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Interference Fringes of Multiple Bragg-Bragg Mode from Very Weakly Bent Crystal

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We report on the observation of interference fringes of multiple Bragg-Bragg mode (IFMBB) from a very weakly bent plane-parallel Si crystal due to gravity.

Under the anomalous transmission condition, a trajectory of the refracted beam (i.e., the beam corresponds to the Poynting vector) shows a hyperbolic form in a weakly bent crystal. Figure 1 shows such trajectories when the strain gradient β is negative. As the refracted beam propagates along a concave curve, the mirage diffraction does not occur. Instead, two refracted beams $\boldsymbol{S}_1$ and $\boldsymbol{S}_3$ interfere with each other to produce IFMBB at A_3 on the top surface, where $\boldsymbol{S}_1$ is the beam once reflected from the bottom surface and $\boldsymbol{S}_3$ is twice reflected from the bottom surface and once reflected from the top surface. The transmitted beams $\boldsymbol{S}_0$ and $\boldsymbol{S}_2$ from B_3 interfere with each other and produce the interference fringes in the transmitted beam (IFTB) [1]. From the lateral surface, the emitted beams show two types of interference fringes, one emitted in the direction of the diffracted beam (IFLSD) and the other in the direction of the transmitted beam (IFLST) [2], as shown in Fig. 1.

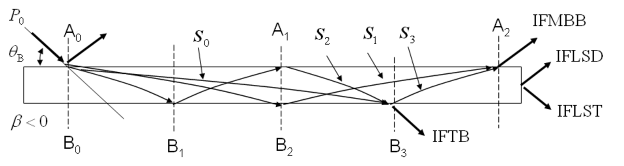

Fig. 1: Beam trajectories in a weakly bent crystal when strain gradient β is negative.

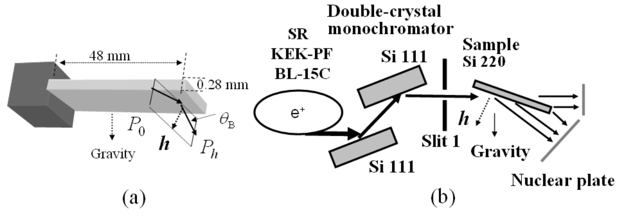

Fig. 2: (a)The geometry of X-rays and the sample and (b) a schematic diagram of the measuring system.

Figure 2(a) shows the geometry of X-rays and the sample and 2(b) a schematic diagram of the measuring system. The experiments carried out using X-rays from the synchrotron radiation at the bending magnet beam line BL-15C, Photon Factory, KEK. The beam intensities were recorded on the nuclear plate.

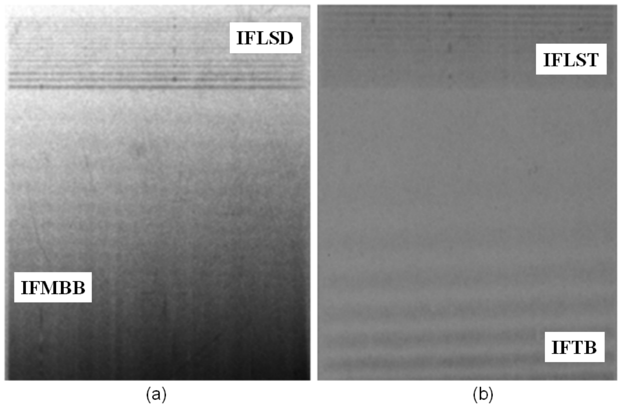

Fig.3: (a) Section topography measured in the direction of the diffracted beam and (b) that in the direction of the transmitted beam.

The left of Figure 3(a) shows the section topography measured in the direction of the diffracted beam and 3(b) the right shows that in the direction of the transmitted beam. It is clearly observed that the fringe spacing of IFMBB is smaller than that of IFTB and becomes large as the distance from the incident point A_0 to the emitted point A_2 increases, as shown in Fig.1. It is noted that when $\beta < 0$, IFMBB should be useful for analysing the strain in a crystal and designing a high resolution X-ray analyser, which is the same as the mirage interference fringes [3].

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References

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