Roll-to-Roll Micromolding of UV Curable Coatings

Yuyang Du, Krystopher S. Jochem, Alon V. McCormick* and Lorraine F. Francis*

Department of Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, Minnesota 55455, United States

ISCST-20180917PM-B-DF7

Presented at the 19th International Coating Science and Technology Symposium, September 16-19, 2018, Long Beach, CA, USA[1].

Drying and Curing Fundamentals

Large-area fabrication of surface microstructures with high throughput is still a challenge. In this research, the fast and continuous fabrication of microscale structures by roll-to-roll UV imprinting was demonstrated on a 150 mm wide wed. This process was enabled by a UV curable thiol-ene-acrylate resin system. A series of formulations were developed with fast curing speeds at ambient conditions, low viscosities, and tunable mechanical properties. The rate and extent of curing in the roll-to-roll process were investigated with Fourier transform infrared spectroscopy as a function of the formulation composition and the processing variables. All the prepared thiol-ene-acrylate formulations show improved curing speed compared to a commercial benchmark and reached high double bond conversions (>80%). The maximum achievable conversion increased with increasing the relative thiol content and decreasing the viscous urethane acrylate oligomer content. Furthermore, the UV lamp power, the lamp distance, and the web speed were systematically varied to elucidate the parameter interactions affecting the process throughput. Defect-free and well-cured microstructured coatings were formed only given sufficient exposure dosage, which is proportional to the lamp power, inversely proportional to the web speed, and independent of the lamp distance. Microscale channel and dot arrays with various dimensions and pattern densities were continuously fabricated at web speeds up to 2.7 cm/s. Our findings expand the available materials space and can serve as a predictive guideline for the selection of processing conditions for the manufacturing of microstructures using roll-to-roll imprinting processes, opening up potential applications in areas of textured coatings, superhydrophobic surfaces, and printed electronics.