Diffraction grating fabrication on 100nm silicon Membrane for EUV interferometry

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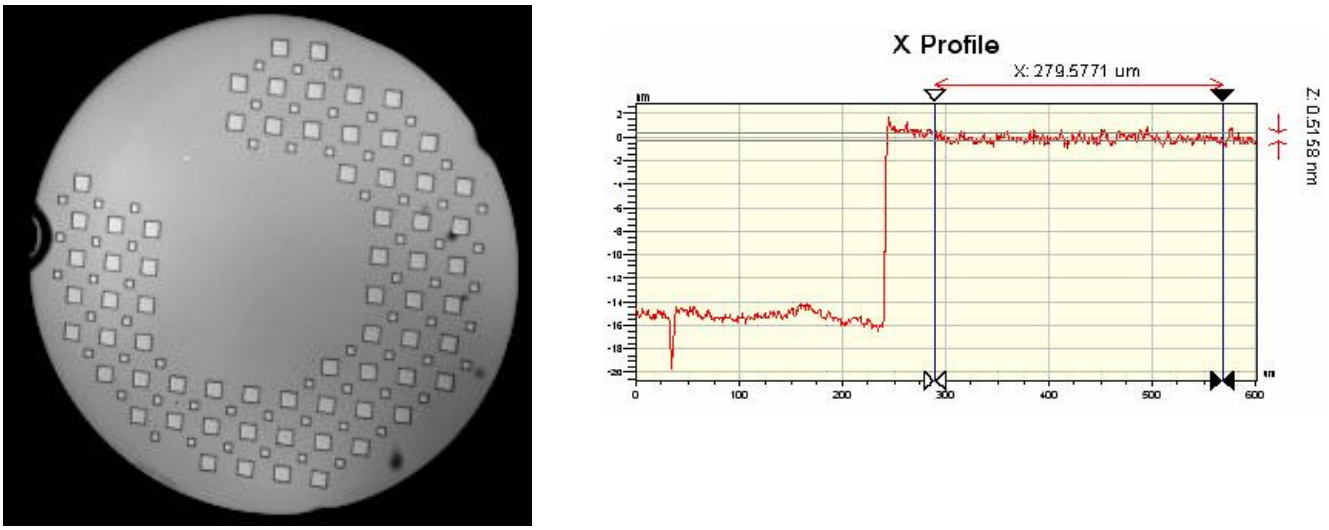
While Extrem Ultraviolet (EUV) projection tool is in development, EUV Transmission interferometric setup, is currently used to pattern at 13.5nm wavelength photoresist with a resolution below 20nm. The setups are often based on diffraction gratings which offer achromaticity and a confident relation between the fringes periods patterned and the grating that generate the fringes. In order to built a stand alone EUV interferometric setup we have optimized the grating fabrication to get at first order a diffraction efficiency of 25% versus 7% usually achieved with standard processes.

We have developed the processes allowing the fabrication of ultra thin silicon membrane (100nm) over several square millimetres with a deformation below 1nm. These membrane should satisfy many applications, but especially EUV or UV transmission because of the transparency in this range of wavelength : T=84% for Si:100nm at λ=13.5nm. The design and fabrication of this membrane will be described, Figure 1.

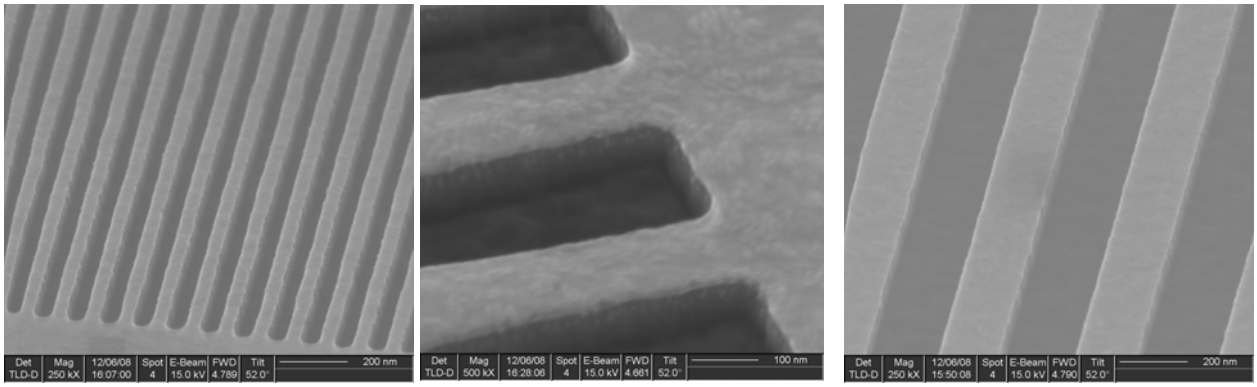
Diffraction grating fabrications from 200 to 30nm half pitch have been achieved onto silicon membrane. The lithography has been performed with a Gaussian Electron Beam VB6 Ultra High Resolution from Vistec. The etching process has been developped using an Etch Stop Layer and Hard Mask in order to keep control on the etching anisotropy, the uniformity and the grating fill factor, which are primordial to optimize the diffraction efficiency, Figure 2.

We will present details of the fabrication processes.



A) B)

Figure 1 : A) 100nm thick silicon membrane of 3x3mm² and 5x5mm² on 8 inches silicon substrate. B) Silicon membrane profile measurement by Phase Shifting Interferometry in visible light, showing a deformation below 1nm.



A) B) C)

Figure 2 : Molybdenum grating after etching on Silicon Membrane, Hard mask not removed. A) 40nm half pitch, B) 100nm Half pitch, C) 200nm half pitch.