Influence of Solubility Switching Mechanism on Resist Performance in Molecular Glass Resists

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Molecular glass (MG) photoresists are a promising alternative to polymeric photoresists for use as imaging materials with improved resolution and line edge roughness (LER) for next generation UV and EUV lithography. They offer advantages over polymers as resins for chemically amplified resists (CARs) because the copolymers used for resists have potential intrinsic problems including polydispersity of the resist polymer, difficulty in maintaining compositional uniformity of the copolymer, polymer aggregate formation, phase separation of polymers and additives, and heterogeneous deprotection not found in MG CARs.[1] Although MGs offer many potential advantages over polymer CARs, they have a number of problems themselves. Removal of protecting groups in positive tone MG resists can cause a loss of up to nearly 50% of the mass of the resist, possibly leading to a loss of pattern quality. MGs small size and often low T_g can lead photoacid diffusion problems as well. Overcoming these problems may be the key to the widespread acceptance of MG resists. However, no systematic study has been done to address how the implementation of the solubility switching mechanism in MG resists affects their performance.

In this work, four different resist systems based 1,1,1-tris(4-hydroxyphenyl)ethane core are compared. Two positive tone systems were made: (1) a high-activation energy *tert*-butoxycarbonyloxy (tBoc) protected version and (2) a low-activation energy tetrahydropyranyloxy (THP) protected version. Two negative-tone resist systems were also made: (1) a glycidyl ether functionalized form that enables ring opening polymerization and (2) a blend of THPE with a crosslinker. These four systems, imaged using 248nm and e-beam, are compared in terms of resolution, photoacid diffusion, LER, contrast, and sensitivity. The performance advantages and disadvantages of each imaging system are discussed and compared. Potential new MG resist designs are discussed.

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[1] Cao, H.; Roberts J.; Dalin J.; Chandhok M.; Meagley R.; Panning E.; Shell M.; Rice B., *Proc. SPIE* 2003, **5039**, 484.

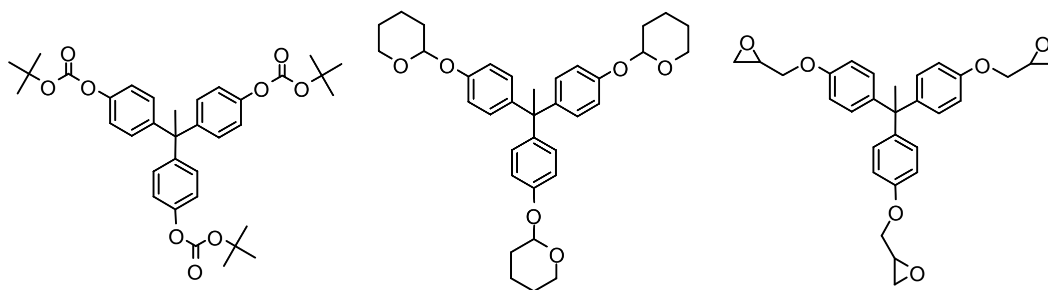

Figure 1. Examples of three of the different resists made using a tris(4-hydroxyphenyl)ethane core with different solubility switching mechanisms.