Development of Parallel X-ray Microbeam and Its Applications

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The parallel X-ray microbeam has been produced at BL24XU for analysis of the strain in a very local area of the electron devices. The X-ray beam was compressed and collimated by asymmetric reflections of silicon single crystals as shown in Fig. 1. X-rays with the energy of 15 keV were monochromatized by the beamline monochromator. The X-ray beam in size of about 7×5 μm^2 was obtained at sample position by adopting 115 (+, -) successive asymmetric reflections, from Si (001)-surface crystals, in both horizontal and vertical directions. The asymmetry factor was about 0.2. The beam divergence was 1.8 arcsec. This value was determined by combining slit size and crystal nature. The beam size obtained was consistent with the calculations considering the compressed beam divergence.

Using this beam, we evaluated the strain induced by field oxidation in silicon wafers by the reciprocal lattice mapping method. Fig. 2(a) shows a 400 reflection reciprocal lattice map resulted from a silicon region and Fig. 2(b) shows that from near field oxide edge. Some streaky intensity distribution due to a dynamical effect of the X-ray diffraction, being elongated in the radial direction from the reflection point, is clearly seen in Fig. 2(a), which means that crystallinity in the silicon region is much perfect. Many peaks which are angularly spaced about 1.4 arcsec apart from each other are clearly seen in Fig. 2(b). We can see from this result that the discrete distributions of directions of lattice surfaces are near field oxide edge.

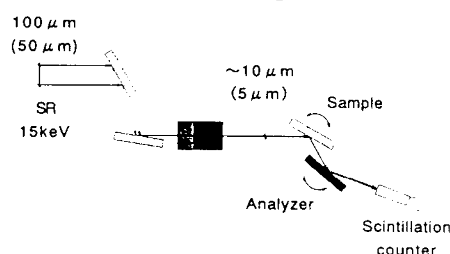

Fig. 1 Optical system of formation of parallel X-ray microbeam.

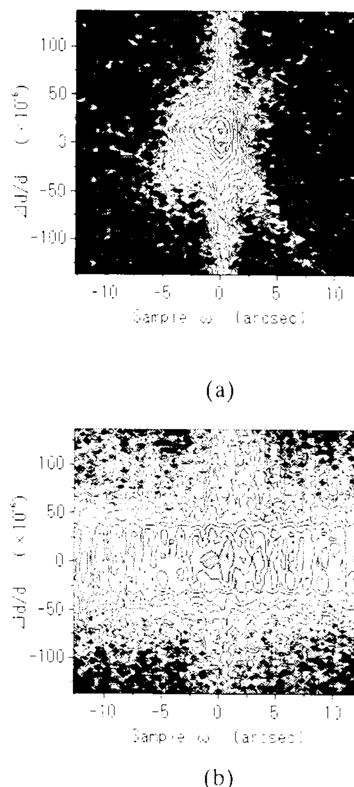

Fig. 2 Reciprocal lattice maps. (a) silicon reagion. (b) near field oxide edge.