

Fabrication of Fine Linewidth Pattern by X-ray Lithography

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Lithography, a nanoscale-technique could reproduce pattern quickly, will be used to fabricate nano scale structure in this work. The energy of x-ray in BL19A beamline is strong enough that could fabricate sub-100-nm feature size. X-ray lithography is the only one technique to fabricate this nano scale structure through optical way. An important phenomenon to minimize feature size is diffraction limit. The diffraction limitation is less than 10 nm by contact lithography technique under synchrotron radiation. Therefore, we could confidently suggest that linewidth less than 30 nm could be fabricated. Due to the strong penetrability of X-ray, the x-ray mask is hard to fabrication. Over than 1 μ m thickness of x-ray mask with nanometer-scale linewidth is essential. However we can fabricate such x-ray mask with thickness 1 μ m and smallest linewidth 45nm via e-beam and electrodeposition. Therefore, we can reproduce nanoscale pattern by x-ray lithography. In this report, we carry out sub-100-nm linewidth using synchrotron radiation; the corresponding mask is with a zone plate pattern whose dimension has the smallest linewidth about 45 nm as shown Fig. 1. The smallest linewidth via the x-ray technique had been successfully achieved is less than 100 nm so far.

The zone plate pattern on x-ray mask is defined by Elionix e-beam writer system, where the pattern has the smallest linewidth about 45 nm. The photoresist used in this work is the PMMA A11 that is with thickness more than 1 μ m. After lithography process, the finished samples were electrodeposited with Au layer about 1 nm for zone plate pattern. The hard mask contacts with resist by normal placing. The photoresist used in the X-ray lithography process is the PMMA A4 with thickness about 200 nm as well.

Figure 2 shows the surface morphology of test plate patterns transferred from corresponding hard mask after development process (Fig. 2(b)). The smallest linewidth less than 100nm had been carried out, but the outer zones can't be transferred completely. Due to the aspect ratio of outer zone of mask is too high to be overwhelmed via contact x-ray lithography process.

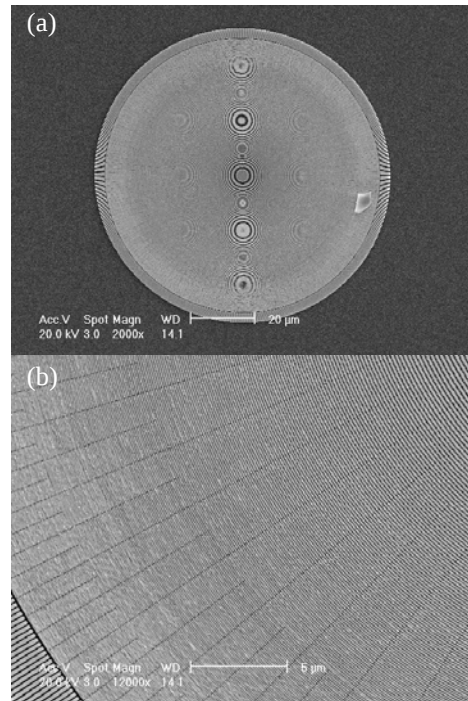


Fig. 1: SEM image of x-ray mask with zone plate pattern

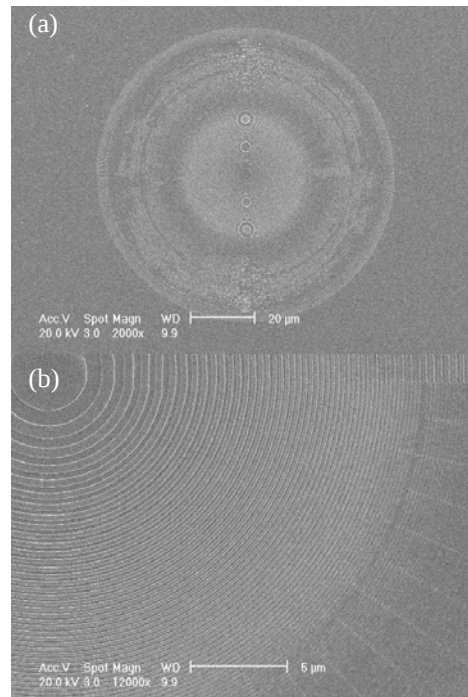


Fig. 2: SEM image of PMMA sheet transferred by x-ray mask in Fig.1