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# 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<sup>1</sup>. 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<sup>2</sup>. At high shear amplitude, the  $\mathbf{ve}$  shear plane, defined by the shear flow direction ( $\mathbf{v}$ ) and shear vorticity direction ( $\mathbf{e}$ ), is parallel to the  $\{110\}$  crystallographic planes. At an intermediate shear amplitude, the  $\mathbf{ve}$  shear plane, the  $\{112\}$  twin planes are rotated  $90^\circ$ , making the  $\mathbf{ve}$  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<sup>3</sup>.

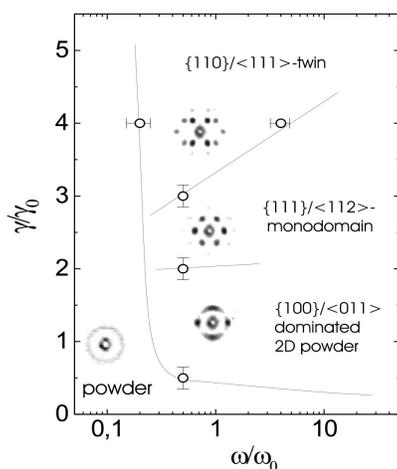


Figure 1. Shear diagram of the bcc phase of a polystyrene–poly(ethylene butylene)-polystyrene gel, showing the different crystal orientations that emerge as a result of mechanical treatment. The axes of the diagram are normalized to the values at which  $G'$  and  $G''$  approach each other.

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. Eskimerger, K. Mortensen, M. Vigild. To be published