Ultra-Low Dose Exposure of HSQ using Electron Beam Lithography

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While electron beam lithography is excellent for fabricating high resolution nanoscale features, the large dose required for electron beam resists results in a lengthy fabrication time that may be unacceptable for many applications. XR-1541, a common negative tone e-beam resist which contains hydrogen silsesquioxane (HSQ), has a relatively low sensitivity using the conventional developing process. However, using nonaqueous developers[1], rather than the traditionally used TMAH-based developer solution, a drastic increase in sensitivity for the XR-1541 resist has been found. Because of the much higher sensitivity, there is a significant decrease in the exposure dose required to pattern the resist.

In this work, one micron squares were exposed, using a 30keV electron beam, at various doses. The samples were developed in a non-aqueous solution, with the exposed areas remaining insoluble for even ultra-low doses. One example is the development in 1:3::MIBK:IPA for 45 seconds. The resist remained insoluble for all doses greater than 10$\mu C/cm^2$. This onset dose is more than an order of magnitude less than for typical developing processes. The use of ultra-low dose exposures can achieve high resolution patterns in a fraction of the time typically required.

50 word:
Commonly used resist XR-1541 has a relatively low sensitivity using the conventional developing process. Using nonaqueous developers rather than the traditionally used TMAH-based developer solution, however, showed a drastic increase in sensitivity for the XR-1541 resist which significantly decreases the exposure dose required to pattern the resist.

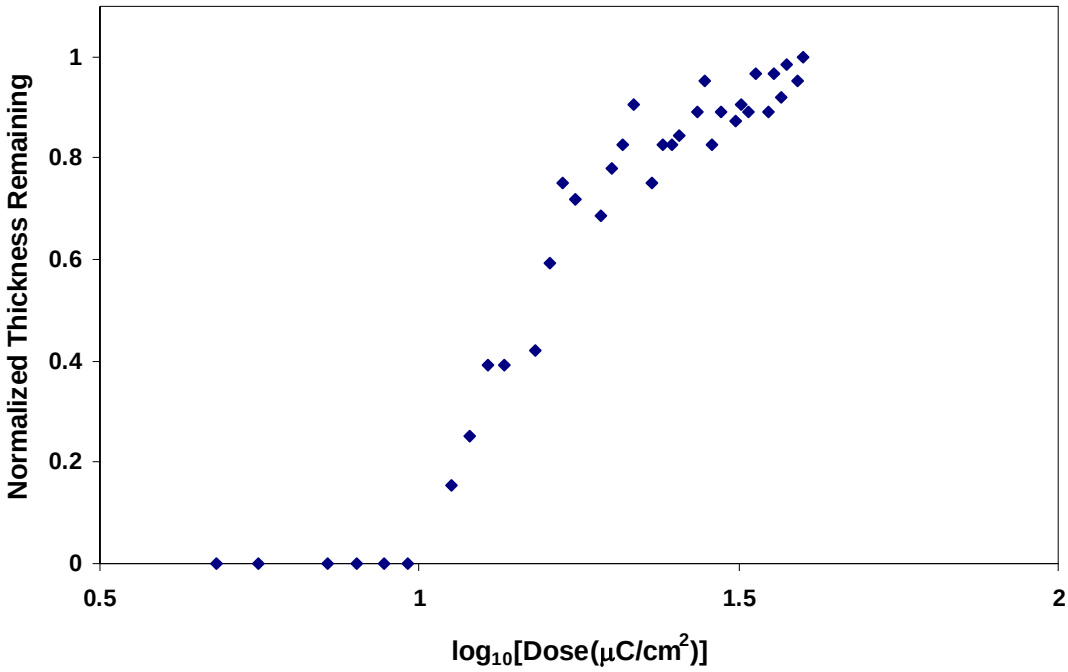

Figure 1: Negative-tone e-beam resist, XR-1541, demonstrates an extremely high sensitivity when developed in 1:3::MIBK:IPA for 45 seconds. The resulting onset dose is approximately 10 μC/cm^2, at least an order of magnitude less than when developed in conventional TMAH-based developers.

[1] Gerard M. Schmid, Leslie E. Carpenter, II, and J. Alexander Liddle, J. "Nonaqueous development of silsesquioxane electron beam resist" Vac. Sci. Technol. B 22, 3497 (2004), DOI:10.1116/1.182501