

X-ray Imaging Microscopy at 82 keV with Sputtered-sliced Fresnel Zone Plate Objective

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Fresnel zone plate (FZP) is widely used as an objective lens of X-ray microscope. Most of FZPs are fabricated using micro-fabrication technique developed for LSI technology (electron-beam lithography). However, these techniques are difficult to apply to fabrication of high-aspect-ratio structures. Therefore, the FZPs fabricated by electron beam lithography can not be used in high energy region (typically above 20 keV) because of low diffraction efficiency due to the thin zone structure.

Sputtered-sliced FZP (SS-FZP) fabricated by depositing concentric multilayer on a wire core is one of the optical elements that can be used in high energy region, because the SS-FZP has no-thickness limit in fabrication process. Recently, SS-FZP was applied to micro-focusing optics for high energy X-rays up to 100 keV, and spatial resolution (focused spot size) of 0.5 micron has been achieved [1, 2].

In this report, we describe X-ray imaging microscopy in high energy region (82 keV) using SS-FZP as an objective lens. The SS-FZP used in the experiment consists of 50 concentric Cu/Al multilayer deposited on a Au wire (50 micron in diameter). The outermost zone width is 0.25 micron, and the estimated thickness of the SS-FZP is about 36 micron. The focal length of the FZP is 1.63 m at 82 keV. The experiment has been done at BL20XU of SPring-8. The object and objective FZP were placed at the first experimental hutch located at 80 m from the light source, and a CCD-based imaging detector is placed at 245 m from the light source. Therefore, magnification of the X-ray optics is 100, in spite of long focal length (1.64 m) of the SS-FZP.

Measured image of a test object is shown in Fig. 1. A gold grid mesh with 1500 mesh/inch was used as the test object. The X-ray energy (82 keV) was selected so as to obtain the maximum absorption contrast by utilizing Au K-absorption edge (80.7 keV).

1. M. Awaji, et al., Rev. Sci. Instrum. **74** (2003) 4948.
2. N. Kamijo, et al., Rev. Sci. Instrum **74** (2003) 5101.

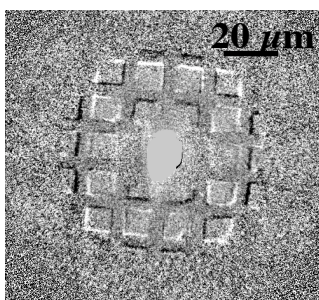


Fig. 1. Result of imaging microscopy at 82 keV with sputtered-sliced zone plate. Magnification of X-ray optics: 100. X-ray energy: 82 keV. Exposure time: 6 min.