Micromolding of UV Curable Coatings

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In micromolding, a microstructured coatings is created by pressing a stamp into a coating, UV curing with the stamp in place, and then removing the stamp. The process can be implemented in roll-to-roll systems; however, one limitation of UV-micromolding is low throughput mainly due to slow curing speed. Additionally, defects may be introduced into the microstructured coating because of incomplete material displacement or strong adhesion between the mold and the coating. In this research, we explored new formulation approaches based on thiol-ene chemistry, which is insensitive to oxygen inhibition, cures fast and forms highly homogeneous polymer networks. Curing rates and the extents of cure of various thiol-ene coating formulations, characterized by Fourier transform infrared spectroscopy (FTIR), were influenced by functionality, chemical structure, and ratio of the curable monomers. Microchannel arrays of 50 μm line width and other microstructures were successfully replicated in thiol-ene coating systems using polydimethylsiloxane stamps fabricated from SU-8 photoresist masters. Pattern quality strongly depends on the duration of UV exposure for a specific coating formulation. To understand the mechanism of the debonding between the mold and the structured coating surface and to control the demolding behavior, the effects of modulus and surface energy of thiol-ene coatings on the demolding force were investigated by T-peel testing. In this set of experiments, the coating modulus was tuned by adding a series of acrylate oligomers and the surface energy was adjusted by adding fluorinated reactive additives into the coating formulations. While a low surface energy of the structured coating reduces the demolding force, the coating modulus should be optimized to balance the shape integrity of surface features with the ease of demolding.