The soft X-ray Interference Lithography Beamline (BL08U1B) at SSRF

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The Shanghai Synchrotron Radiation Facility (SSRF) is the first third-generation synchrotron in China and operates at an electron energy of 3.5 GeV. The soft X-ray interference lithography beam line (XIL) which has been opened to the users in January 2013 is one of the SSRF beamlines. The layout of the beamline is shown in figure 1.

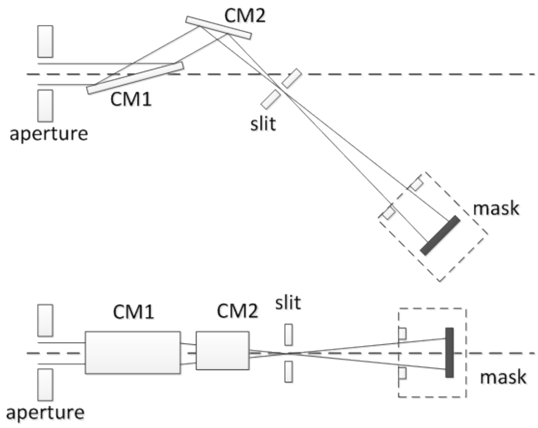

Figure 1. Schematic layout of the BL08U beamline

A four-jaw aperture is employed to define the acceptance angle of the beamline in horizontal and vertical directions and to absorb most of the heat load to protect the downstream optical elements. Two side-water-cooled cylindrical mirrors are used in the beamline. The both mirrors are coated with Au. The first mirror is used to produce a parallel beam in vertical and deflect the incoming beam horizontally by 3°. This mirror also plays a role in cutting the higher energy radiation (>2000eV). The beam is focused to the exit slit by the second mirror which is placed opposite to the first one. The exit slit which is as a high quality secondary source for the mask (diffraction grating) is used to obtain spatial coherent photons.

XIL employs extreme-ultraviolet (EUV) light passing through a grating mask to form multiple beams and the resulting interference pattern is exposed in a polymer resist to produce nanoscale periodic structures. Figure 2(a) shows the geometry for making one-dimensional gratings (line / space) patterns. The $\pm 1^{st}$ order diffracted beams from the two grating interfere in the center to form a fringe pattern which has double the frequency of the diffraction gratings. The patterned area has the same width as the diffraction gratings. The scheme for two-dimensional gratings is shown in figure 2 (b) where four square shaped gratings diffract into a central area.

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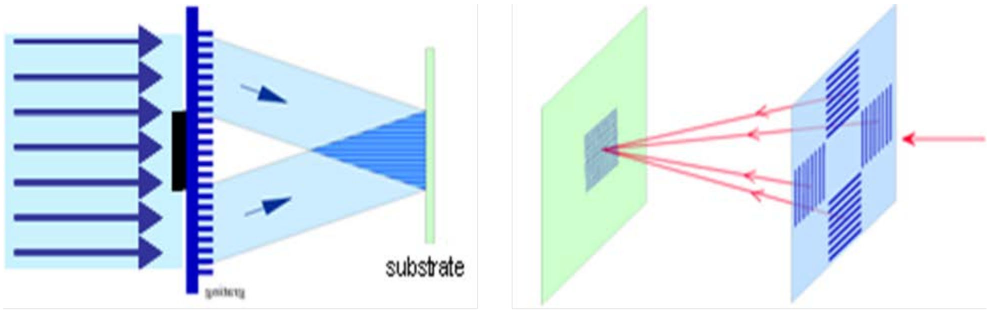
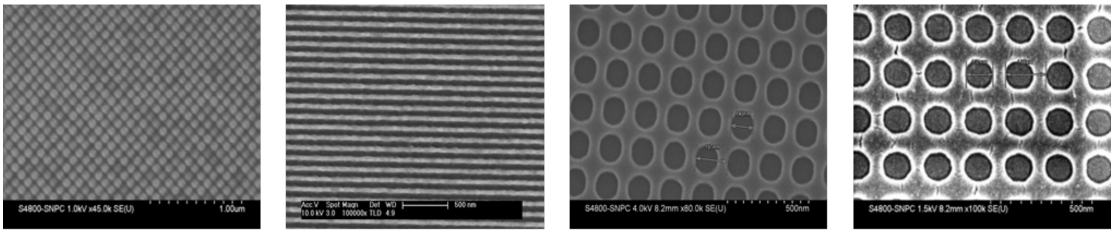


a b

Fig.2 Schemes for (a) two-beam interference and (b) four-beam interference

Up to now, we have the ability to provide user at least 100nm period 1D/2D periodic photo resist nanostructures. Furthermore, according to the request of the user, we can also transfer these photo resist pattern to other films such as metal or silicon nitride (as shown in Fig.3 a～d).



a b c d

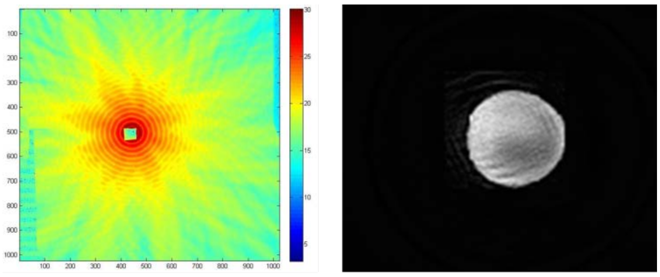
Fig3. a) 100nm period 2D photo resist dots on Si substrate

b) 100nm period 1D photo resist line on Si substrate

c) 200nm period 2D Si_3N_4 grids on Si substrate

d) 200nm period 2D Cr grids on Si substrate

In addition, broadband Coherent Diffraction Imaging (CDI) study has been carried out at the XIL beamline thanks to the high quality coherent photons. The preliminary result is shown in figure 4.



a b

Fig 4 a) the diffraction pattern of a pinhole; b) the reconstructed image of the pinhole