Release-Optimized UV-NIL Resists

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Defect-free sub-50 nm patterning in nanoimprint lithography (NIL) has been achieved using various fluorinated anti-sticking layers (ASL) on the mold, which exhibit low surface energy.[1] Employing low concentrations of various fluorinated components in the resist formulation is a way to reduce the occurrence of the demolding defects.[2]

A different, but promising strategy for UV-NIL applications is the use of highly fluorinated UV-curing materials based on perfluoropolyether (PFPE) as main components. Due to their superior surface properties they have been used as soft stamps.[3, 4] However, it is troublesome to employ these materials as UV-NIL resists, mainly because of the loss of substrate adhesion and other parameters like poor wetting, high viscosity, etc. In this contribution we present the implementation of PFPE components in spin-coatable UV-NIL resists (denoted as XNIL) which are optimized with respect to the whole spectrum of industrial requirements for UV-NIL, particularly resulting in very low release forces.

The loss of substrate adhesion is not an issue for the new resists in a well examined process window or when commercial adhesion promoters are in use. Besides, when the substrate is treated with primers the stability of the resist layer is increased and it can be stored a couple of days without dewetting. Even after long storage times the coated resist can be processed successfully, allowing perfect curing and release at sub-100 nm resolution with different kinds of stamp materials (Table I) without ASL. Resolution was at sub-20 nm level when an ASL is in use.

Generally, miscibility issues play an important role, because the high fluorine level of PFPEs excludes many common reactive diluents and solvents in the formulations. Nevertheless, stable formulations covering a range from sub-100 nm to 1 µm layer thickness were formulated and successfully applied in UV-NIL processes. The surface properties of the cured resists were investigated extensively by contact angle measurements. An extensive report about etching, shrinkage and curing speed as well as the usage of the resists on plastic substrates (PC, PMMA and PET) will be presented.

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[1] H. Schift and A. Kristensen, in Handbook of Nanotechnology edited by B. Bhushan (Springer, Berlin, 2007) 2. edition. p 239-278.

[2] H. Atasoy, M. Vogler, T. Haatainen, A. Schleunitz, D. Jarzabek, H. Schift, F. Reuther, G. Gruetzner, and Z. Rymuza, Microelectron. Eng. (2011). doi:10.1016/j.mee.2011.01.080.

[3] K. Tsunozaki, Y. Kawaguchi, Microelectron. Eng. **86** (2009) p. 694

[4] J. P. Rolland, E. C. Hagberg, G. M. Denison, K. R. Carter, J. M. De Simone, Angew. Chem. **116**, 5920 (2004)

TABLE I. Achieved results with XNIL prototypes using different substrates and molds.

Mould Substrate	With ASL		Without ASL	
	Si	Quartz	Si	Quartz
Si + Primer (*mr-APS1*)	n/a	75 nm	n/a	100 nm
Glass + Primer (*mr-APS1*)	15 nm	75 nm	75 nm	n/a