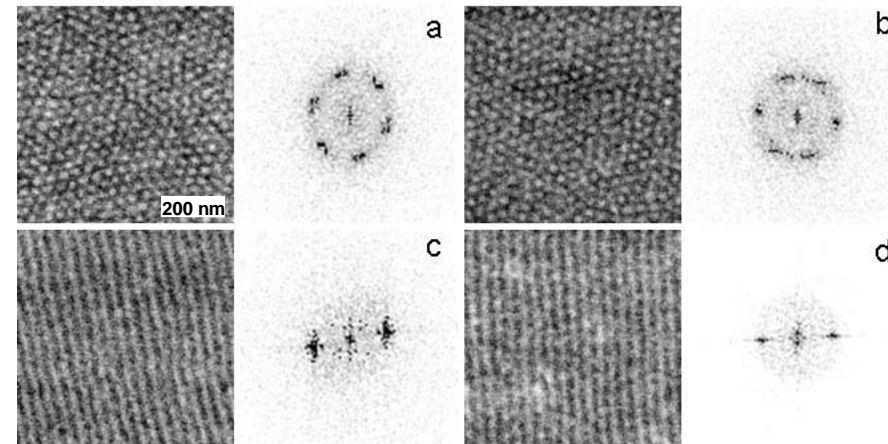
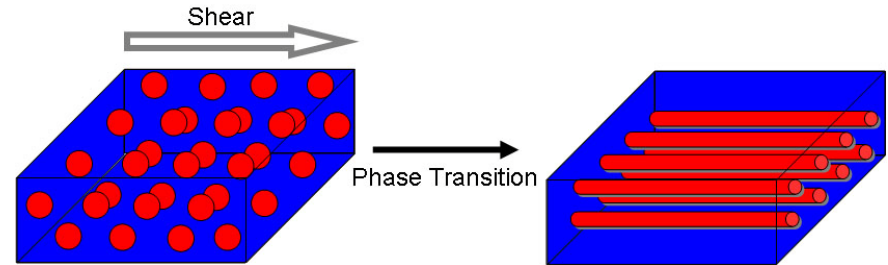




# IRG-C: Shear Stretches Spheres into Cylinders in Block Copolymer Thin Films (DMR-0819860)

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Block copolymer thin films can be robust and effective templates for patterning macroscopic areas with nanoscale features: for example, an array of trillions of 20-nm dots or millions of 20-nm stripes completely covering a 100 mm silicon wafer. Previously, PCCM researchers showed that applying shear to a thin block copolymer film can align the nanodomains it contains— for example, orienting all the 20-nm cylinders parallel to each other over wafer-scale distances. For sphere-forming block copolymers, two or more layers of spheres were thought necessary, to generate “easy” and “hard” directions for the shear relative to the nanodomain lattice. But very recently, we have discovered a new mechanism for shear alignment of spheres: sufficiently strong shear can *transform* spherical nanodomains into cylinders, which are stable during the shear but “snap back” into spheres when the stress is removed. This transition occurs even in films so thin that they contain only one layer of nanodomains— exactly the thickness most effective for use as a fabrication template.



**Top:** Schematic of the sphere-to-cylinder transition in a “bilayer” film, thick enough to contain two layers of spheres or cylinders. **Bottom:** Demonstration of the transition in a molten “monolayer” film of a polystyrene-polyisoprene diblock copolymer which forms spheres of polyisoprene when quiescent (unsheared). Scanning electron microscope images (left) and corresponding fast Fourier transforms right as the shearing stress is progressively increased: a) 5 kPa, b) 10 kPa, c) 15 kPa, and d) 20 kPa.

**Reference:** Y.-R. Hong, D.H. Adamson, P.M. Chaikin, and R.A. Register, “Shear-Induced Sphere-to-Cylinder Transition in Diblock Copolymer Thin Films”, *Soft Matter*, **5**, 1687-1691 (2009).