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Observation of X-ray Interference Fringe in Bragg-(Bragg)m-Laue Case from Thin Finite Crystal

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In the Bragg case of an absorbing thin crystal, it has been confirmed experimentally [1,2] that part of the incident X-rays are confined in the crystal at a certain angle when the absorption factor is effectively diminished by the dynamical effect (Borrmann effect). In the thin finite crystal as shown in Fig. 1, the confined X-rays can come out from the side edge. The diffraction condition in Fig. 1 is called as "Bragg-(Bragg)m-Laue case" (BBmL case for short). The first "Bragg" means the first diffraction in the Bragg case, the second "(Bragg)m" a sequence of "m" diffractions in the region between the top and bottom surfaces of the crystal and the final "Laue" the last diffraction in the Laue case before emitting from the edge. The experiment was carried out at beam line 15C, Photon factory (PF), KEK, Japan. X-rays from synchrotron radiation were monochromated by a Si 111 double crystal monochromater and Ge 220 monochromater, σ-polarization was used. The used X-ray energy was 11100±0.5eV which was 3eV below the Ge K-absorption edge (11103eV). The vertical and horizontal widths of the incident beam are 25 and 500μm respectively. The distance between the incident point of X-rays and edge of the crystal L is 907μm. The photographs of the 220 reflection from the Ge thin crystal whose thickness is 32μm are shown in Fig. 2. The upper part shows the transmitted beam (IT) and the emitted beam (IT') from the side edge of the crystal in the transmission direction. The lower part shows the reflection beam (IR) and the emitted beam in the reflecting direction (IR'). The interference fringes can be seen in IT' and IR'. The photographs show: 1) The period of the fringe in IR' is smaller and that in IT' is larger in each upper side. 2) The period increases as distance L increases. 3) It decreases when the crystal thickness increases.

It is possible to calculate the rate of X-ray confinement in the thin crystal by the resonant dynamical theory [3], but it is still not easy to analyze the flux of the confined X-rays. Quantitative analysis of the origin of the interference fringe in BBmL case should be a future work. It is noted that many applications to precise X-ray optics such as those seen in the interference fringe of an X-ray interferometer would be expected, once the origin is fully analyzed.

References

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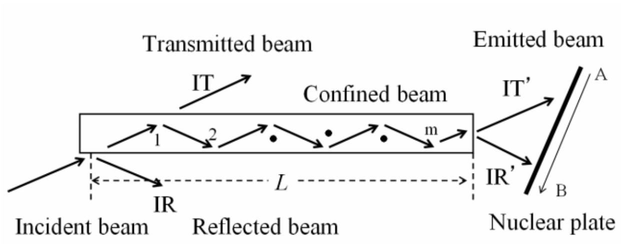

Fig. 1. Schematic diagram of Bragg-(Bragg)m-Laue case.

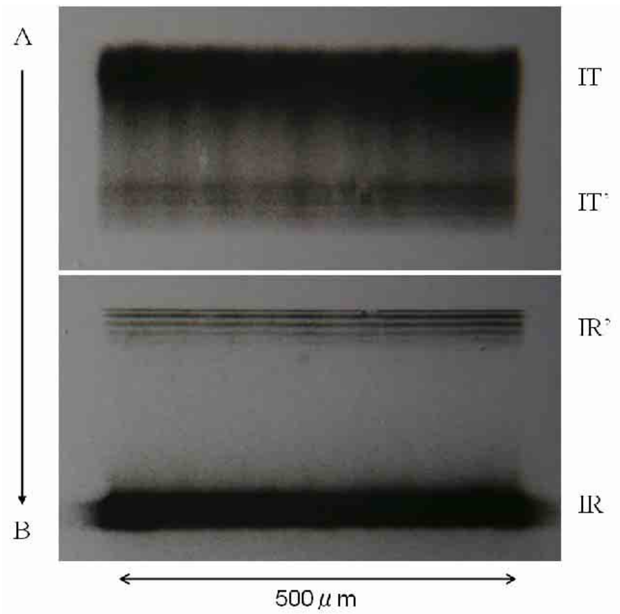

Fig. 2. Photographs of IT and IT' (upper part) and IR and IR' (lower part).