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Observation of X-ray mirage fringes from cantilever loaded crystal

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We report on the observations of X-ray mirage interference fringes from a cantilever loaded Si crystal of 50 mm long, 15 mm wide and 0.28 mm thick.

It is possible to understand the mirage diffraction from a weakly distorted crystal on the basis of the conventional dynamical theory of diffraction [1-3]. In a bent crystal, the interference fringes called mirage fringes [4] are formed by interference between two refracted beams whose trajectories are of hyperbolic forms, as shown in Fig. 1(a) [2]. When an anomalous transmission is dominant, the interference occurs as the refracted beams disperse and propagate as a spherical wave 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 [3,5].

The diffraction experiments of Si 220 were carried out using X-rays from the synchrotron radiation at the bending magnet beam line BL-15C, KEK-PF. X-rays were σ-polarized and monochromated using a Si 111 double-crystal monochromator. The X-ray energy was 11100 ± 0.5 eV.

The period of mirage fringes strongly depends on the crystal distortion, and decreases as the distortion increases. Figure 2 shows mirage fringes when the cantilever displacement D was 2 μm (a), when D=0 μm (b), and when the cantilever is not loaded and D= -2 μm.

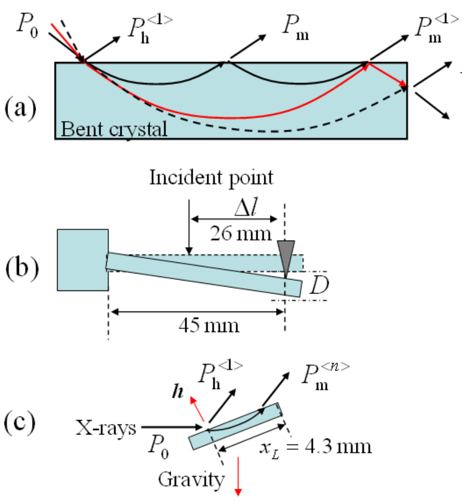

Fig. 1. (a) Beam geometries in a bent crystal. (b) Sample and bending jig. (c) Cross sectional side view of geometry of X-rays and the sample.

Mirage fringes are observed in all the topographies in Fig. 2. The period of the fringes in (c) is shorter than that in Fig. 2(b) and is approximately the same as that in Fig. 2(a). The fourth fringe in Fig. 2(a) is clearer than that in Fig.2(c). The mirage fringes in Fig. 2(c) are formed when the uniformly distributed load is applied by gravity. It is very interesting to know why the distortion increases when no cantilever load is applied, which will be our future work.

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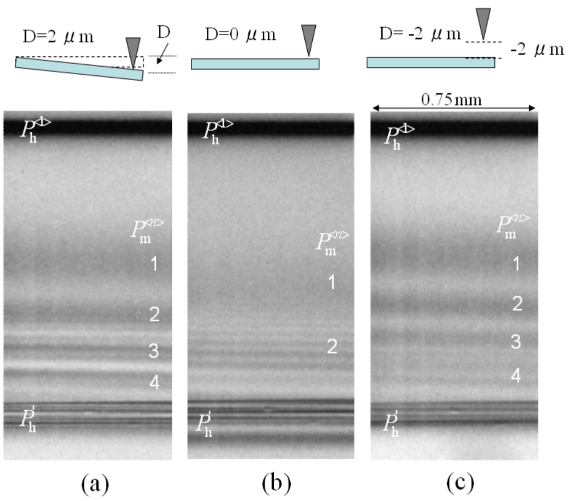

Fig. 2. Section topographies of Si 220. $P_h^{<1>}$ is the intensity of the primary diffracted beam, $P_m^{<n>}$ that of mirage fringe and $P_h^{'}$ that of the emitted beam from lateral surface.

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