Improved Time Dependent Performance of HSQ Resist Using a Spin on Top Coat

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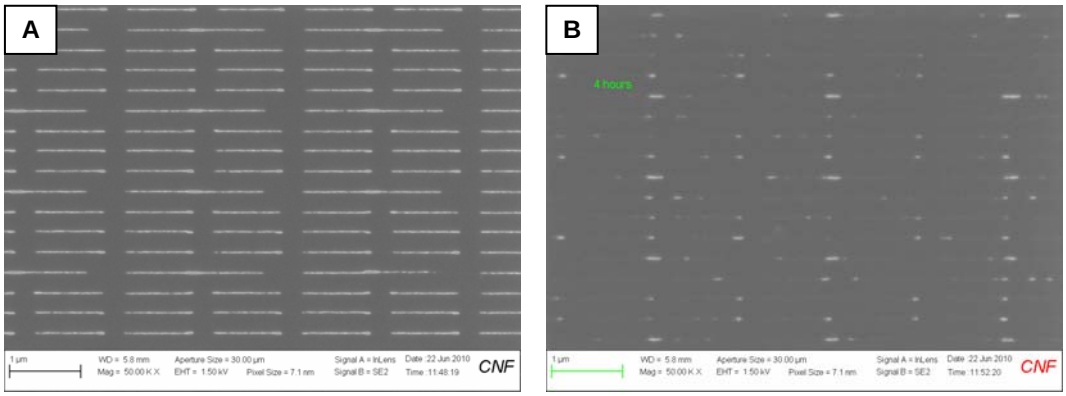
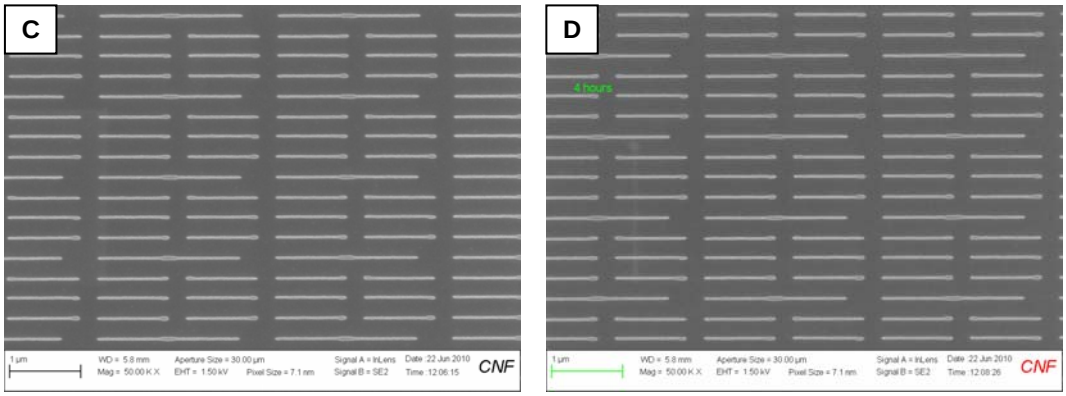
Hydrogen silsesquioxane (HSQ) is a high resolution negative tone electron beam resist with a resolution well below 10nm. However, it is known that the time delay between spinning and e-beam exposure has an effect on the contrast and sensitivity of the resist. There has been significant effort put into finding the best developer conditions (time, temperature, concentration, etc) to maximize the performance of the resist. However, to date, little progress has been made to mitigate the problem of temporal dependence of optimal results. We report a significantly improved time dependent performance of HSQ by using a water-soluble, spin on top coat developed by Showa Denko. The material is based on a poly (isothianaphthenesulfonate). Exposure delays from 0 to 30 hours were performed in air and vacuum and the effect on contrast, sensitivity, and ultimate resolution was compared to results without a top coat. Various substrates and bottom layers were also used and the change in performance was evaluated. In all cases a significant improvement is observed when the top coat is applied and little change occurs with others parameters. The time lag effect is shown to be the equivalent of a decrease in sensitivity over time with about a 30% change in optimal dose over a test window of 12 hours if no top coat is used. The use of the top coat reduces the effect to about 5%. We believe this technique represents a widely applicable solution to the time lag issue common to HSQ processes.



Figures A and B: HSQ exposed with no top coat. Figure A shows the results of the initial exposure of 35nm lines without a top coat. Figure B shows the results of the exposure after a 4 hour delay in vacuum. Both exposures were at 3500 $\mu C/cm^2$. A significant change in the sensitivity of the resist is seen.



Figures C and D: HSQ exposed with top coat. Figure C shows the results of the initial exposure of 35nm lines with the top coat. Figure D shows the results of the exposure after a 4 hour delay in vacuum. Both exposures were at 3500 $\mu C/cm^2$. No change in sensitivity is seen.