Development of kinoform lenses made of quartz for microbeam X-ray diffraction

Kazushi Sumitani, Yasuhiko Imai and Shigeru Kimura

Japan Synchrotron Radiation Research Institute, 1-1-1 kouto, Sayo, hyogo, Japan.

sumitani@spring8.or.jp

Refractive lens is one of the promising optics for focusing X-rays as its robustness, easy on-axis alignment, and availability for high-energy X-rays. Polymer, Aluminum, Silicon, beryllium etc. are frequently used as a lens material, however, they have a problem such as tolerance to X-ray radiation or difficulty in the manufacturing process of the micro-scale structure. Quartz glass is an attractive material for the lens because of high uniformity, low density, and high affinity for microfabrication process. Recently, we have developed refractive lenses using quartz glass for 25 and 30 keV X-rays [1]. We succeeded in 100-μm-deep etching and realizing highly efficient microfocusing for high-energy X-rays.

In this study, we newly developed kinoform lenses made of quartz for improving efficiency of focusing X-rays. The picture of the lenses by an optical microscope is shown in fig. 1. The lenses were fabricated on a quartz glass substrate by optical lithography and dry etching process. Rectangular regions on the side of the lenses, which corresponds to the phase variation by the multiple of 2π within the lens thickness, were removed for reducing the absorption of X-rays. The lenses for X-ray energy of 10, 12.4, 15, 20, 25, 30 keV were designed with the aperture of 100 x 100 μm^2. We prepared pairs of lenses at each energies which have a focal length of 200 mm and 100 mm for focusing both vertically and horizontally.

Evaluations of the lenses were performed at BL13XU in SPring-8. X-ray beam emitted from the undulator source was monochromatized from 10 to 30 keV, and then focused by a pair of lenses in a crossed geometry. The focused beam sizes were measured by knife-edge scan with Au wires. For example at 15 keV, the size of the focused beam of 1.0 x 1.3 μm^2 and the focusing efficiency of 29 % were obtained.

In our presentation, detailed designs of the quartz kinoform lenses and the focusing performance at each X-ray energies will be reported.

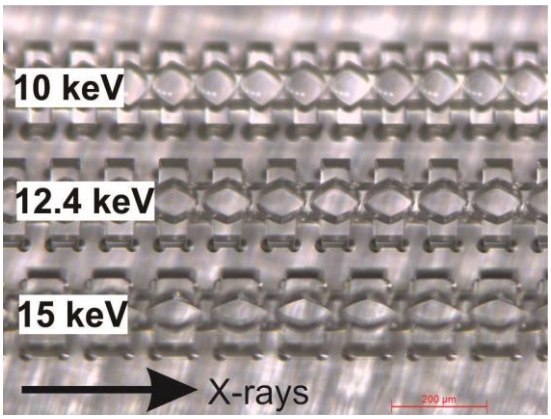

Fig. 1 Optical microscopic image of the kinoform lenses for 10, 12.4 and 15 keV.

[1] S. Kimura and Y. Imai, Jpn. J. Appl. Phys. **55**, 2016, 038001.