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

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The Shanghai Synchrotron Radiation Facility (SSRF) is the first third-generation synchrotron in China and operates at electron energy of 3.5 GeV. The soft X-ray interference lithography (XIL) beamline which has been opened to the users in January 2013 is one of the SSRF beamlines. A novel optical design was adopted to provide a symmetrical beam spot at the end-station. The coherent radiation can be adjusted from 85eV to 150eV, and a $0.4\times0.4mm^2$ one-shot exposure area can be obtained. The coherent photon flux density at mask is 3.5×10^{15} ph / s / cm^2 / 2.4%BW / 0.24A@92.5eV, and the beam size at mask is about several mm^2.

The XIL employs an achromatic aberration interference method, in which a soft X-ray light passes through a grating mask to form multiple beams and the resulting interference pattern is exposed in a polymer resist to produce nanoscale periodic structures. The ±1st order diffracted beams from the two grating interfere in the center (Fig.1) 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.

Up to now, we have the ability to provide users with 1D/2D periodic photo resist nanostructures at least 50nm/70nm period (Fig.2). Furthermore, according to the request of users, we can also transfer these photo resist pattern to other films such as metal or silicon nitride.

To better meet the users' demands, some progresses on the XIL experimental methodology will be presented. With a 140eV photon energy, we can provide the 220nm thick photo resist pattern, which can provide bigger processing window for pattern transfer process. Furthermore we are able to stitch the exposure pattern at micro-meter precision level, so that we can easily get the high density resist pattern over several square centimeters (Fig.3).

Thanks to the performance of the system in terms of pattern resolution, uniformity, size of the pattern area, the system has been used in numerous applications such as EUV resist test, surface plasmon, nanoscale magnetism, biology self-assembly and nano-photoelectron device.

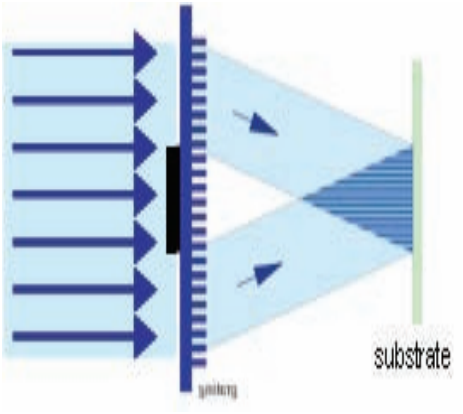

Fig.1: two grating interference schematic diagram

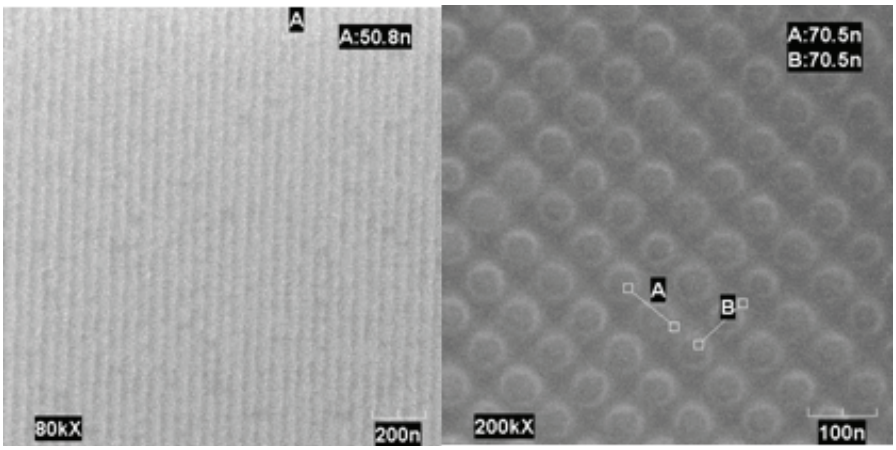

Fig.2: 50nm/70nm pitch 1D/2D PMMA pattern

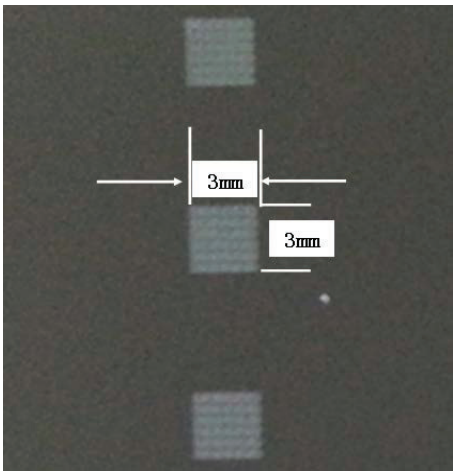

Fig.3: Stitched PMMA pattern