ESRF	**Experiment title:** X-ray topography using the three-beam cases of interference in the Bragg-Laue diffraction geometry	**Experiment number:** HS 558
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Shifts: 18	**Local contact(s):** Frank Heyroth	*Received at ESRF:* 2 6 MAR. 1998

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Report:

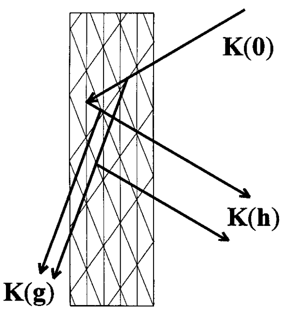


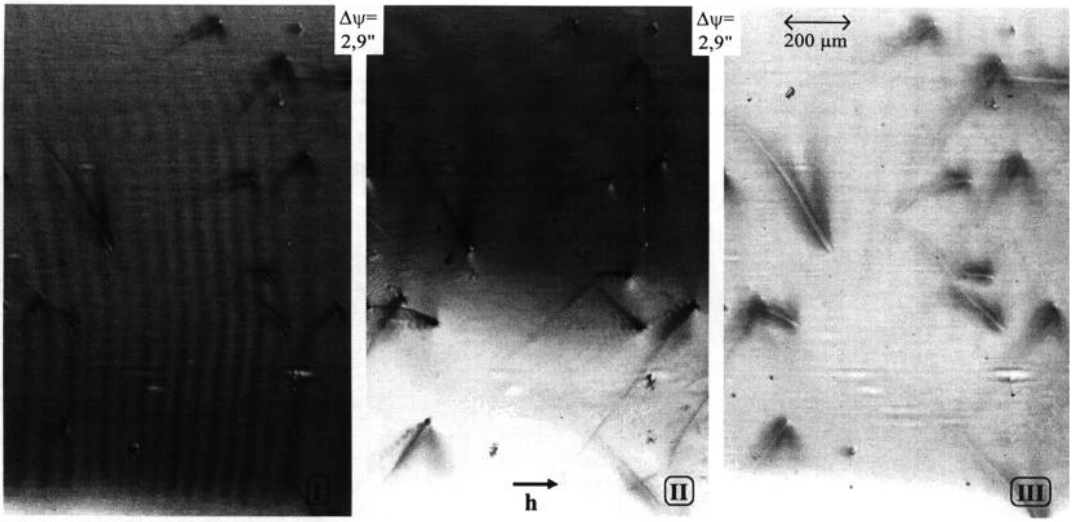
Fig. 1: three-beam case in the direct space (crystal)

The aim of this experiment was the first investigation of the topographic contrast of dislocations using the three-beam case in Bragg-Laue diffraction geometry. In the three-beam case, two reflections h and g are simultaneously excited and three strong wave fields K(O), **K(h), K(g)** exist inside the crystal. /l/ The directly excited wave diffracted by the lattice planes of **h** and the detour excited wave successively reflected on the lattice planes of g and **h - g** propagate in the same direction. **(h** - g describes the Umweg wave inside the crystal.) Owing to the coherent excitation of all internal waves it comes to interference effects between these waves, a complicated standing wave field is created inside the crystal. For the systematical investigation of such a case, a ψ - rotation (a rotation around one of the primary diffraction vectors e.g. **h)** was used.

The h and g reflections were arranged in the Bragg (reflection)- and the Laue (transmission)-geometries respectively. With this experimental setup we could take several series of plane wave topographs in different three-beam interferences. The control parameter was the ψ - position of the crystal.

For a single Bragg reflection the penetration length of the waves inside the crystal corresponds to the extinction length. Beyond this distance in the crystal the whole intensity is reflected. /2/ This is no more valid in the Bragg-Laue three-beam geometry. In this case, the Bragg reflection on h is coupled with the Laue transmission on g over h - g and a larger crystal thickness can contribute to the intensity of the Bragg reflection.

Despite the fact that all the results are still under analysis as this experiment ended only one month ago, we can already say: The penetration (information) depth of the Bragg reflected beam is a function of the excitation of the three-beam case. New contrast phenomena in the dislocation images were found. The most characteristic ones are intensity oscillations produced around the dislocations, especially for the ψ positions with a constructive interference between the direct and Umweg-waves (compare for instance Fig. 2). The detailed interpretation of the data is not finished at present.



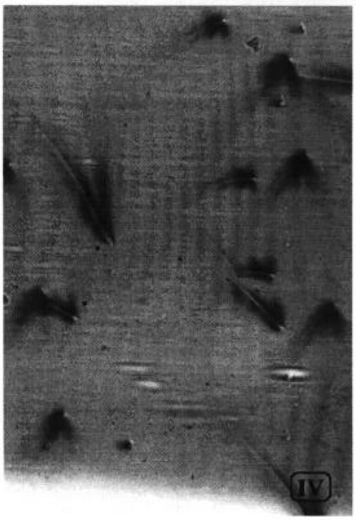


Fig. 2: Example of the contrast change of dislocations in quasi plane wave topographs, when scanning through the three-beam case: h=(335);g=(113);h-g=(242). The h-reflection is arranged in Bragg-geometry; the g-reflection in Laue-geometry. A quasi-monochromatic incident beam ($\lambda \approx 0.75$Å) on a silicon crystal plate with a (111) surface was used.

I-III topographs from the h-reflection of the three-beam case taken at different distances ψ away from the exact excited position. The black-white contrast jump in image II can be related to the exact three-beam position.

IV corresponding monochromatic topograph in the two-beam case for h = (335)

All the presented images were taken under the same experimental conditions.

references

/l/ Heyroth, F.; Eisenschmidt, C. & Höche, H.R. (1998) „X-ray Topography of Perfect Crystals using the Laue-Laue Three-beam case of Diffraction“ Cryst. Res. Technol. 33,545-552.

/2/ Bedynska, T.; Bubakova, R. & Sourek, Z. (1976) „Comparison between Experimental and Theoretical dislocation image for the Bragg case“ Phys. Stat. Sol. A36,509-516.