

Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Get in Line: Orienting Cylinders in Block Copolymer Thin Films via Shear RALEIGH DAVIS, RICHARD REGISTER, Princeton University, PAUL CHAIKIN, New York University — Block copolymer thin films have garnered much attention for their potential as nanolithographic masks. For many patterning applications, however, the need to impart well-defined order to the microdomains is paramount. One method to achieve long-range orientational order in thin films is through the use of shear. The ease with which orientation is achieved as well as the ultimate quality of alignment is strongly influenced by the copolymer composition and molecular weight, film thickness, and shearing conditions, as revealed using a series of cylinder-forming poly(styrene)-poly(hexylmethacrylate) (PS-PHMA) copolymers. Quality of in-plane alignment is assessed via atomic force microscopy, quantified through an orientational order parameter (ψ_2). The ease with which alignment is achieved is determined by measuring ψ_2 as a function of applied shear stress and comparing the results to a melting-recrystallization model which allows for the determination of two key alignment parameters: the critical stress needed for alignment (σ_c), and an orientation rate constant (Γ). The ψ_2 vs. stress behavior, including the time-dependence, is well captured by the model. For monolayers, as PS weight fraction or overall molecular weight increases, σ_c also increases, while Γ greatly decreases. As the number of cylinder layers is increased, σ_c decreases to a plateau. The ultimate quality of alignment is studied by comparing ψ_2 vs. lattice defect density for well-aligned films; ψ_2 is limited by both undulations in the cylinder trajectories as well as the presence of isolated dislocations.

Raleigh Davis
Princeton University

Date submitted: 12 Nov 2014

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