Comparison of PSF for non CAR and CAR resists in E-Beam lithography

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Next generation lithography tools should address the 15nm node in a near future. Various solutions are possible candidates if blocking issues are to be overcome. One of these technologies is electron beam lithography especially since multiple electron beam systems that are currently under development will bring a significant increase in throughput. Going down to sub 20 nm resolution is a challenge as proximity effects may degrade the patterns shape. Proximity effect correction is mandatory in order to properly delineate dense features.
Proximity effect correction in electron beam lithography was studied extensively[1]. Dose modulation is the most classical way to correct proximity effects. It consists in adjusting locally the exposure dose in order to develop properly the printed patterns. However there is still limitations and to go further in the proximity effect correction, geometrical modulation is also used. Inscale (from Aselta Nanographics™) is an electron beam lithography software that allows using both strategies. It has been demonstrated that using both dose and shape modulation increases significantly the proximity effect correction efficiency[2]. However, a precise correction is possible only if the Point Spread Function (PSF) is accurately known. PSF are generally expressed as a sum of exponential functions. When determined experimentally, the measured PSF combines the effect of energy deposition by electrons with the resist's own response to electron exposure. Specific layouts give a direct representation of the point spread function (PSF) as a transferred pattern[3] and this makes it more efficient to experimentally determine the PSF.
This work deals with the PSF determination for different classes of resist. PSF are determined by using the layout of Figure 1. The exposure tool is a Jeol JBX-9300FS working at 100 kV. Two types of resist are studied. One is a chain scission resist where no diffusion occurs during the exposure step. The second one is a negative chemically amplified resist where acid diffusion occurs. Both resist films have been spun onto a silicon wafer in order to get almost same thickness. Hence the diffusion of electrons is the same in both resist. The observed differences in the PSF are only due to the resist. Figure 2 shows the simulation of the patterns for various PSF conditions using Inscale™. Experimental data will be presented at the conference.

[1] T.H.P. Chang, Jour of Vacuum Science Technology, 12(6), 1271-1275 (1975)
[2] L. Martin, S. Manakli, B. Icard, J. Pradelles, R. Orobtchouk, A. Poncet and L. Pain, in proceeding SPIE 7470, 74700R (2009)
[3] S. V. Babin and A. A. Svintsov, Microelectron. Eng., vol 17, 417 (1992)

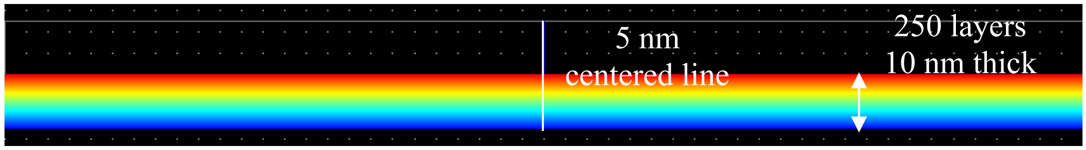

Figure 1: PSF determination Layout: A centered isolated 5nm line, exposed with a dose D_{line}, normal to a 2.5 µm thick stack of 250 layers 50 µm of length with doses decreasing linearly from 10% of D_{line} at the bottom to zero at the top.

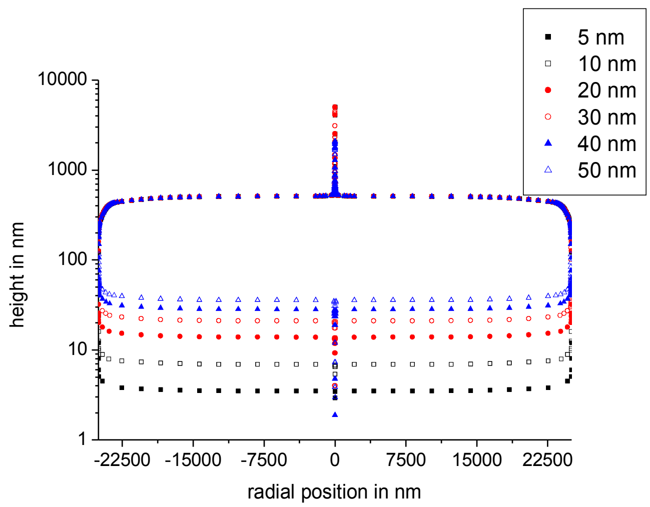

Figure 2: Simulation of the psf contour in the resist: A simulation of contours for various PSF.

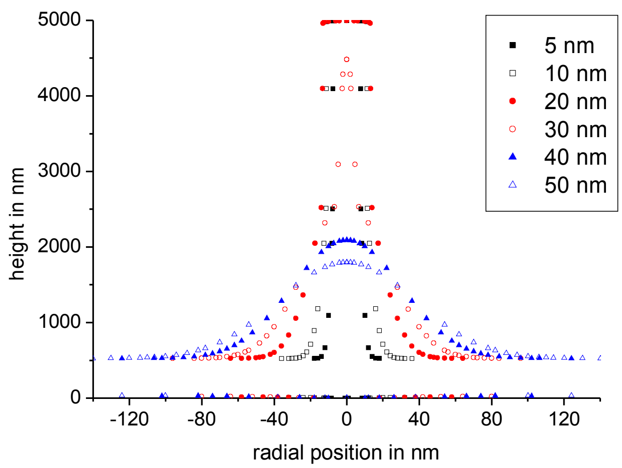

Figure 3: Zoom of figure 2 in the [-140,140] nm range