Effects of Molecular Structure on Lithographic Performance of Aqueous Base Soluble Epoxide Molecular Resists

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We have previously reported TPOE-3Ep, a negative-tone, epoxide-containing molecular resist, that was designed to contain a single phenol in order to provide an epoxy-based resist that is soluble in standard 0.26N TMAH developer. TPOE-3Ep resolved 26nm lines under EUV exposure, but delamination of patterned features at low doses in TMAH development and insoluble material in nominally unexposed regions at high doses prevented resolution of smaller features. At low doses, network formation was likely incomplete, which might have allowed the TMAH to wet the resist/substrate interface. Additionally, at these low doses, any formed network would have a very low crosslink density which may have caused the resist to swell, leading to delamination. Therefore, an underlayer was developed in-house that improved adhesion of the resist to the substrate. Another issue was that significant bridging occurred in the low-dose regions of the resist because the solubility transition for TMAH development occurs at lower doses than in MIBK. Thus, as dose was increased, the bridging only became worse.

For TMAH development of these resists, ideally the solubility transition for TMAH would occur where network formation is almost complete, reducing the amount of bridging observed as well as potentially eliminating delamination and need for an underlayer. Additionally, since we desire highly-crosslinked features, if lines are resolved in TMAH at doses well below doses where complete network formation occurs, the patterned features will likely not be as mechanically robust as those at higher doses. Thus, it is important for us to identify a ratio of epoxides to phenols that results in similar solubility transitions in both organic solvent and in 0.26N TMAH developers.

This presentation will present the results of varying the ratio of epoxides and phenols on several different resists in an effort to identify an optimal ratio between the two functional groups that maintains TMAH solubility until network formation is nearly complete to produce mechanically-robust features without suffering from bridging between patterned lines. DUV contrast curves will be used to probe the effect of altering this ratio on network conversion by comparing TMAH and organic solvent development conditions. By introducing more phenols into the resists, the glass transition of the materials will likely increase, and the effects of this change on patterning performance will also be discussed. 100 keV e-beam patterned lines of these materials will be presented as a final figure of merit of these new materials.