Contributions of Resist Polymers to Innate Material Roughness *

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Increased understanding of fundamental resist material characteristics is needed to develop resists with improved resolution and line edge roughness. A material's characteristics will not only influence resist sensitivity and resolution, but they also may influence the critical dimension control of the lithography process through their effects on line width roughness (LWR). Critical dimension control at sub-100 nm resolution will be extremely sensitive to the fine details of the molecular structure.

We have developed an AFM-based technique to measure intrinsic material roughness (IMR) after base development. Employing this technique, we have deconstructed the resist into component materials and established the PAG as a major material contributor of film roughness and that PAG segregation in the resist is responsible for nano-scale dissolution inhomogeneities.

Experimentally, we have found that the IMR is dependent on the interactions between the PAG and the polymer employed in the resist. The IMR of the resist is also strongly dependent on the bake conditions, with increasing IMR at higher bake temperatures. Several PAGs have been identified that result in significantly lower material roughness and thus the potential for significantly reduced line width roughness in resist imaging.

We now have investigated the contribution of different polymers to IMR. These polymers include polyhydroxystyrene and polymethacrylate based polymers, commonly found in resists, as well as various fluorinated polymers. The IMR of these polymers with both EUV and DUV exposure was determined and similarities and differences between exposures at the two wavelengths will be described. Selected polymers were imaged with both EUV and DUV exposure and the relationship between IMR and LWR for these polymers will also be described.

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