Lithographic Evaluation of gL-2000: A High-Resolution Resist for Electron-Beam Lithography

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In this work we have evaluated the lithographic performance of gL-2000 a high-resolution, positive-tone, electron-beam lithography (EBL) resist, which is chemically similar to ZEP. The resist was developed by Gluon Labs and is distributed by MicroChem Corp. In the present investigation we have compared the performance of gL-2000 to well-established positive-tone EBL resists such as 950 kDa molecular weight poly(methyl methacrylate) (PMMA), and ZEP 520A (Zeon Corp.). We have observed that gL-2000 performs similarly to ZEP, with comparable resolution, etch-resistance and sensitivity demonstrated during our evaluation. As such, gL-2000 may be considered as a direct replacement for ZEP.

We evaluated the resolution of gL-2000 by exposing nested "L" and grating patterns as per our previous investigations. [1,2] The patterns were created in 40-80 nm thick films of gL-2000 using 125 keV electrons in an Elionix F-125 EBL system. We developed the exposed samples in o-xylene at room temperature and also at 0 °C to study the resolution and sensitivity of the resist. Figure 1 shows an electron micrograph of 40-nm-wide, 80-nm-pitch nested L's produced at a dose of 500 $\mu C/cm^2$. The inset of figure 1 shows a 40-nm-pitch array of 9-nm-wide lines in gL-2000 exposed using a line-dose of 1.0 nC/cm. Both sets of structures shown in figure 1 were developed in o-xylene at 0 °C.

Additionally, we have compared the etch selectivity of gL-2000 to SiO_2 (etch rate of SiO_2/etch rate of resist) using a CF_4 reactive-ion-etch (RIE) process, which was previously developed for etching nanometer features in SiO_2 thin films (15 sccm CF_4, 75 W, 10 mTorr, 110 V DC, 60 s). [3] The etch selectivity tests were performed on blanket films of SiO_2, PMMA, ZEP, and gL-2000. Film thicknesses were measured before and after etch tests by optical reflectometry, profilometry and inspection of film cross-sections using a scanning electron microscope. The etch selectivity of gL-2000 was found to be identical to that of ZEP and a factor of two higher than PMMA (Figure 2).

[1] H. Duan, D. Winston, J. K. W. Yang, B. M. Cord, V. R. Manfrinato, and K. K. Berggren, J. Vac. Sci. Technol. B **28**, C6C58 (2010). [2] J. K. W. Yang and K. K. Berggren, J. Vac. Sci. Technol. B **25**, 2025 (2007). [3] R. G. Hobbs, Y. Yang, P. D. Keathley, M. E. Swanwick, L. F. Velásquez-García, F. X. Kärtner, W. S. Graves, and K. K. Berggren, Nanotechnology **25**, 465304 (2014).

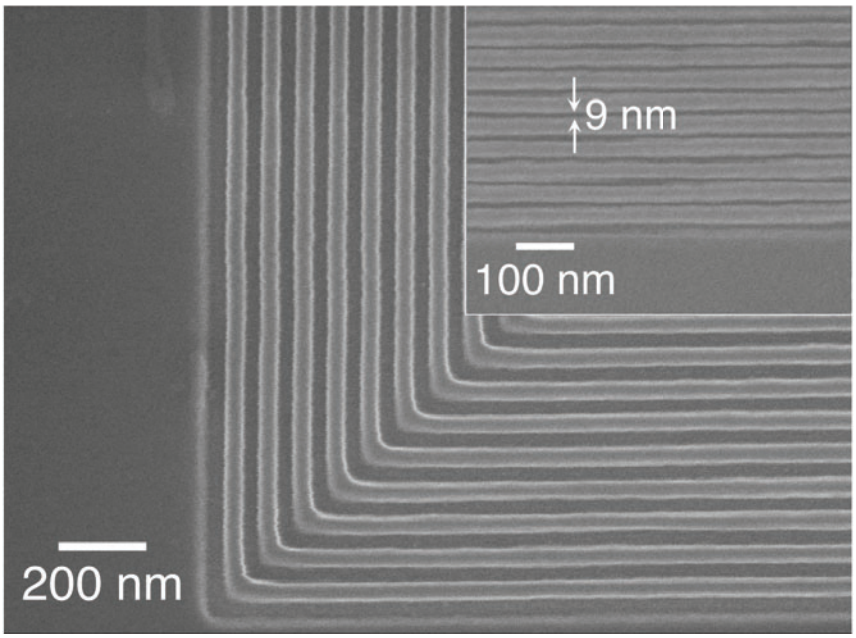

Figure 1: SEM micrograph of 40-nm-wide, 80-nm-pitch nested L's exposed in a 63-nm-thick film of gL-2000. Inset, 9-nm-wide, 40-nm-pitch lines exposed in a 40-nm-thick gL-2000 film.

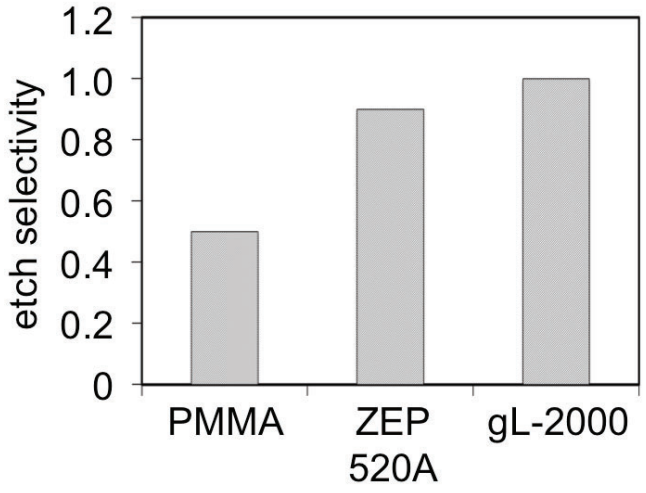

Figure 2: Etch selectivity of PMMA, ZEP 520A and gL-2000 vs. SiO_2. The difference in the etch selectivity values for ZEP 520A and gL-2000 is within the margin of error of the measurement.

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