

Feasibility Study of Wide-Angle Incidence X-ray Waveguides Prepared by Micro-/Nano-Technology

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Grazing incidence X-ray waveguides have been most studied because of its simple geometry and its applicability for all photon energies. However, wide-angle incidence waveguides are also essential for modern X-ray optics, as far as coupling/guiding X-ray beams into given directions are concerned. We have prepared waveguides on silicon wafers by X-ray lithographic technique. The shapes of the waveguides are 100 μ m high and 1cm long with different widths and the distance between the adjacent waveguides is 2.5 mm. We plated the silicon waveguides with gold. The thicknesses of the top and the bottom Au layers are about 3000 Å. (Fig.1).

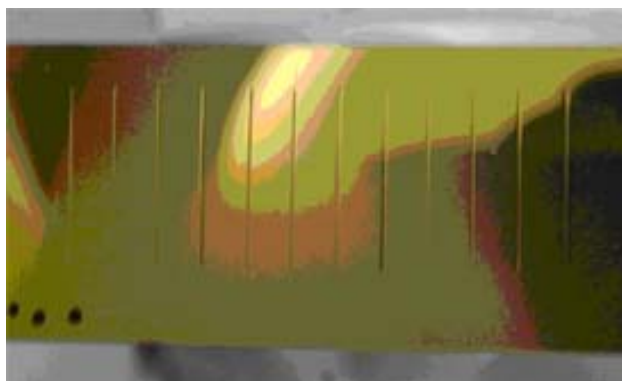


Figure 1. Waveguides on silicon wafers by X-ray lithographic technique. Three sets of waveguides (4 each) are offset from [110] by -0.5° , 0° , 0.5° respectively (left to right).

The x-ray waveguide measurement was performed at the 17B1 beam line. From the crystal orientation and diffraction geometry, we calculated the photon energy for Si (113) as a surface diffraction being 8.878 keV, at which the surface diffracted beam is along the waveguide.

We detected the intensity distribution normal to the crystal wafer by scanning the 2θ angle (see Fig.2). Interference pattern, similar to that for single-slit diffraction, was observed. When we tuned the photon energy, i.e., changing the incident angle, the diffraction pattern became asymmetric with respect to the zeroth order peak (Fig.3). Detailed data analysis is in progress.

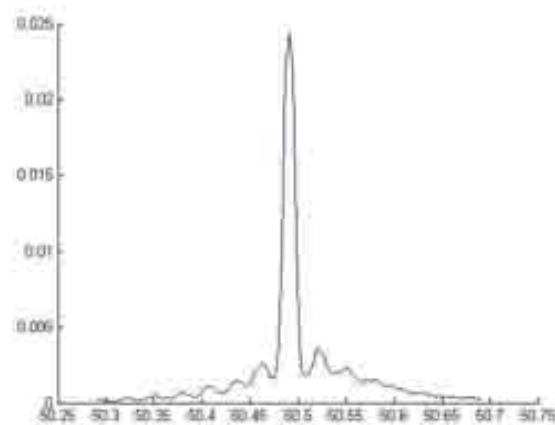


Figure 2. Interference pattern in the normal direction of the waveguide on the silicon wafer (2θ -axis).

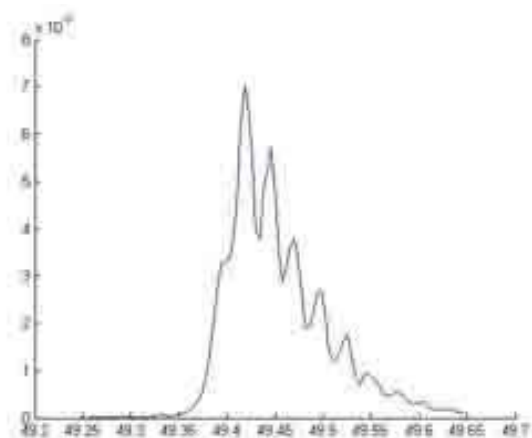


Figure 3. As we tuned the photon energy (the incident angle also changed), the diffraction pattern became asymmetric with respect to the zeroth order peak.

We have observed interference phenomenon in an asymmetric Bragg reflection for different photon energy. Other types of waveguides will be investigated in the near future.