Fogging Characterization and Mitigation for Large-Format Electron-Beam Grating Exposures

R. McCurdy, J. McCoy, R. McEntaffer, F. Grisé, C. Eichfeld, and M. Labella III
Pennsylvania State University, University Park, PA 16802
rmccurdy@psu.edu

Electron-beam lithography (EBL) has been shown to be a promising technique for fabricating next-generation X-ray and UV diffraction gratings that have high spectral resolving power and diffraction efficiency. Variable-line-space, blazed, grating patterns are required to meet the requirements of future astronomy observatories as well as synchrotron beamline experiments. Maintaining pattern fidelity over a large exposure area, on the order of 10 -100 cm^2 is essential for enabling the performance of these gratings. EBL fogging at larger pattern areas, caused by backscattered electrons from the substrate re-scattering off of the tool column and depositing additional dose into the resist layer, can significantly increase the total dose received by the resist and degrade the quality of the exposed grating pattern.

Using greyscale EBL and spectroscopic ellipsometry, we have worked to characterize and quantify the additional dose received from fogging in larger (50 cm^2) EBL exposures using a Raith EBPG 5200 Plus at the Nanofabrication Lab at Penn State. We will present our ongoing work showing spatial maps of the additional fogging dose in the resist and in creating a correction map similar to proximity effect correction to reduce the resulting fogging dose. Initial results show an approximately 70% reduction of the additional fogging dose, with some residuals that suggest further work is necessary to improve the correction. We will also discuss additional methods we have explored to correct for fogging.