Performance Optimization of Sub-10nm Electron Beam Lithography

R. Bonam, J. Hartley
College of Nanoscale Science and Engineering, University at Albany,
State University of New York, Albany, NY 12206, USA

*Electronic mail: jhartley1@uamail.albany.edu

A major challenge for sub-10nm patterning with electron beam lithography is tool and process efficiency. With unlimited time and patience, beam currents can be kept low enough to avoid space charge limitations while dose can be kept high enough to avoid shot noise and resist resolution limits. Fabrication of complex test structures in the sub-10nm domain can be constrained by practical limits on writing time. In this paper, we explore the process envelope for 3 commercially available resists that range in sensitivity from close to the shot noise limit to slow material with high resolution.

This paper will present current work at the College of Nanoscale Science and Engineering to optimize the tool and process conditions for efficient operation in the sub-10nm domain. Using our Vistec VB300 Gaussian beam tool, we systematically investigate the tool and process parameter space to determine the limits to sub-10nm patterning with several commercially available materials.. The VB300 has a 50Mhz pattern generator and 2nm theoretical minimum spot size which makes it capable of writing on the fastest e-beam resists available without compromising on resolution. NEB-31 is one of the materials we have been investigating and has an experimentally measured large area dose to clear of $30\mu c/cm^2$ [Figure 1]. We have achieved 8-10nm [Figure 2] isolated lines at 14 times less dose compared to HSQ.

For a lithography system to be fully qualified at a given dimension, it is necessary to span the full space of pattern density. For dense feature patterning, proximity effect correction and a well-determined point spread function is important to obtain the best results. This paper aims at determining a point spread function for NEB-31 which would assist in performing corrections, consecutively facilitating in high resolution patterning.

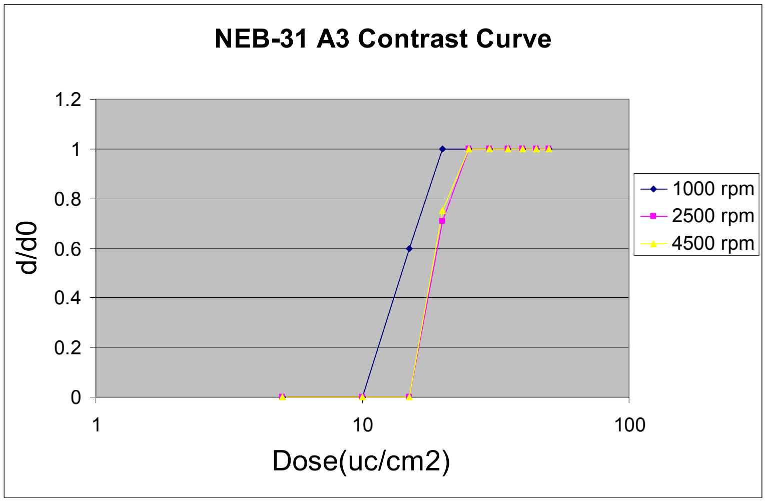

Figure 1 contrast curve for NEB-31 A3 at different spin speeds

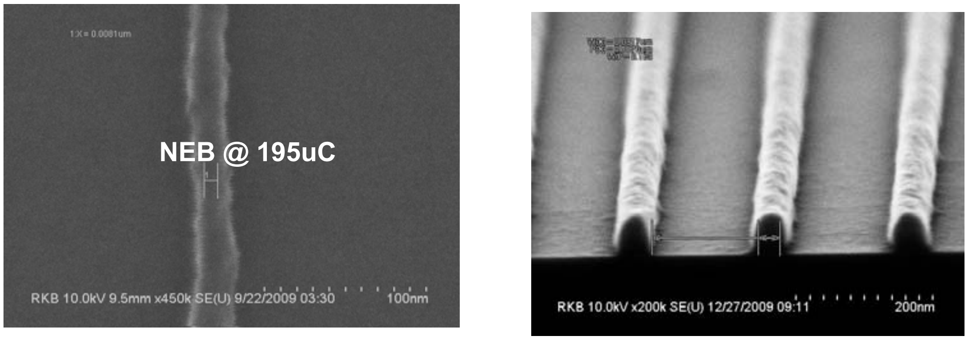

Figure 2 High resolution isolated lines on NEB-31. Left – top down 8nm image, Right – 30nm x 150nm pitch cross section.