins and [111] axes parallel to the shear flow[2]. At high shear amplitude, the ***ve*** shear plane, defined by the shear flow direction (***v***) and shear vorticity direction (***e***), is parallel to the {110} crystallographic planes. At an intermediate shear amplitude, the ***ve*** shear plane, the {112} twin planes are rotated 90°, making the ***ve*** shear plane parallel to the {112} twin planes. The low-amplitude shear texture is dominated by {001} planes perpendicular to the shear gradient and by the [110] axis parallel to the flow direction, that is, the {001}/[110] slip system. Shear, however, may not only influence the texture. Shear may also affect the thermodynamic ground state, causing shear induced ordering and disordering (melting), and shear-induced order-order transitions. One example is shear-induced ordering in diblock copolymer melts; another is the shear-induced destabilization of the complex gyroid state[3].

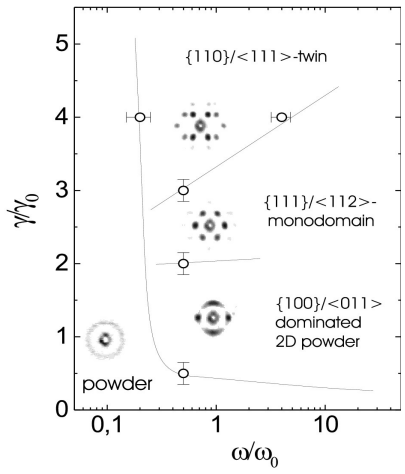

Figure 1. Shear diagram of the bcc phase of a polystyrene–poly(ethylene butylene)-polystyrene gel, showing the different crystal orientations that emerge as a result of mechanical treatment. The axes of the diagram are normalized to the values at which *G*' and *G*" approach each other.

1. K Mortensen, E Theunissen, R Kleppinger, K Almdal, H. Reynaers. *Macromolecules* **35,** 7773 (2002)
2. K. Mortensen *J. Polymer Science B: Polymer Physics*, **42**, 3095 (2004)
3. R. Eskimergen, K. Mortensen, M. Vigild. To be published