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Determination of Strain Gradient of Bent Crystal by Measuring Rocking Curves

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We report on the determination of strain gradient β of a Si bent crystal by measuring the angle difference $\Delta\theta$ from the peak of the diffracted beam (P_h) to that of the transmitted beam (P_t) in the Bragg mode.

The experiments were carried out using X-rays from synchrotron radiation at the bending magnet beam line BL-15C, Photon Factory, KEK. The optical system is shown in Fig.1 (b). The X-rays were σ-polarized and the energy was tuned at 11100 eV. After Slit 1, the first crystal was set as a collimator. The Si plane parallel crystal (50 mm long, 15 mm wide and 0.28 mm thick) was bent with displacement *D* at one end and the other end fixed as shown in Fig. 1(a). The beams P_h and P_t were measured by the scintillation counters (SC1 and SC2). The interference fringes of mirage diffraction $P_m^{<n>}$ (IFMD) were measured by moving Slit 3 in front of SC1.

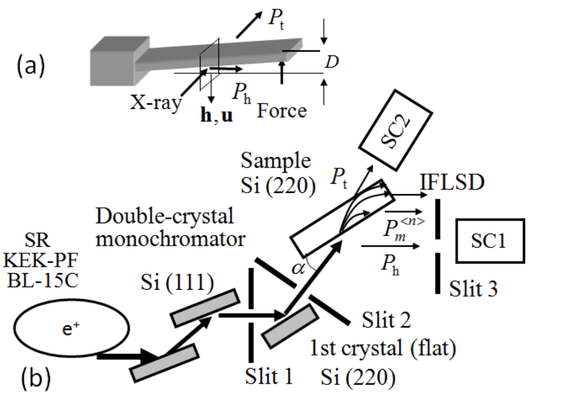

Fig. 1: (a) Geometry of sample and X-ray. (b) Schematic diagram of the optical system with double crystal diffractometer in (+,-) configuration.

The rocking curves of P_h, P_t and IFMD were measured for various *D*. Fig. 2(a) shows the measured IFMD for three values of *D*. *x* is the distance from the incident point to the emitted point of the beam. The spacing of IFMD becomes small as *D* increases. β was determined by measuring IFMD according to ref. [1]. β linearly increases as *D* increases (Fig. 2(b)). Fig. 3(a) shows the measured rocking curves of P_h and P_t for the same values of *D*. $\Delta\theta$ increases as *D* increases (inset table of Fig. 3(b)).

The mirage diffraction beam is excited at the angle outside the total reflection region in a bent crystal. When it is excited, the corresponding refracted beam does not cause the transmitted beam as shown in Fig. 1(b). If *D* increases, the angle width of the mirage diffraction beam becomes large and $\Delta\theta$ becomes large, as the mirage diffraction is observed between P_h and P_t.

The measurement of rocking curves should be very useful for determination of the strain gradient, as the measurement is easier than that of IFMD.

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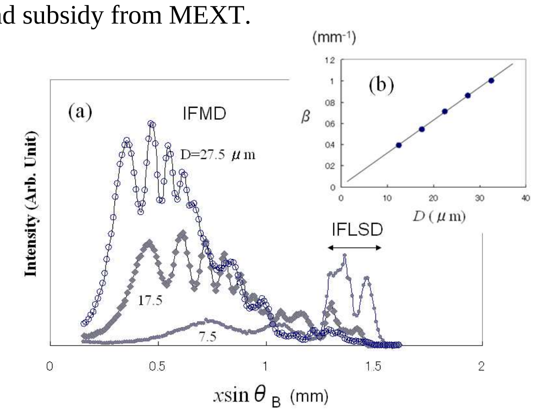

Fig. 2: (a) Intensities of IFMD and IFLSD (interference fringes in the beam emitted from the lateral surface) as a function $x\sin\theta_B$. (b) Relation between *D* and β.

(b)

	D(μm)	β(mm-1)	Δθ(sec)
Pt1	7.5	0.22	3.25
Pt2	17.5	0.54	4.25
Pt3	27.5	0.86	5.25

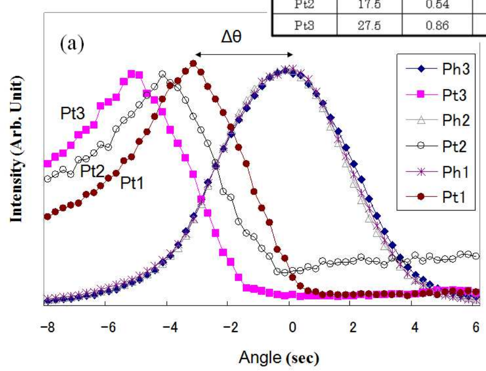

Fig. 3: (a) Measured rocking curves of P_h and P_t of Si 220. (b) Values of β and $\Delta\theta$ in P_t as a function of *D*.

References

[1] S. Jongsukswat *et al*., Jpn. J. Appl. Phys. **51**, 076702, (2012).

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