Static Speckle Patterns in Diffracted X-rays from a Mosaic Crystal

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Recently coherent X-rays have been used successfully in X-ray diffraction experiments, such as in X-ray speckle pattern observation. This report describes transport and deformation of the transverse coherence of synchrotron radiations during the Bragg diffraction of crystals.

Experiments were performed using 1.39 Å synchrotron radiation X-rays from a normal bending magnet source, BL-3A. Experimental set-up was similar to those in previous works.[1, 2)] Angular divergence of the SR was limited to approximately 10^{-5} rad. by using 100 mm slits and pin-holes set 10-15 m apart. Transverse coherence was characterized by measuring the Fraunhofer diffraction patterns of the pin-holes. Partially coherent X-rays passing through the pin-hole were used in Bragg diffraction experiments of single crystals of two type, a nearly perfect crystal and a mosaic crystal, which were set 10 cm down stream from the pin-hole. Diffracted X-ray intensity distributions were recorded on nuclear emulsion photoplates.

Figure 1 shows the Fraunhofer diffraction pattern from the 5 mm f pin-hole. Higher order interference fringes are clearly observed. This observation indicates that the transverse coherence length was larger than the diameter of the pin-hole. Figure 2 shows the Bragg diffraction pattern of the dislocation-free CZ-Silicon 400 reflection. Interference patterns are still observed clearly. This shows that the coherence of the X-rays was not destroyed by the Bragg diffraction of the nearly perfect crystal. The 200 Bragg diffraction pattern from the mosaic Cu(Fe) crystal is shown in Fig. 3, where co-circular interference patterns are not observed anymore, and the speckle patterns are observed. These speckle patterns were not observed when the larger pin-hole such as 20 mm f was used.

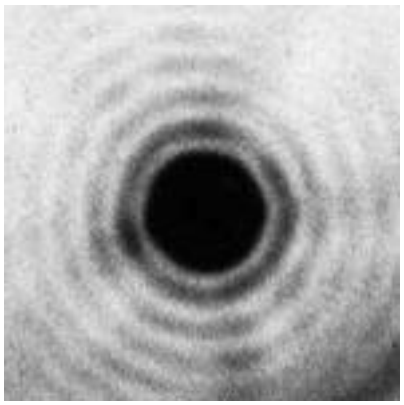

Fig. 1.
Fraunhofer diffraction pattern of 1.39 Å X-rays from a 5 mm f pin-hole recorded on the photoplate set 1010 mm apart from the pin-hole.

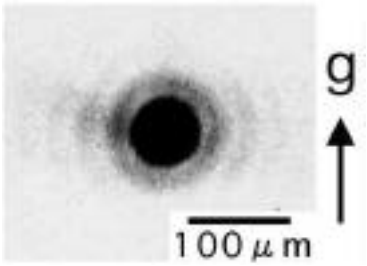

Fig. 2.
Bragg diffraction pattern of Si (400) reflection with X-ray passing through the 5 mm f pin-hole. The distance between the sample crystal and the photoplate were 900 mm.

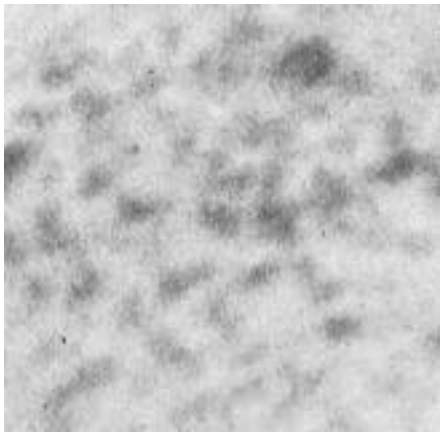

Fig. 3.
Bragg diffraction pattern of Cu(Fe) (200) reflection with X-ray passing through the 10 mm f pin-hole. The distance between the sample crystal and the photoplate were 900 mm.

Reference

1) S. Iida, K. Harada, S. Sasaki and T. Mori: Photon Factory Activity Report **#13** (1995) p. 25.
2) S. Iida , K. Ishikawa, S. Sasaki, F. Saito, T. Mori and K. Mori: Photon Factory Activity Report **#16** (1998) p. 105.