Development of High Resolution X-ray Imaging by the Refraction Contrast Method

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Refraction contrast X-ray imaging has been recently studied actively. Using this method, the radiation dose can be small, comparing with the absorption contrast imaging. Another advantage of this method is that the high contrast images of the sample consisted of light elements may be obtained in hard X-ray region. However, this method needs a micro-focused X-ray source or a well-collimated X-ray beam (order of a few micro-radians).

The experiments were carried out at BL24XU. The X-ray beam was expanded and collimated by asymmetric reflections of silicon single crystals. X-rays with the energy of 15 keV were monochromatized by the beamline monochromator. The X-ray beam in size of about 5×5 mm^2 was obtained by adopting successive and asymmetric reflections, two times 115 (+, -) reflections from Si (001)-surface crystals, in both horizontally and vertically directions. The asymmetric factor was about 0.2. The beam divergence was 4 arcsec. This value was determined by the combination of the slit size and crystal nature. The sample was mounted at downstream of the last crystal, and an image detector (an X-ray camera, an X-ray film or a nuclear emulsion) was put about 4 m apart from the sample. This system enables us to take images of samples in real time. We confirmed that the boundary structures in refraction contrast images were clearly seen with higher contrast than those of absorption images.

In order to get the wider field of view and to eliminate the background noise, the scanning method was also tried. The X-rays with the energy of 25 keV was chosen by the monochromator. The beam was expanded in horizontal direction by two times 117 (+, -) asymmetric reflections of the Si (001)-surface crystals. In vertical direction, the beam was collimated by a slit of 0.5 mm mounted at about 65 m downstream of the X-ray source. To obtain the wide field of view, the sample and the image sensor, here an X-ray film, were synchronously moved in vertically direction. Figure 1 shows an image of a part of a nude mouse taken with scan speed of 2 mm/sec. The distance between the sample and the X-ray film is about 4 m. Lung structures are clearly seen at a left part in figure 1.

This method may be more useful for high energy X-ray imaging because of the X-ray energy becomes higher, the crystal alignment becomes more difficult.

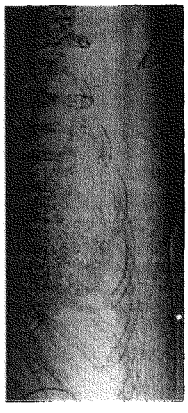

Figure 1. Refraction contrast image of a nude mouse.

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