Single Component Molecular Resists with Covalently Bound Photoacids

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Despite the smaller size of molecular resists (MRs) compared to polymers, most MRs reported in literature still have LER values of ~5 nm or more, which is approximately the same limit found for conventional polymeric chemically amplified resists (CARs).[1] Since the smaller size of the MRs does not dramatically improve performance beyond that of polymeric resists in those cases, there is likely another controlling factor. Literature studies of MRs have found that photoacid generator (PAG) homogeneity[2] and the polydispersity/distribution of the protecting groups[3] have significant effects on the LER performance of MRs. These studies indicate that inhomogeneity in MRs is the dominant factor in controlling LER in these materials. Our approach to solving this problem is to design molecular resists that are composed of a single component, e.g. every molecule in the film is the same and contains all the desired functionality of a resist including PAG, protected base solubilizing groups, and etch resistant moeties.[4] This approach eliminates inhomogeneity inherent in blended systems.

Our initial compounds using this design principal used a triarylsulfonium MR core and showed a low 3σ LER of 3.3 nm, much better than blended MR systems (see Fig. 1). Although these onium salt MRs could achieve sub-100 nm patterns, smaller features blurred due to photoacid diffusion. Our new family of MRs presented in this study maintain our single component approach, but the photoacid product is now covalently bound to the central MR core (see Fig. 2), reducing its diffusion length and enhancing the MR resolution. This study reports on the initial imaging results of this new family of compounds with different MR cores, PAGs, and protecting groups. The effects that changing these properties have on performance is investigated and used to develop structure-property relationships in these materials and to optimize materials to achieve high resolution and low LER.

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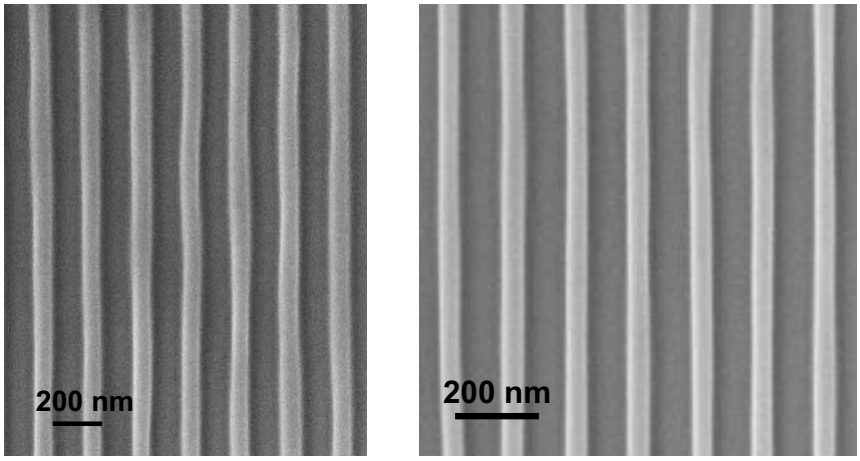
[1] A. R. Pawloski, et al., *Proc. SPIE* **2004**, 5376, 414.
[2] Hirayama, T., D. Shiono, et al., *Proc. SPIE,* **2005**, 5753, 738.
[3] Hada, H., et al., *Proc. SPIE,* **2007**, 6519, 65193U.
[4] R. A. Lawson, et al., *Proc. SPIE*. **2007**, 6519, 65191N.



(A) (B)

Figure 1. High resolution imaging of the initial family of single component resists under 100 keV e-beam. (A) 100 nm 1:1 line/spacing (B) 50 nm 1:2 line spacing demonstrating a LER (3σ) of 3.3 nm.

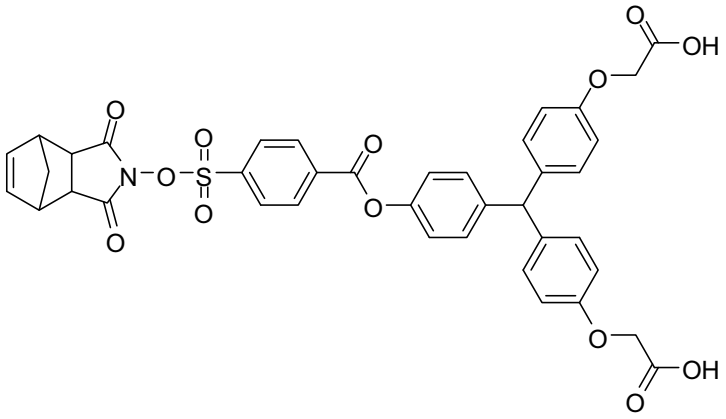


Figure 2. Example of the chemical structure of the new family of single component molecular resists with covalently bound photoacid, this one using a norbornene dicarboximide PAG.