Exploring the use of Aberration-Corrected Electron-Beam Lithography with Novel Metal-Based Electron-Beam Resists

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In the quest for ultimate resolution of lithographic patterning, low molecular mass metal-based resists have shown promise to pattern features down to the probe size of the commercial e-beam writer used.[1] The work in [1] invites patterning investigation with even smaller probes, such as an aberration-corrected electron beam writer with a spot size of ~1 Å to explore the possibility of angstrom-scale patterning.

In previous works, we have used aberration-corrected electron-beam lithography (ACEBL) to achieve single-digit nanometer resolution in popular electron beam resists.[2-4] In this work, we present results on a novel negative-tone zinc-based resist patterned with a) a conventional SEM (30 keV beam energy), and b) via ACEBL (200 keV), both equipped with a pattern generator. In resists of ~20 nm thickness spin-casted on Si substrates, the SEM produced pillar arrays of 16 nm pitch and lines of ~6 nm width (measured at FWHM). However, using ACEBL, we have so far only achieved pitches around 20 nm and similar linewidths (resist spin-casted on 50-nm-thick TEM membranes). In this work we discuss possible ways in which ACEBL can achieve smaller patterns.

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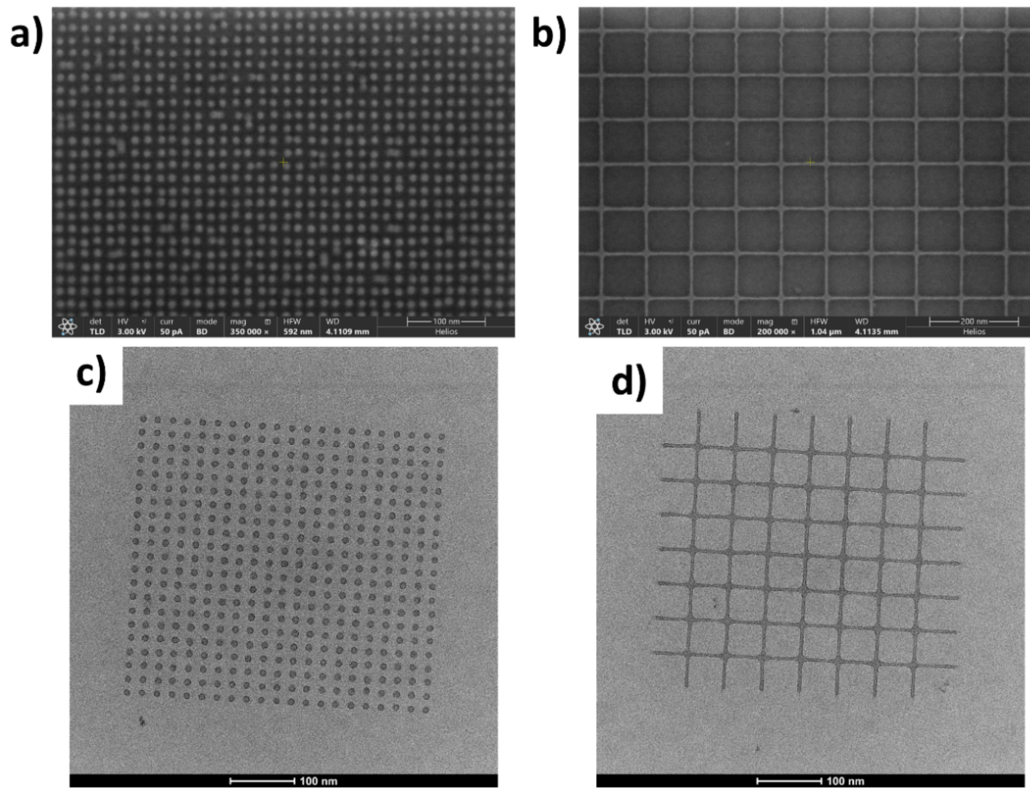

Figure 1: Examples of Zn-based resist exposed with a conventional 30 keV SEM and a 200 keV aberration corrected STEM, both equipped with a pattern generator: a) and b) show array of pillars (16-nm pitch, 7.5 fC/dot dose) and lines (~ 6 nm wide at FWHM, 5 nC/cm), respectively, patterned using a 30 keV SEM. Both patterns are written on ~20-nm-thick metal-based resist spin-casted on Si substrates. c) and d) show array of pillars (23-nm pitch, 41 fC/dot) and lines (~5 nm wide, 6 nC/cm), respectively, patterned with a 200 keV aberration-corrected STEM. Both patterns are written on ~10-nm-thick resist spin-casted on 50-nm-thick SiN_X TEM membranes.