Correlation of SML and ZEP Resists Lithographic Performance with the Resist Chemistry

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Resist-based electron beam lithography is most apposite when critical feature size is sought after. The lithographic resolution is however hindered due to many intrinsic components. It does not only depend upon the e-beam properties alone but also on resist chemistry.

A systematic study on a relatively new electron sensitive positive resist known as SML will be presented. Its lithographic performance is compared to that of the traditional high-resolution ZEP resist. SML has been produced with the aim of enhanced performance like generation of high aspect ratio structures (50:1) under high voltage e-beam exposure and minimum electron scattering in the resist[1]. The resist mechanisms however remain unrevealed.

The resolution of SML and ZEP resist of 50 nm thickness was compared by exposing single pixel gratings. SML was developed in 7:3 IPA:water whereas for ZEP its standard developer ZED N50 was used. The gratings with SML and ZEP were etched into silicon using ICP etching and cross sections of the gratings were examined to determine etch quality of the resists. To understand the chemical composition of the new resist, Fourier transform infrared spectroscopy (FTIR) measurements were performed on both the resists and their IR spectra were compared. Contrast curves were obtained for SML and ZEP resists of 300 nm thickness and specific dose values were chosen to quantify by AFM the surface roughness as a function of the exposure dose.

The FTIR spectra in Figure 1 show that SML has a chemical structure (unknown) similar to the ZEP resist. High sensitivity of ZEP is attributed to the Cl group in compound, which is not present in SML and can explain for the lower SML sensitivity. Unlike ZEP, SML shows intense peaks around 1730 cm^{-1} and 1150 cm^{-1} suggesting the presence of C=O stretch and C-C stretch, respectively, depicting the presence of ketone group rather than ester as found in ZEP resist. On comparing the gratings etched in Si in Figure 2, higher line edge roughness (LER) can be observed in the gratings created with ZEP than with SML. This low LER in SML can be attributed to the lower surface roughness as seen in Figure 3. Additional surface roughness and FTIR measurements of pre- and post- exposed resists together with their attributions to the resolution of the SML and ZEP resists shall be demonstrated at the presentation.

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[1] EM Resist Ltd: SML Resist Technology. http://www.emresist.com/technology.html

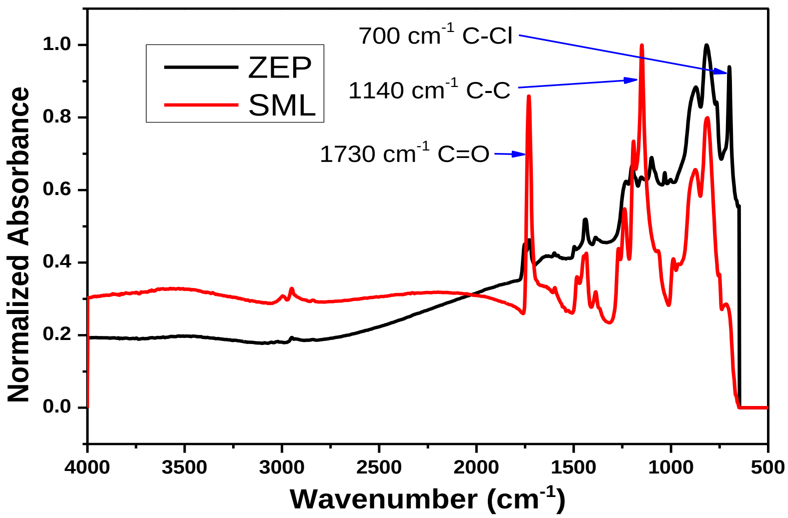

Figure 1: Fourier transform infrared transform spectroscopy spectra of SML and ZEP resists.

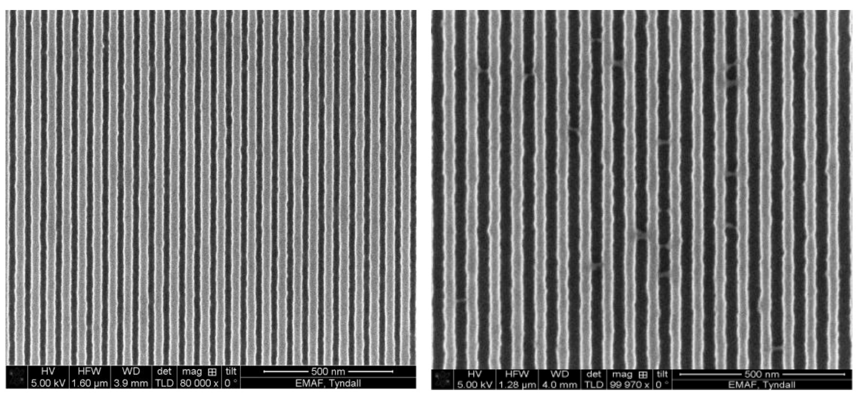

Figure 2: SEM micrographs showing dense single pixel gratings with 60 nm pitch ICP etched into Si using SML (left) and ZEP (right) resists

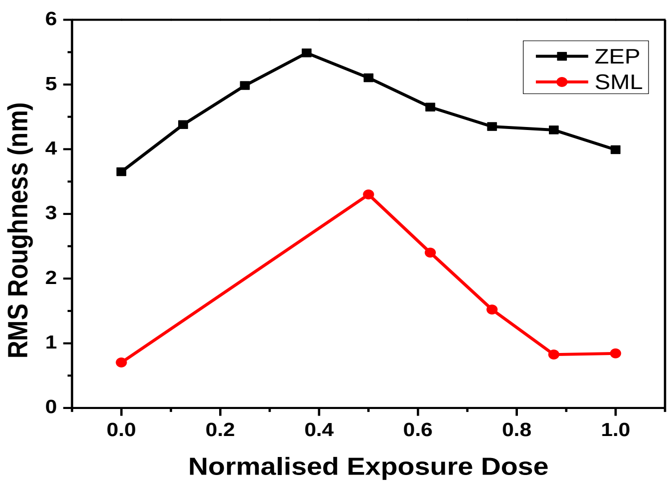

Figure 3: Graph showing roughness of SML and ZEP resists at various electron beam exposure doses