Towards a Novel Positive Tone Resist mr-PosEBR for High Resolution Electron Beam Lithography

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Electron beam lithography (EBL) evolved to one of the most important nanofabrication techniques as it enables the reliable generation of arbitrary two-dimensional patterns with lateral resolution down to the nanometer scale.[1] One of the most widely used high resolution EBL resist materials is high molecular weight poly(methyl methacrylate) (PMMA).[2] However, PMMA only provides limited performance in terms of sensitivity and etch resistance. The resist's low sensitivity results in higher doses and concomitantly in longer exposure times which is unfavorable for high throughput and large area applications. The low plasma etch resistance of PMMA is also disadvantageous for resist pattern transfer into the underlying substrate by a subsequent plasma etch process. Alternative positive tone EBL resists either suffer from a limited availability or resist residues after development.[3]

Herein, we present early lithographic results obtained with a newly developed positive tone electron beam resist mr-PosEBR. The resist material was specifically tailored to meet the needs for high resolution, sensitivity and etch resistance. This means that, in terms of sensitivity and contrast, the resist performs better than PMMA and comparably to the known high resolution resist ZEP-520A (Figure 1).[4] For example, line and space patterns with a pitch of 100 nm could be written with doses of less than 100 µC/cm^2 at an acceleration voltage of 30 kV in a 400 nm thick film of mr-PosEBR (Figure 2). Moreover, preliminary investigations proved that the etch stability of mr-PosEBR is higher than the one of PMMA (CF_4/SF_6 dry etch process, mr-PosEBR: 170 nm/min, Si: 440 nm/min). Under identical conditions as described above the material ZEP-520A showed a dose-to-clear of ~60 µC/cm^2 and an etch rate of 150 nm/min.

In this contribution we will provide further information towards a comprehensive characterization of the lithographic performance of the new, tailored positive tone electron beam resist mr-PosEBR.

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[1] M. A. Mohammad, M. Muhammad, S. K. Dew, and M. Stepanova in *Nanofabrication - Techniques and Principles*, edited by M. Stepanova and S. K. Dew (Springer-Verlag, Wien, 2012), Chap. 2, p. 11.

[2] M. Hatzakis, J. Electrochem. Soc. **116**, 7 (1969).

[3] S. Thoms and D. S. Macintyre, J. Vac. Sci. Technol. B **32**, 6 (2014).

[4] (a) T. Nishida, M. Notomi, R. Iga, and T. Tamamura, Jpn. J. Appl. Phys. 31**,** 4508 (1992); (b) H. Wang *et al.*, J. Vac. Sci. Technol. B **25**, 1 (2007);

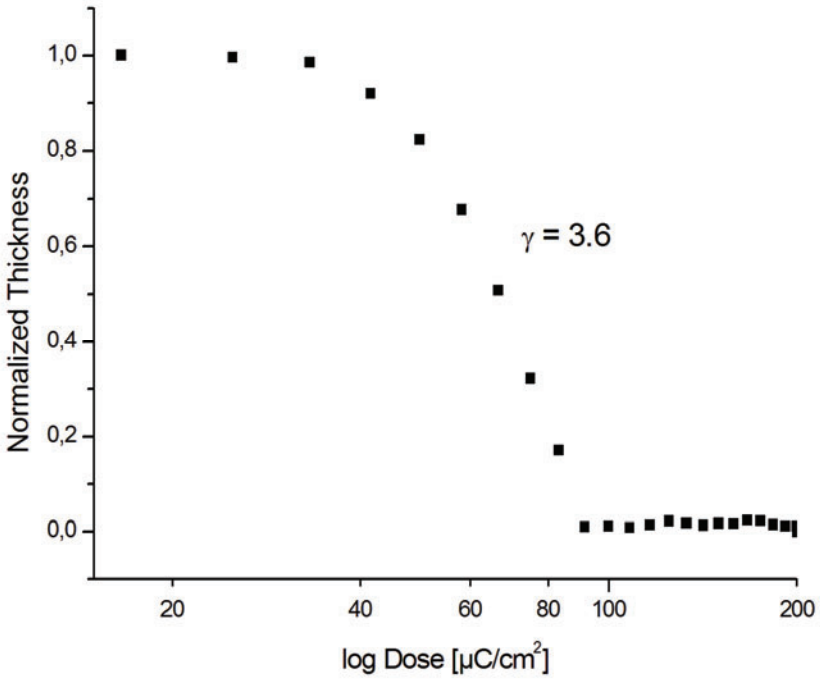

Figure 1. Contrast plot for mr-PosEBR developed using amyl acetate, film thickness was 400 nm.

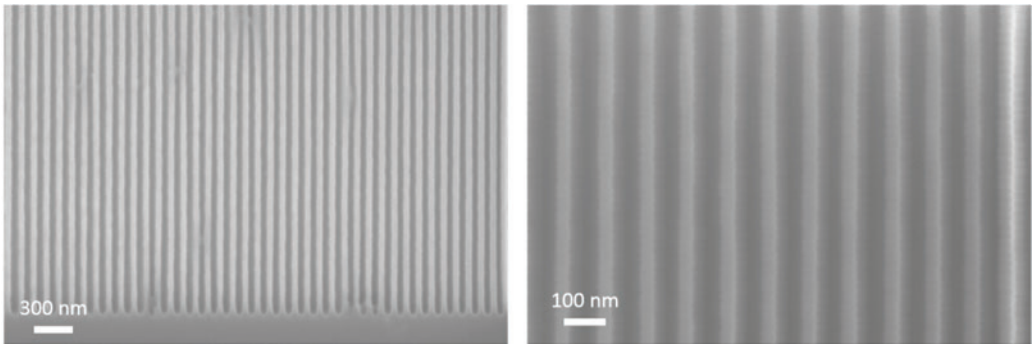

Figure 2. SEM pictures of lines and spaces in mr-PosEBR resist after EBL processing, demonstrating the high resolution capabilities of the material. The patterns were written with a RAITH150 TWO system (acceleration voltage: 30 kV, dose area: 100 µC/cm^2) and developed in amyl acetate.