THE PATH TO ROLL-TO-ROLL NANOIMPRINTING AND FUTURE OPPORTUNITIES

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Nanoimprint Lithography was originally developed to address the needs to fabricate high density magnetic storage and nanoelectronic circuitry, and can pattern feature size beyond the light diffraction limit in the UV photolithography. The extreme-low defectivity requirement of these applications has presented great challenges for the deployment of the technology, even with the demonstration of single digit nm resolution over a decade ago. On the other hand, many other applications that require the nanoscale features can benefit from such high-throughput and potentially low-cost patterning technology. Indeed Nanoimprinting has been applied in many nanoscale engineered devices; applications include displays, organic electronics, photovoltaics, optical films, and optoelectronics; and in some cases, direct imprinting of functional polymeric devices. For many applications, large area patterning is highly desirable, which motivated the development of even higher throughput roll-to-roll nanoimprint (R2RNIL) technique, as well as other roll-based patterning processes. To enable a cost-effective process, the nanoimprint mold should be made from durable materials; and the resist materials for R2RNIL should offer scalability in production, e.g. can be based on cationic polymerization that is not affected by oxygen inhibition. Further development in this area and combination of different approaches will likely push the technology towards many important applications. But several technical challenges need to be addressed, e.g. in-line metrology and feedback; web tension, dimension and distortion control; fast filling of resist materials into mold patterns; and methods for multi-layer registration and alignment. These also present opportunities to further advance the R2RNIL technology for real-world manufacturing.