Immersion microlithography testing at 193 nm with a Talbot prism interferometer

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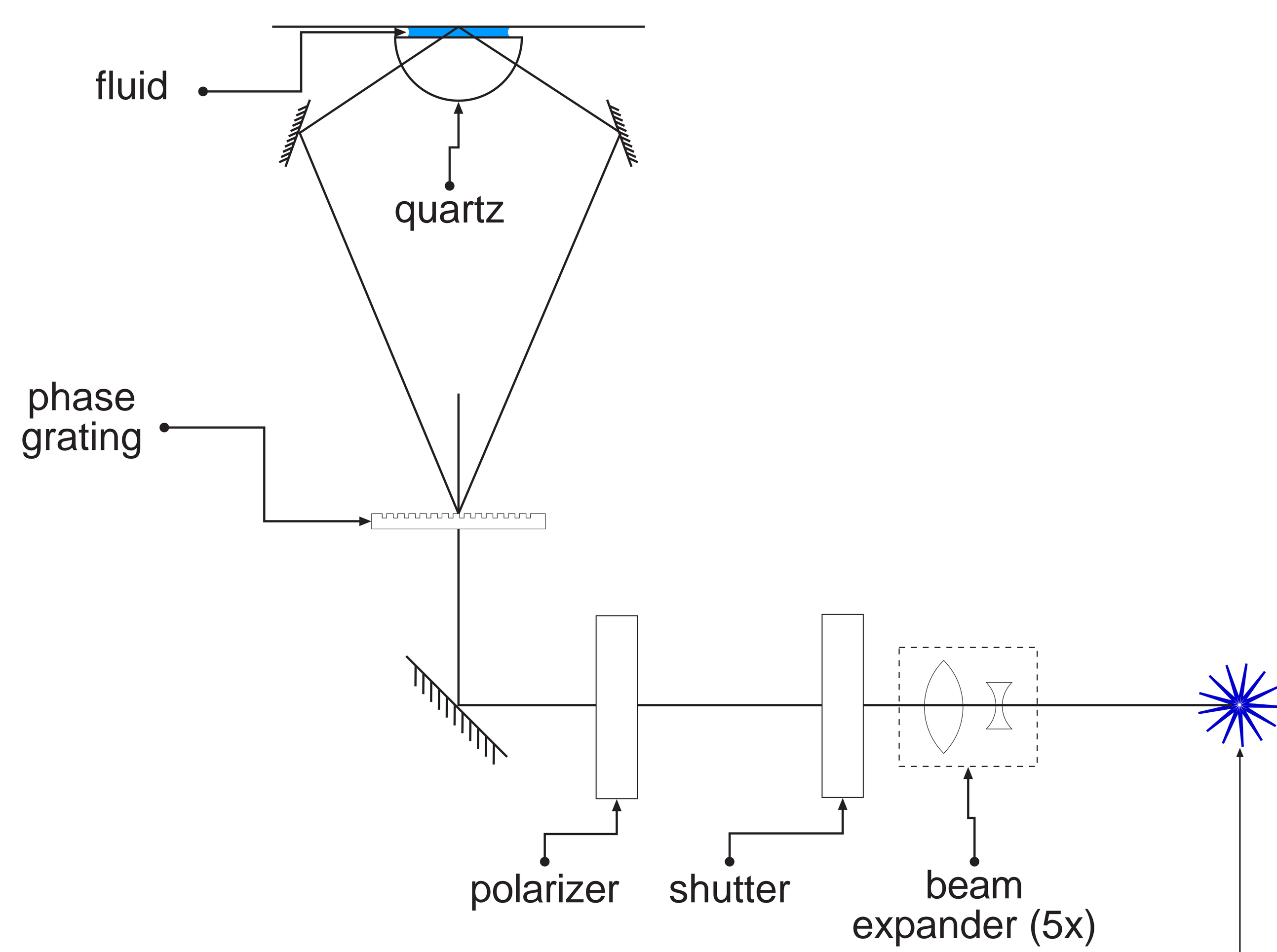
Abstract

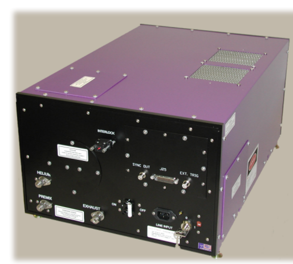
Images of 38 nm periodic pattern were printed using an Excimer ArF laser operating at 193 nm. A Talbot interferometric system was used in combination with immersion lithography to produce an equivalent NA of 1.25 and k_1 of 0.25.

Benchtop Prototype system

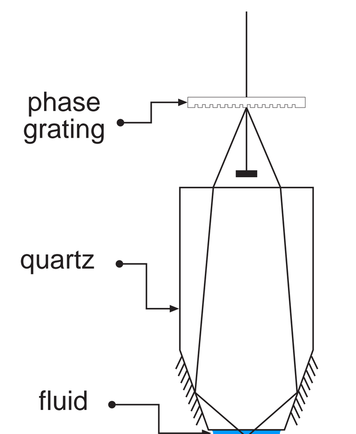


GAM EX10 Braggmaster ArF Excimer Laser

- 5 mJ pulse energy
- 6 pm linewidth (FWHM)
- 200 Hz rep. rate
- 10^6 pulse gas lifetime
- 0.5 mm spatial coherence (2.5mm with beam expansion)
- Better than +/- 5% beam uniformity
- Tui Laser BraggStar option

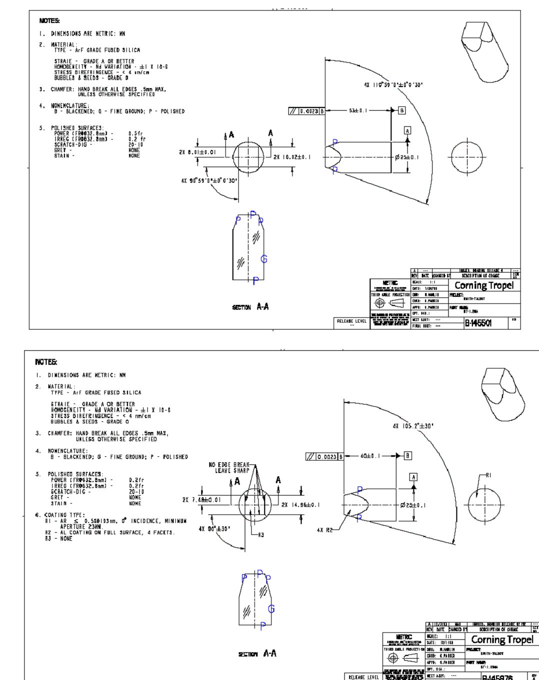


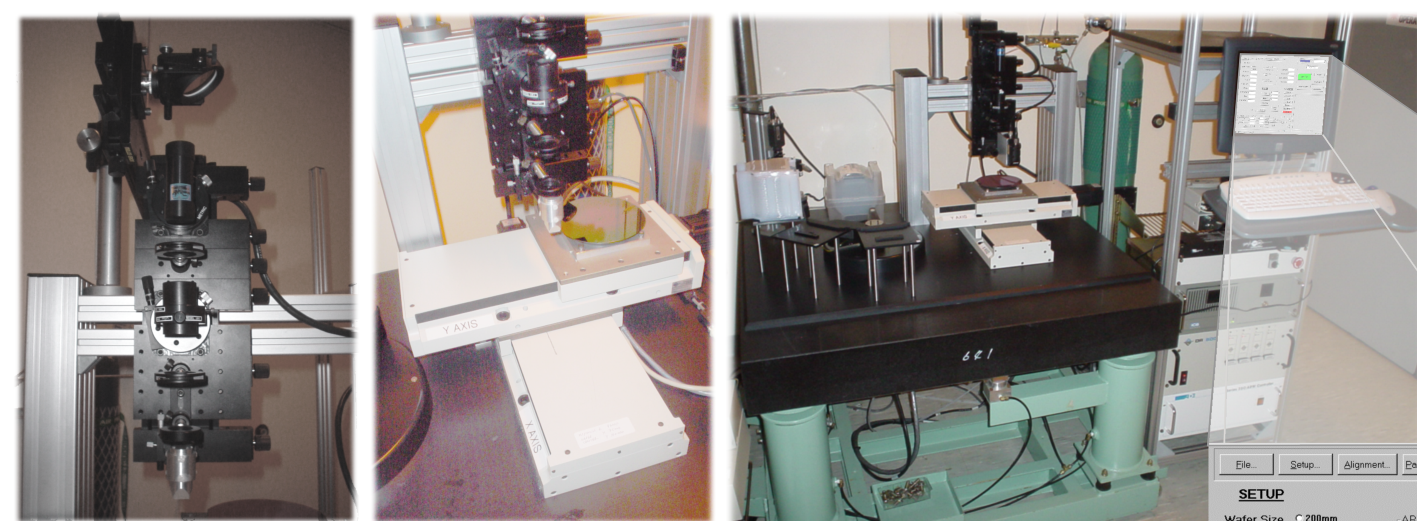
Automatic compact system XIS-193

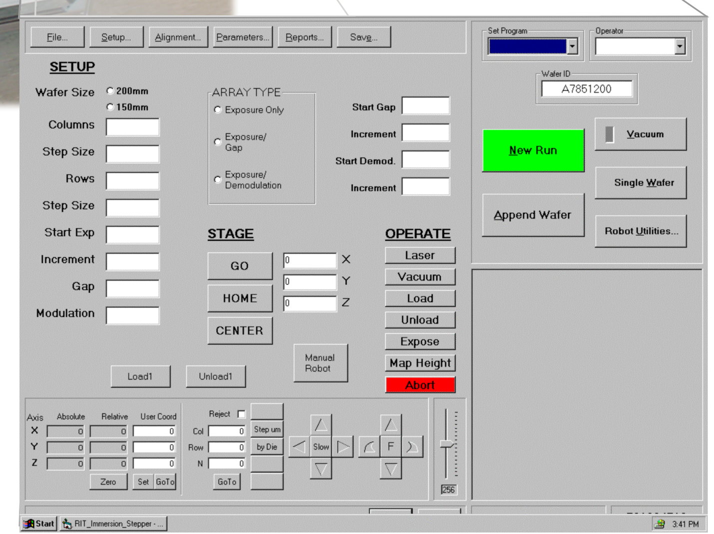


193 Prism Lens Designs

NA	half-pitch
0.8	60nm
1.05	45nm
1.20	40nm
1.35	36nm



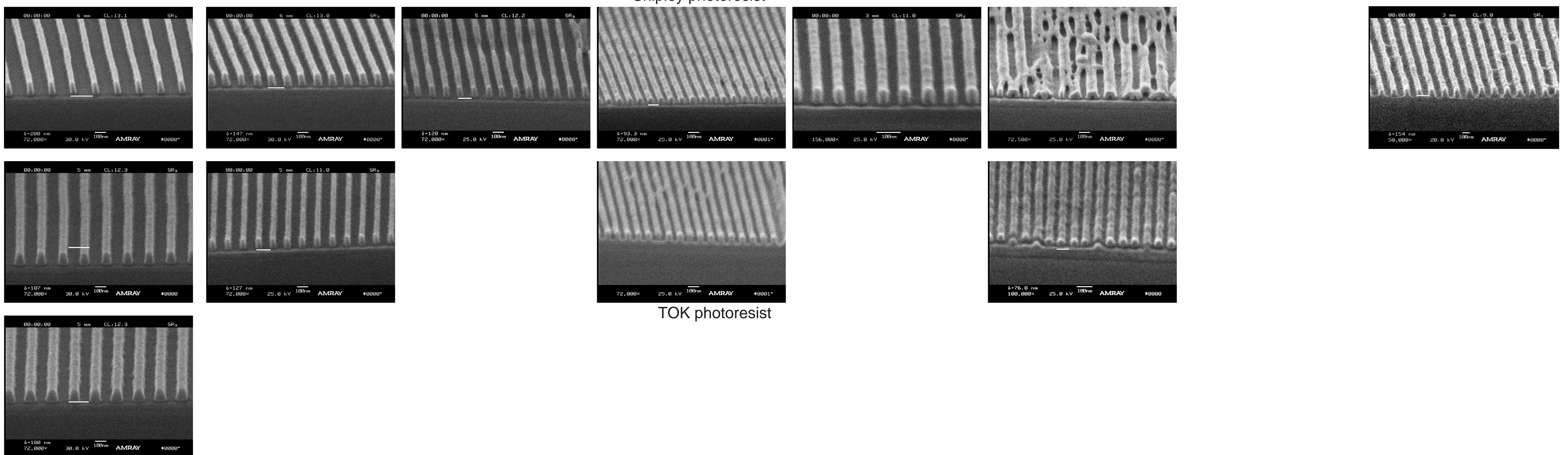




- The entire 193nm Talbot interferometer is incorporated into the prism lens
- Operation at 248nm possible via p248- PS grating
- 600nm phase grating produces +/-1st diffraction orders at 18.8°
- Prism lens angle increases NA up to 1.35
- Line/space and contact patterns are possible
- 2/4 beam interference allow for large tolerances
- Prism lens is combined with beam expander and polarizer for a complete projection imaging system

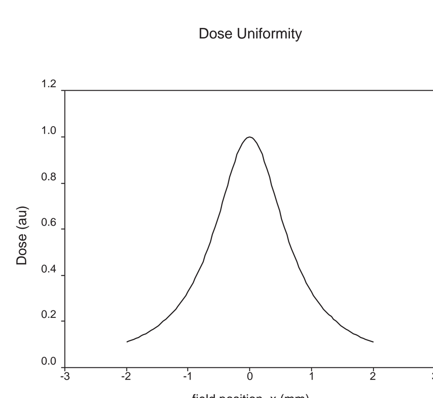
Results

NA=0.5 NA=0.7 NA=0.8 NA=1.0 NA=1.05 (compact prism) NA=1.25 Krf



Temporal Coherence considerations

- 6 pm bandwidth
- 6 mm coherence length
- Not achromatic, multiple frequencies are present. The beats effect limits the field size.
- Field of 0.4 mm with 90% dose uniformity



Spatial Coherence considerations

- Spatial coherence width 2.5 mm (after beam expander)
- Modulation is reduced with image plane out of alignment
- 0.1 mm tolerance in heigt to maintain modulation of 0.9