



Combined neutron and rheological studies of polymer networks, revealing shear-controlled texturing and shear-induced instabilities (invited paper)

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Combined neutron and rheological studies of polymer networks, revealing shear-controlled texturing and shear-induced instabilities

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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.

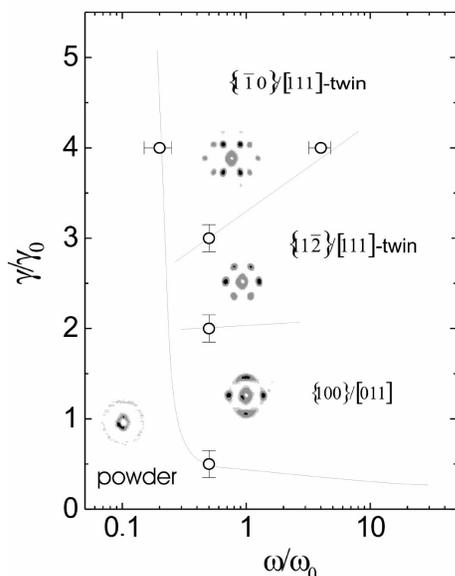


Fig. 1 Shear diagram of the bcc phase of a SEBS block copolymer micellar network, showing the different crystal orientations that emerge as a result of mechanical treatment [1,2].

Applying well-controlled large-amplitude oscillatory shear can be used to effectively control the texture of soft matter materials in the ordered states¹. An example is the unique control one may have on the lamellae orientations in LAM-ordered, symmetric diblock copolymers. A related example is the body-centered-cubic phase of diblock copolymer melts as well as block copolymer micellar gels, showing 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 shear plane is parallel to the $\{110\}$ crystallographic planes, while at moderate shear-amplitude the shear-plane is rotated 90° , *viz* 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. 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-to-order transitions. Examples are the shear-induced bcc-to-fcc transition in block copolymer micellar networks, shear-induced ordering in diblock copolymer melts and shear-induced destabilization of the complex gyroid state [3].

References:

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- [3] R Eskimergen, K Mortensen, M E. Vigild *Macromolecules* **38**, 1286 (2005)