Comparison of monomer and polymer resists in thermal nanoimprint lithography

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NanoImprint Lithography (NIL) is a promising technique for high throughput and large area fabrication of nanoscale structures. However, it is not clear which kind of resist is best suited and only few dedicated imprinting materials are commercially available. In thermal NIL, researchers and industrials are generally using well-known thermoplastic polymers and only few results are reported using liquid monomer based thermosetting resists.

In this paper, we compare a polymer resist to a thermally curing monomer resist in a full 8 inch wafer NIL process. The polymer used is NEB22 resist (from Sumitomo chemical, Japan) and the monomer solution is composed of Laromer 8765 (diacrylate monomer from BASF, Germany) with a peroxide thermal initiator. The same equipment (EVG520 hot embosser), the same mould and the same imprinting pressure are used for both resists, only the printing sequence and temperature are different. The polymer is first heated at 130°C and then printed before cooling down. On the contrary, for the monomer solution, pressure is first applied at room temperature and the wafers are then heated at 150°C for 1 min.

Line gratings with sub-micron pitches and variable densities are printed in both resist for the same time and under the same pressure. Characterization is performed using scatterometry [1], which is a nondestructive technique measuring the shape of the printed lines as well as the residual resist layer thickness.

Results show that the printing uniformity is much better with the monomer solution than with the polymer. The monomer, with a much lower viscosity (especially in thin film and confined geometry) can flow on much longer distances, thus shortening the transition areas (where the residual resist layer is non uniform) between fields of different densities. Using this kind of resist is therefore especially interesting for complex mould designs. In addition, one can expect to have very good mechanical, thermal or optical properties with dedicated monomers, which can be of great importance for applications. At the moment, the only drawback with this first home-made low viscosity resist is the resist shrinkage after polymerization and cooling down. Work is currently under progress to develop low shrinkage thermally setting monomer resists based on a ring opening polymerization system.

[1] D. Fuard, C. Perret, V. Farys, C. Gourgon, and P. Schiavone, J. Vac. Science and Techno. B **6**, 3069 (2005).