ZEP520A – New resist for Electron Beam Lithography

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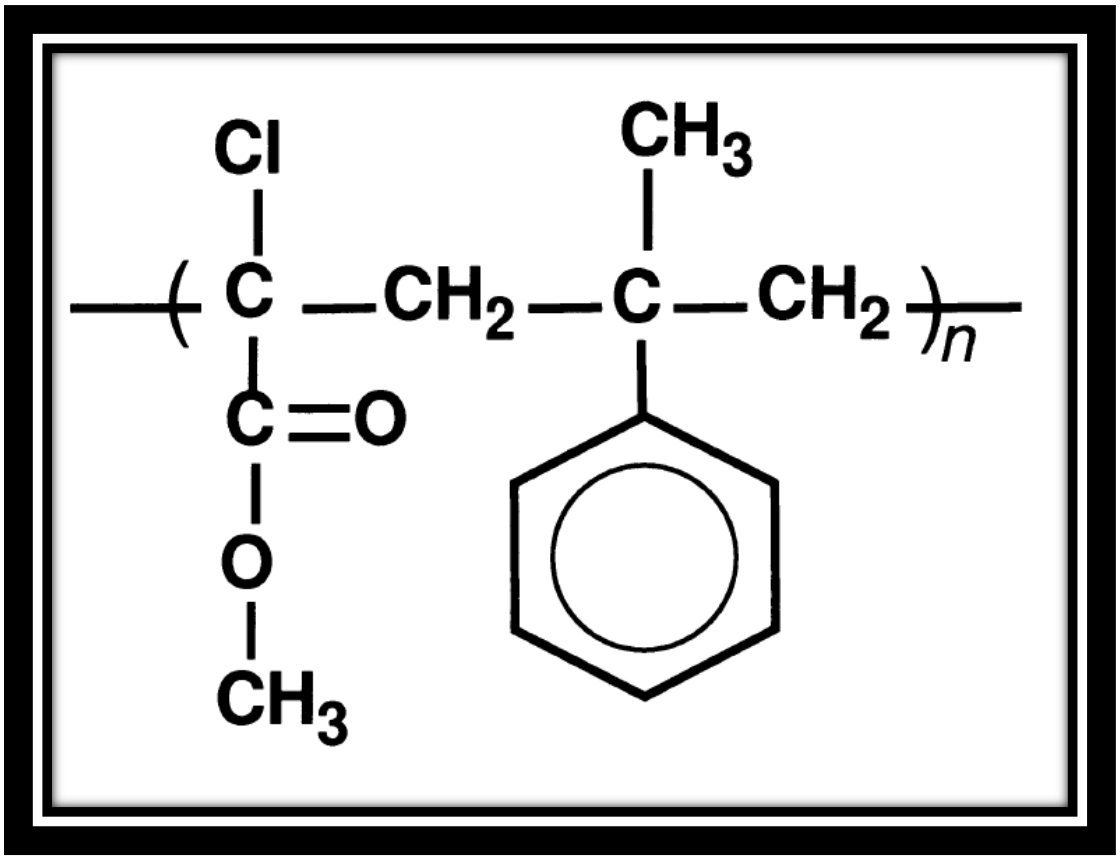
Introduction

ZEP 520A is a high resolution positive electron beam (EB) positive tone resist. ZEP 520A has a molecular weight of 57,000 and is a solution composed of 11% methyl styrene and chloromethyl acrylate copolymer (solid) and 89% anisole (solvent). It has a viscosity of 11 mPa*s and higher sensitivity than polymethyl methacrylate (PMMA) due to the αCl group as well as higher dry etch resistance due to the α-methylstyrene. Amyl-acetate and xylene are two recommended developers for ZEP, although Xylene is preferred. The resolution at 245μC/cm^2 and film thickness of 125nm with pitch of 72.1nm was 55.2nm.



Matrix Resist ZEP520A

Process

Preparing the Wafers

The ZEP520A is first diluted in the solvent Anisol with a 1:1 ratio. To coat one wafer, approximately 5ml of the diluted ZEP520A is needed. Once in the cleanroom follow the instructions to successfully coat the wafer using the Solitec Spin Coater and measure the film thickness with the Nanospec.

- Select a brand new wafer or a clean wafer that you want to use.
- Before you start make sure to start the hot plate so that it reaches the desired temperature.
- Turn on the spin coater and use these settings for 100-125nm film thickness.
  Spread: 6 seconds at 400rpm
  Spin: 60 seconds at 4000rpm
- Make sure to align the wafer without any wobbling on the Solitec Spin Coater to ensure uniform film thickness and no streaks. A few streaks may be acceptable but excessive streaks do leave much usable area.
- Use a syringe to draw up 5cc of ZEP and then draw the syringe back 1cc more to ensure that there are no air bubbles at the tip.
- Use a 0.2 micron, or smaller filter to dispense the ZEP onto the wafer. Insert the filter onto the syringe and then push the ZEP through the filter till the liquid can be seen on the filter tip and all the air bubbles have disappeared.
- Make sure to dispense the ZEP solution onto the wafer in one motion uniformly across the surface of the wafer and try to avoid air bubbles.
- After you have dispensed the ZEP on the wafer press start and cover the spin coater.
- Then bake for 3 minutes at 180C.
- Next check the film thickness and uniformity in the Nanospec. ZEP520A has a refractive index of 1.541. Make sure to check at least 5 different spots across the wafer to ensure uniformity.

- Make sure that the hot plate has cooled down significantly before turning it off. Also it is important to dispose of the syringe tips in the sharps trash and not the regular trash.
- Protect the wafer in a single wafer box for later use.
- Now the wafer is ready for EBL use.

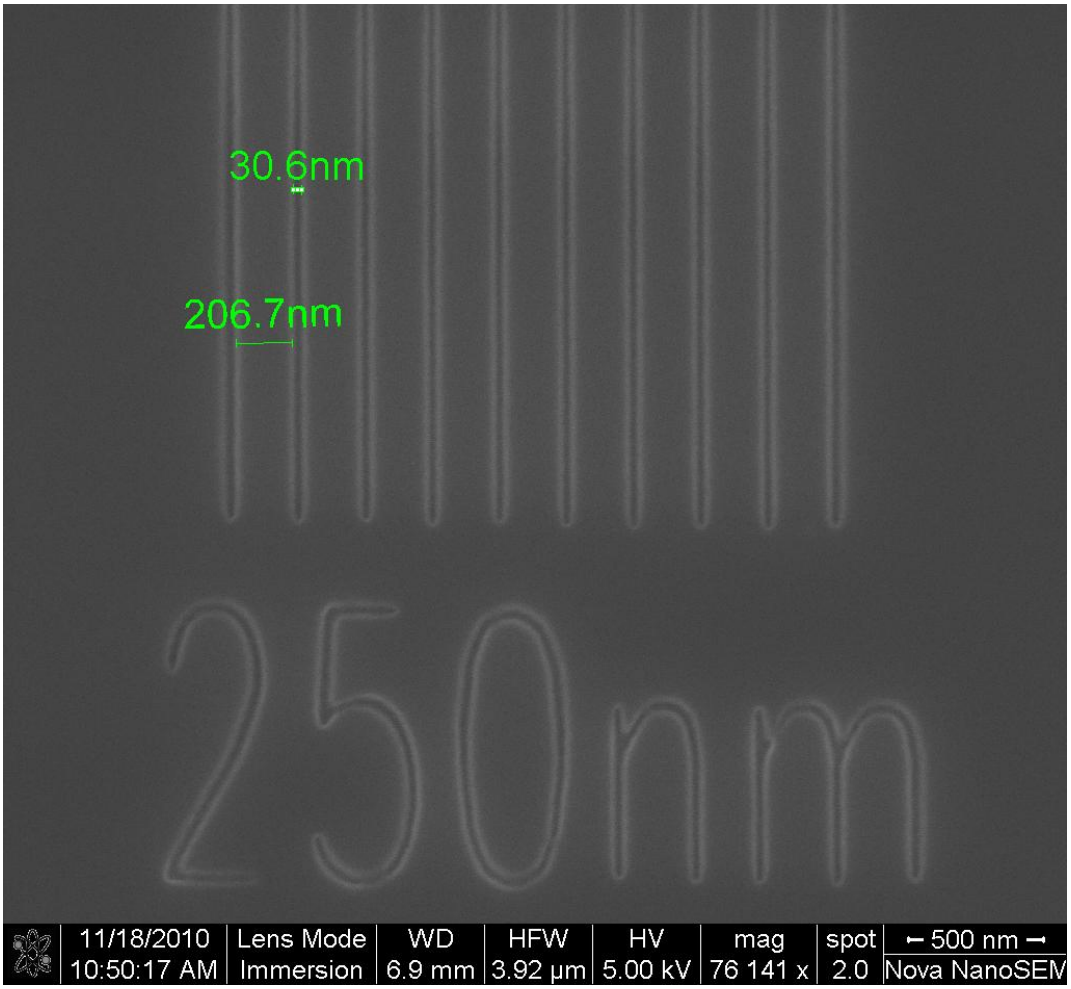
Using ZEP520A for Electron Beam Lithography

- ZEP520A has been tested with different patterns and has proved to have higher sensitivity than PMMA. The etch rate is for ZEP was discovered to be high as well, but it is still being tested.
- We recommend using Xylene as the developer after writing the pattern. Prepare two separate containers of Xylene and Isopropanol (rinse solvent) both approximately 15ml.
- Use approximately 15ml of Xylene and stir the sample for 70 seconds immediately afterwards rinse the sample in 15ml of Isopropanol and stir for 70 seconds.
- Then place the sample under table lamp to evaporate any leftover solvent for 5 minutes. Now the sample is ready for SEM viewing and micrograph documentation.

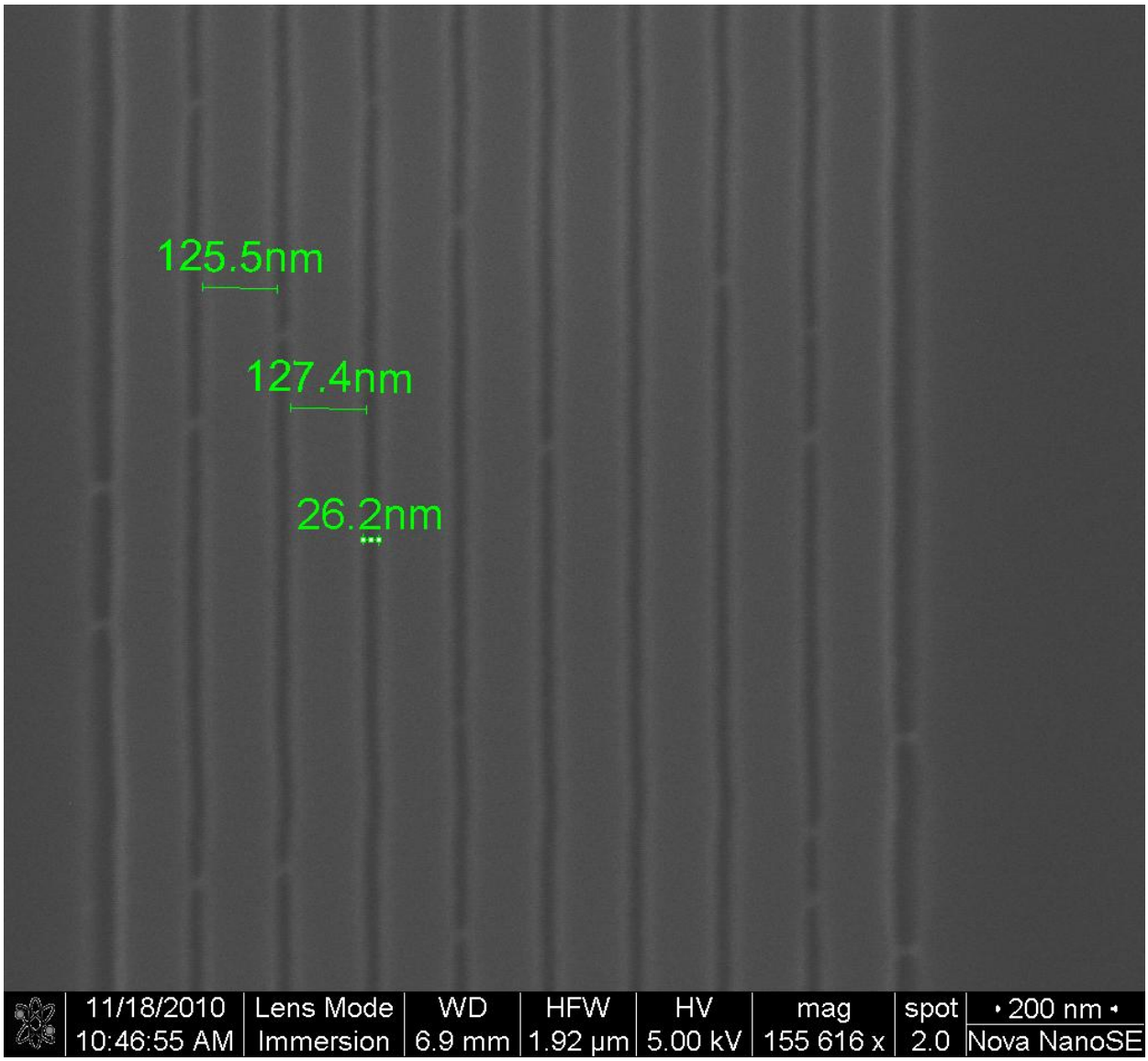
Results for ZEP520A

Here are images for a line and spaces pattern. The minimum exposed lines start clearing at $220\mu C/cm^2$ but we recommend $245\mu C/cm^2$ for well cleared lines with a pitch of 100nm. The images are ordered in descending pitch lengths. Since ZEP520A is a positive tone resist the cleared lines (dark) are exposed and developed area.

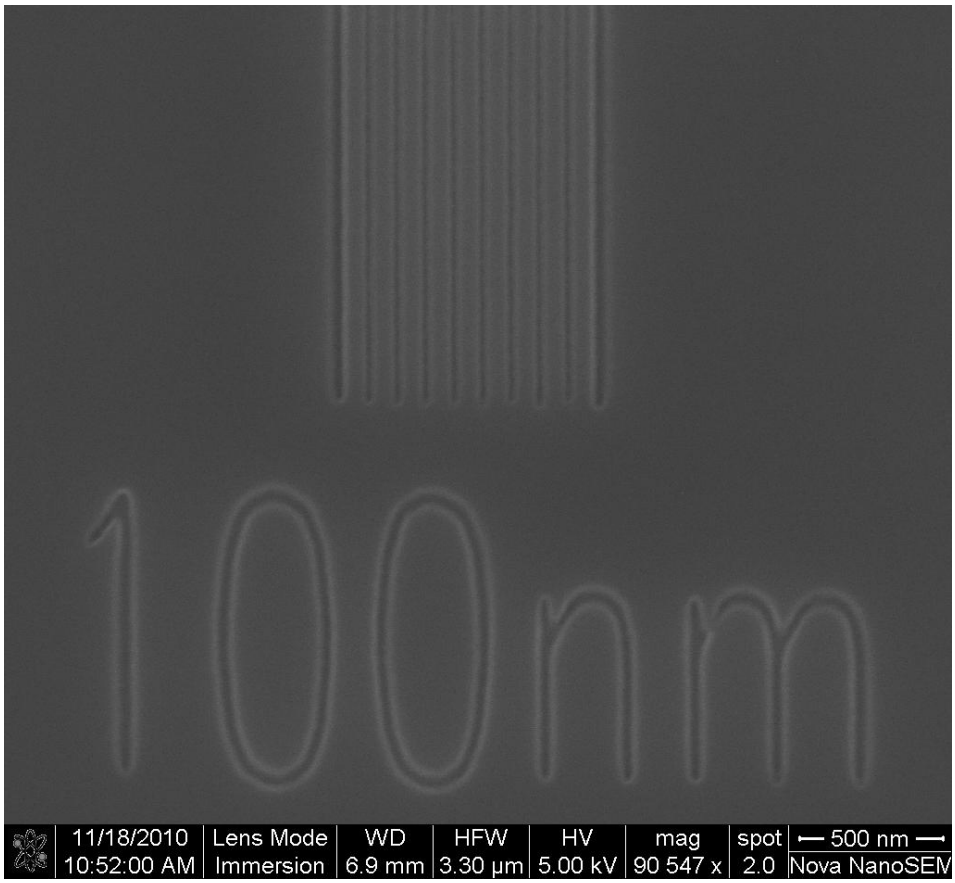
Pattern Name: Line&Spaces
Film Thickness: 125nm
Pitch: 237.3nm
Resolution: 30.6nm
Energy (Area Dose): 245μC/cm^2
Energy (Line Dose): 0.12162nC/cm

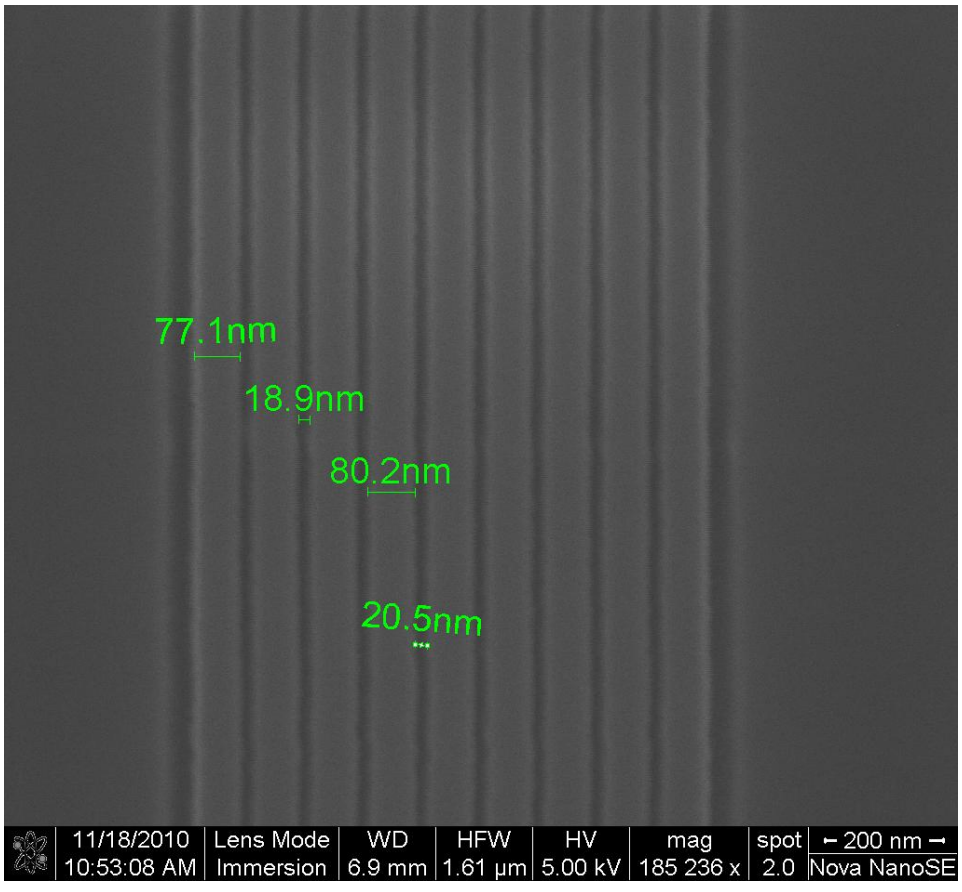


Pattern Name: Line&Spaces
Film Thickness: 125nm
Pitch: 151.7nm
Resolution: 26.2nm
Energy (Area Dose): 245μC/cm^2
Energy (Line Dose): 0.12162nC/cm

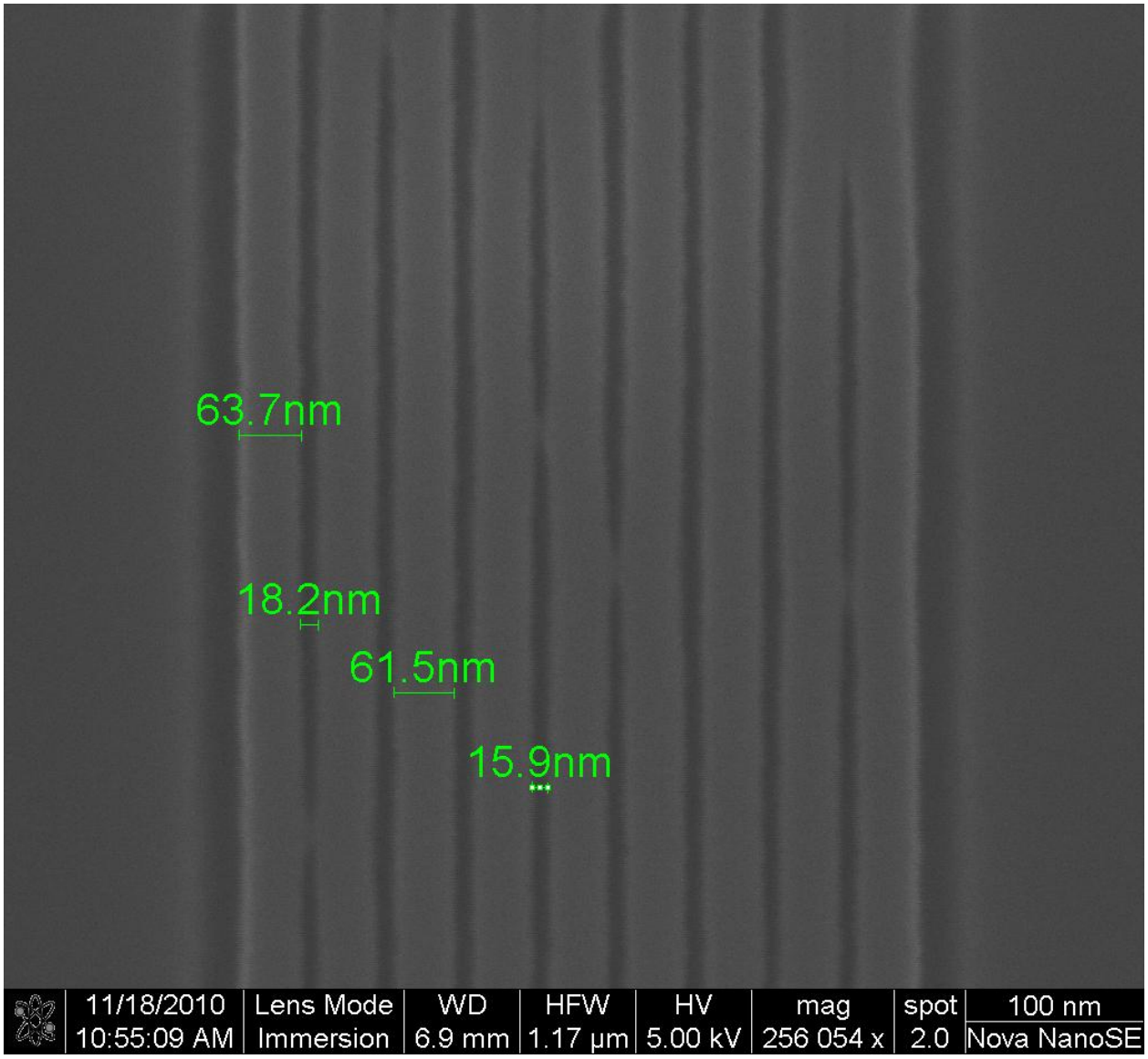


Pattern Name: Line&Spaces **Film Thickness: 125nm** **Pitch: 100.7nm**
Resolution: 18.9nm **Energy (Area Dose): 245μC/cm^2** **Energy (Line Dose): 0.12162nC/cm**



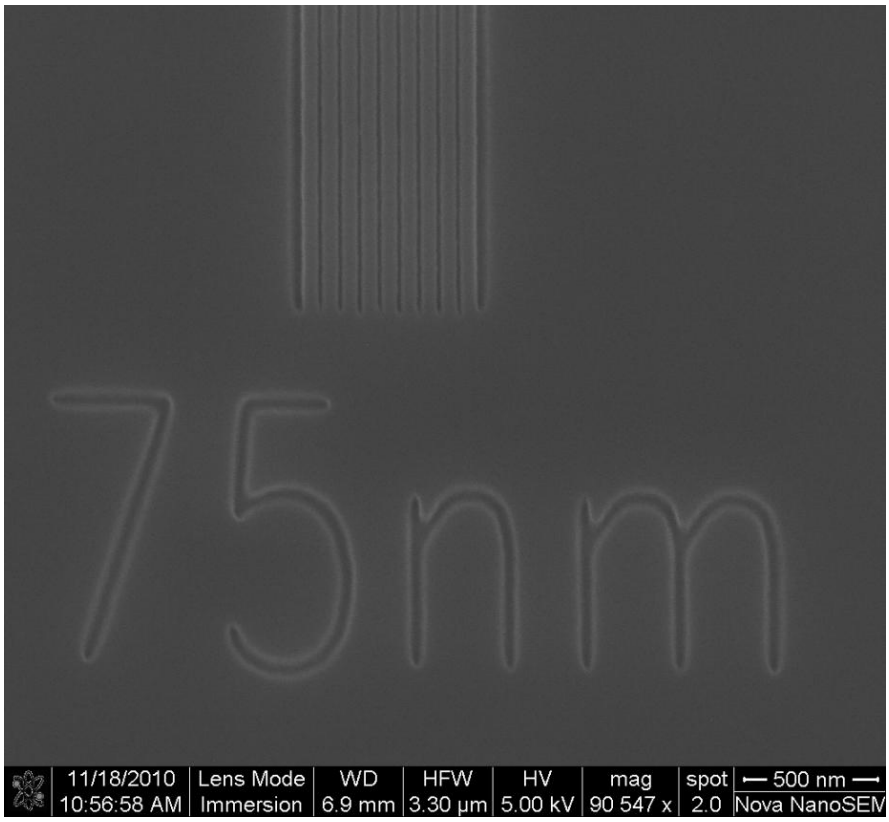


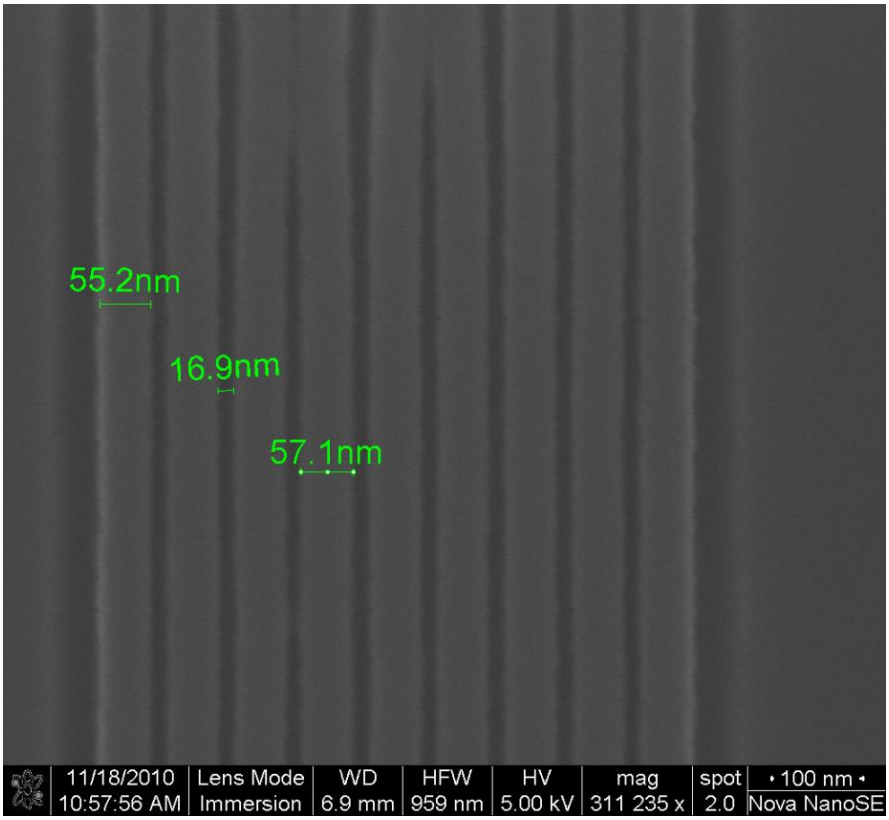
Pattern Name: Lines&Spaces
Film Thickness: 125nm
Pitch: 77.4nm
Resolution: 15.9nm
Energy (Area Dose): 245µC/cm^2
Energy (Line Dose): 0.12162nC/cm



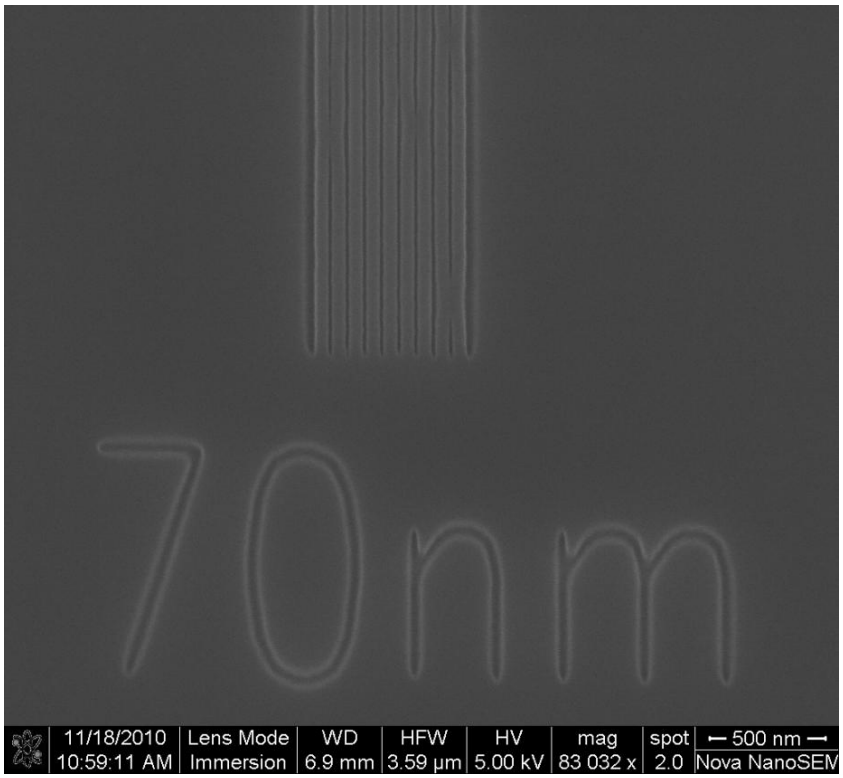
Collapsed lines may be encountered occasionally at lower pitches while viewing them under the SEM.

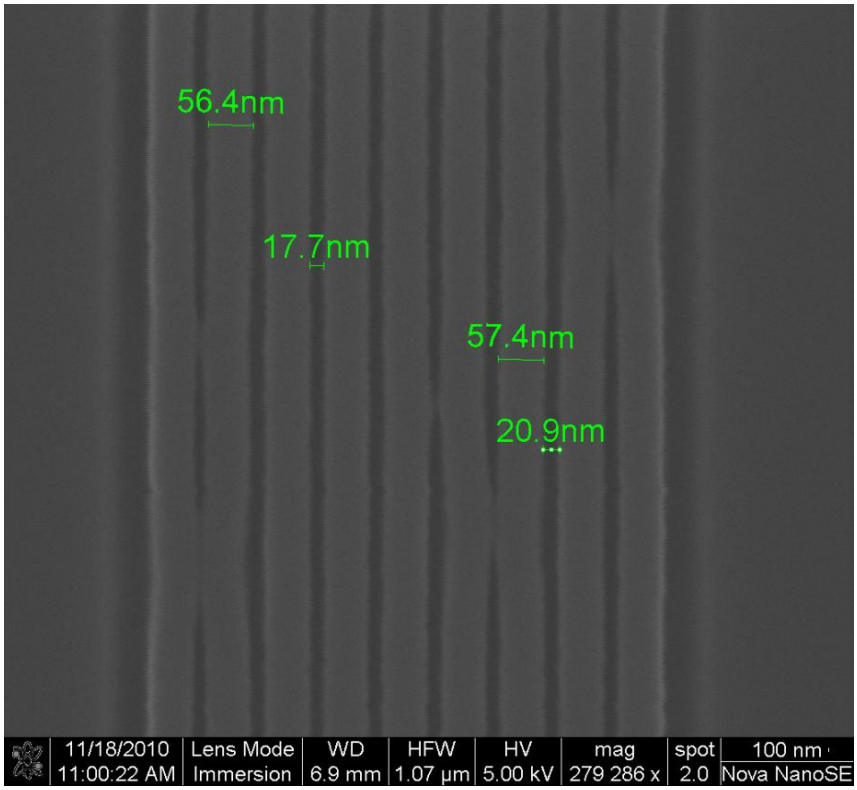
Pattern Name: Lines & Spaces Film Thickness: 125nm Pitch: 72.1nm
Resolution: 16.9nm Energy (Area Dose): 245µC/cm^2 Energy (Line Dose): 0.12162nC/cm





Pattern Name: Lines & Spaces Film Thickness: 125nm Pitch: 74.1nm
Resolution: 17.7nm Energy (Area Dose): 245µC/cm^2 Energy (Line Dose): 0.12162nC/cm





Collapsed lines may be encountered occasionally at lower pitches while viewing them under the SEM.