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X-ray interference fringes in transmitted beam of Bragg mode from weakly bent crystal

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We report on the observation of a novel X-ray interference fringe in the transmitted beam of the Bragg mode from a weakly bent crystal.

It is possible to know trajectories of the refracted beams by observing interference fringes in the section topography from a plane-parallel crystal in the Bragg mode. Figure 1 shows the beam geometry in the Bragg mode. In an unbent perfect crystal, the beam trajectory is linear as shown in Fig. 1(a).When an anomalous transmission effect is dominant, the refracted beam disperses in the Borrmann triangle even if the dispersion angle of the incident beam is less than 1 arcsec and the incident beam is regarded as a quasi-plane wave. Since the refracted beams disperse as a spherical wave, the interference between the refracted beams in the BL mode and that in the BBL mode occurs, as shown in Fig. 1(a). This interference fringe is called the multiple Bragg-Laue (MBL) fringes [1]. In a bent crystal, the interference fringes called mirage fringes are produced by interference between two refracted beams of hyperbolic form [2-4], as shown in Fig. 1(b).

The diffraction experiments of Si 220 were carried out at the bending magnet beam line BL-15C, KEK-PF. X-rays were σ-polarized and monochromated using a Si 111 double-crystal monochiromator. The X-ray energy was 11100 $\pm$ 0.5 eV. The geometry of X-rays and the sample is shown in Fig. 2.

When the distortion decreases, the interference fringe between a mirage beam and a reflected beam from the bottom surface (IFMRB) appears instead of the mirage fringe [5], as shown in Fig. 3(a). When the IFMRB appears, a novel interference fringe was observed in the transmitted beam as shown in Fig. 3(b). We call this new type of fringe as the interference fringe in the transmitted beam (IFTB). This fringe is caused by interference between the refracted beams in the BB and BB^3 modes, as shown in Fig. 1(c). When this fringe was observed, MBL fringes were also observed from the lateral surface located 14 mm from the incident point of X-rays. The X-ray propagates over a long distance in the crystal.

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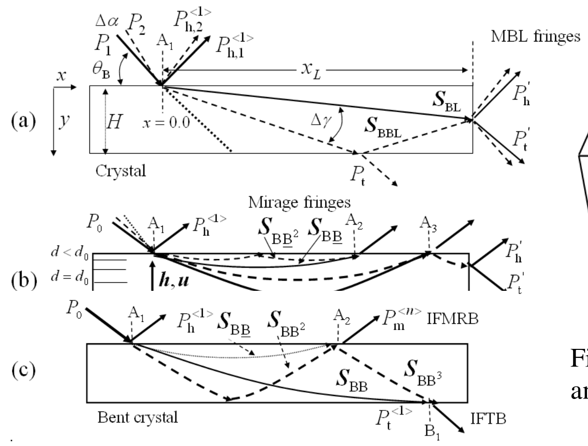

Fig. 1. Beam geometries in a perfect crystal when it is unbent (a), and it is bent (b, c).

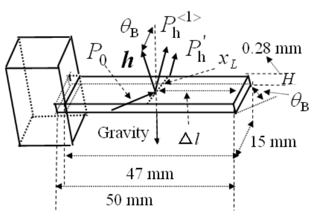

Fig. 2. Geometry of X-rays and the sample.

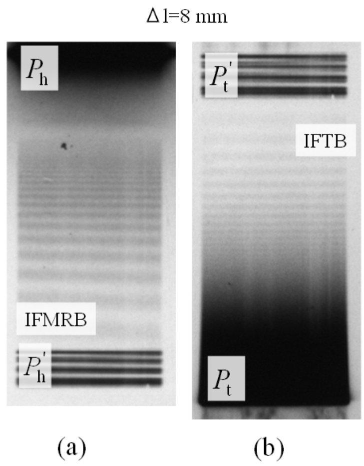

Fig. 3. Section topographies of Bragg mode. $x_L = 6.6\,\mathrm{mm}$.
(a) IFMRB. (b)IFTB.