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**Coupling Dynamic Thermal Shear Field to Block Copolymer Molecular Ordering for Highly Oriented and Hierarchically Patternable Nanostructures** GURPREET SINGH, The University of Akron, KEVIN YAGER, Brookhaven National Laboratory, HO-CHEOL KIM, Almaden Research Center, ALAMGIR KARIM, The University of Akron — Dynamic thermal field processing of block copolymer (BCP) thin film is a highly attractive roll-to-roll directed self-assembly method for molecular level organization of BCP nanostructures over large areas without requiring physical or chemical guiding templates. Previously, we discovered that a sharp temperature gradient  $>30$  °C/mm flips BCP cylinders from horizontal to vertical orientation with respect to the substrate such that tuning the dynamic thermal sweep rate to the BCP's terminal relaxation time is critical for optimal hexagonally-packed vertical order. We now exploit the dynamic thermal field to induce a directional gradient soft-shear field via a thermally expanding elastomeric overlayer that yields highly oriented and hierarchically patternable horizontal BCP cylinders. BCP thin films confined under a flat or patterned elastomeric overlayer and translated across the dynamic thermal field experience directional elastomer expansion-contraction in the heating-cooling zone as a single oscillatory shear cycle that aligns the BCP films. We successfully characterize the molecular level ordering mechanism and create unidirectionally aligned single crystal cylindrical BCP thin films over a wide range of thicknesses and processing speeds. Excitingly, the BCP cylinder alignment is fully decoupled from the PDMS mold pattern direction and dimensions.

Gurpreet Singh  
The University of Akron

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