Structural Mechanics of Roll-to-Roll Nanoimprint Lithography

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Extended Abstract (six page maximum):

Roll-to-roll nanoimprint lithography is an attractive method for high-throughput manufacturing of nano patterned materials and devices. The process consists of four steps: deposit photoresist onto a substrate via ink jet, imprint features by applying a pre-patterned template, solidify the resist via UV curing, and release the template. Because the surface-roughness length scale of a typical substrate is of the same order as the template feature size, the substrate and template must be structurally flexible to achieve complete filling. Effectively, the template must conform to the substrate during the process. Our goals are to model the imprint stage of the process at a machine scale. The model needs to be three-dimensional and include both capillary hydrodynamics of the resist flow and elastohydrodynamic interaction amongst the resist, substrate, and template. The approach we take to model the flow of photoresist is addressed in an accompanying presentation entitled “Multi-phase flow model of J-FIL”. Here, we are addressing fluid-structure interaction between the resists and the substrate. The substrate is modeled as an inextensible membrane, and its contribution to the elastohydrodynamic interaction is controlled through the tension on the web. We apply the model to predict the optimal applied tension for a given resist drop distribution and template configuration which best leads to uniform filling and minimum trapped gas.

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