Hard X-ray Microbeam and Scanning Microscopy using Fresnel Zone Plate with 50 nm Outermost Zone Width

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Fresnel zone plate (FZP) with 50 nm outermost zone width has been fabricated, and tested at SPring-8 medium-length-beamline 20XU. The FZP was fabricated by electron-beam lithography at NTT Advanced Technology. The zone material is tantalum with a thickness of 0.5 micron. The diameter of the FZP is 250 μm, and the focal length is designed to be 80 mm at an X-ray energy of 8 keV. Focused beam profile for the first-order diffraction measured by knife-edge scan is shown in Fig. 1. Focused beam size defined as full-width at half-maximum (FWHM) is 58 nm that is very near to the diffraction-limited resolution. The measured diffraction efficiency for the first-order diffraction is 5% at 8 keV. Scanning microscopy experiment was also done for the purpose of confirming the spatial resolution. An example of measured image is shown in Fig. 2. The test object is resolution test patterns with 70 nm line and space. The nanometer-scaled structure is clearly observed in the measured image. Focused beam profiles for the third order diffraction was also tested for investigation of ultimate performance of the FZP. The measured spot size was 31 nm at an X-ray energy of 8 keV [1]. We consider that this value is present technical limitation of FZP fabrication, while the theoretical limit of spatial resolution of FZP is about 10 nm in the X-ray region [2]

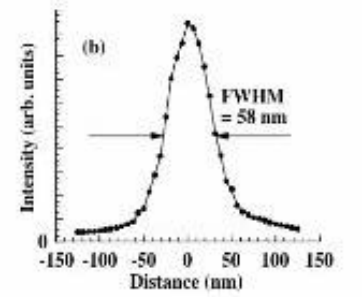

Fig. 1. Focused beam profile measured by knife-edge scan. X-ray energy: 8 keV.

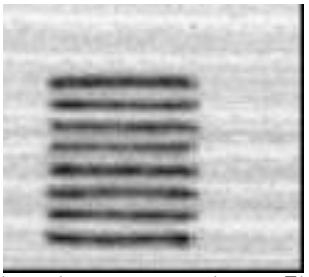

Fig. 2. Scanning microscopy experiment. Field of view: 950 nm x 950 nm, X-ray energy: 8 keV, sample: resolution test pattern

1. Y. Suzuki et al., Jpn. J. Appl. Phys. in press.

2. Y. Suzuki, Jpn. J. Appl. Phys. **43** (2004) 731.