

Nano-fabrication of Fresnel Zone Plates for X-ray Focusing

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Condenser zone plate is a kind of device for light focusing. Both fine linewidth (sub-micro scale) and high aspect ratio are important characters to affect the focusing efficiency. A technique of LIGA can be used to achieve both of them, and lithography is an essential process of LIGA to define the nano scale feature size of pattern. Both the scattering and diffraction are the main effects which limit lithography resolution, thus in order to fabricate this device, the photon energy of ultraviolet is not strong enough to limit lithography resolution to sub-microscale. The shorter wavelength and stronger intensity of light for lithography process is essential. Therefore, x-ray source via synchrotron radiation was adopted. X-ray lithography has been developed to reproduce pattern of sub-100-nm feature size by synchrotron radiation.

Figure 1 shows the surface morphology of hard mask after electrodeposition, the zone plate has good electrodeposition quality. The smallest zone width is 45 nm in Fig. 1(b). The mask is used to test the limitation of linewidth fabricated in BL18B.

Figure 2 shows the SEM images of zone plate pattern with thickness of photoresister (PMMA A11) about 4.5μm transferred from corresponding hard mask from Fig. 1. The smallest line width of transferred PMMA sheet is smaller than 200nm. The aspect ratio more than 20 had been achieved. By the way, the beamline was used in BL18B in NSRRC; the electron energy of the synchrotron source is 1.5GeV, and the characteristic photon energy is 0.5~3 keV.

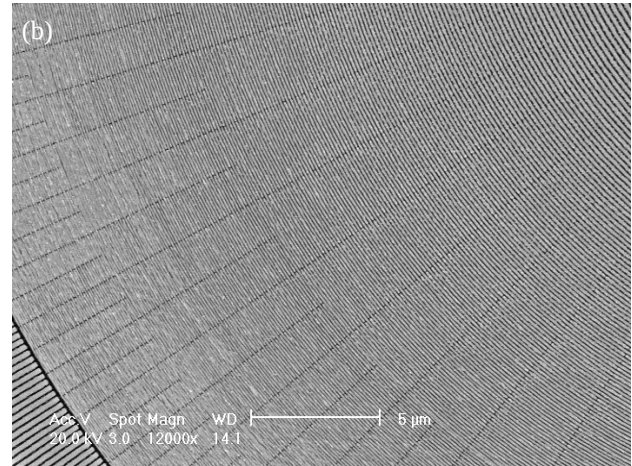
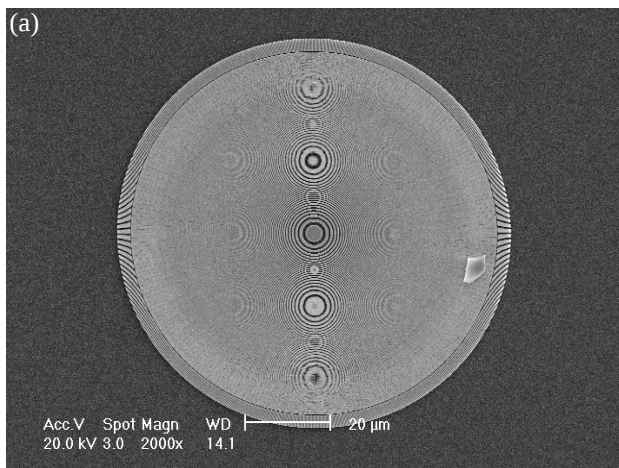


Fig.1: SEM image of X-ray mask; (a) the top view of the whole x-ray mask; (b) the outer zone of x-ray mask

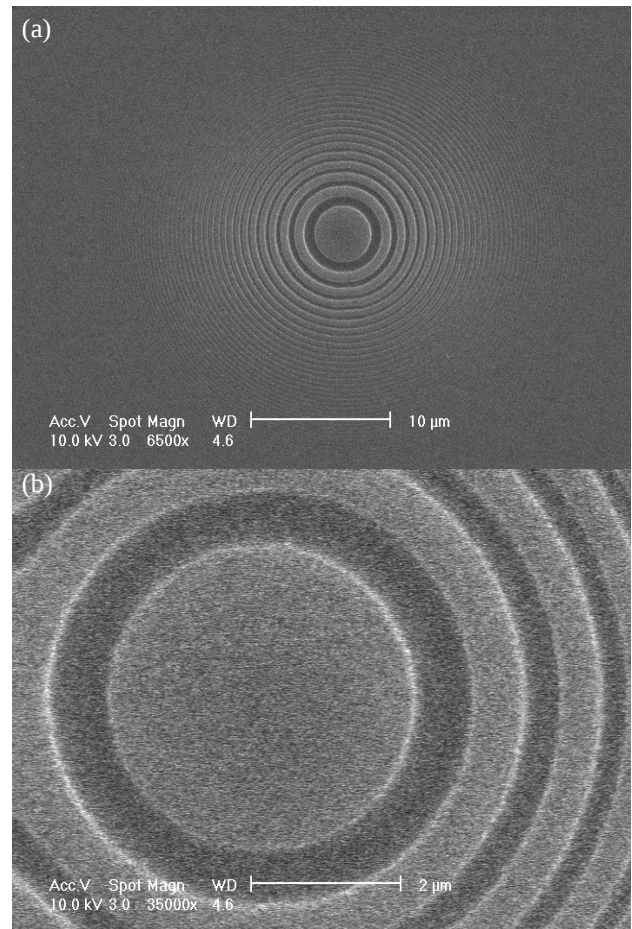


Fig. 2: SEM image of PMMA sheet transferred by x-ray mask in Fig. 1