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High-quality Diffraction Topography by Resonant Scattering

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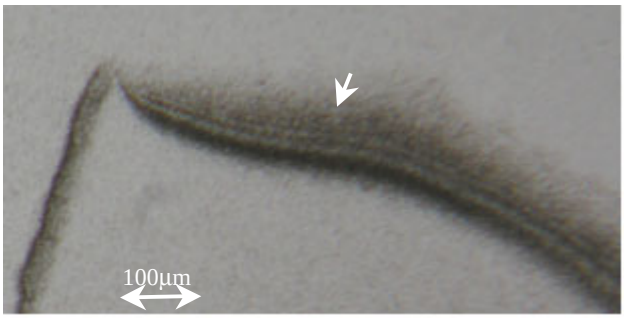
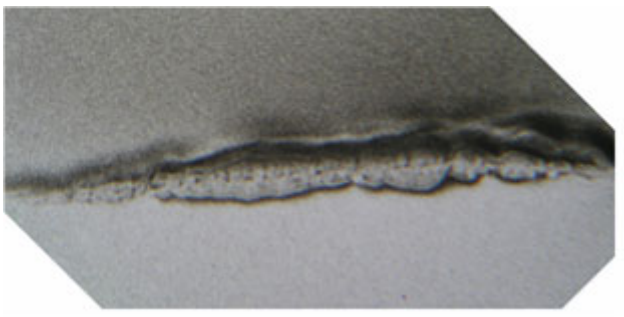
It has been reported that topographic images are blurred due to Borrmann effect when $|\chi_{hi}|$ is large, and that the contrasts of the images become clear when $|\chi_{hi}|$ is negligibly small [1]. Here χ_{hr} and χ_{hi} are the real and imaginary parts of Fourier coefficients of X-ray polarizability $\chi(\boldsymbol{r})$. It should be interesting to observe distinct topographic images at the condition that only $|\chi_{hr}|$ contributes to them. We will report on the comparison between topographic images by resonant scattering with only χ_{hr} and those with only χ_{hi}, and on the high-quality images of the former.

The experiment was carried out at the beam line 15C, Photon Factory, KEK. The X-rays from synchrotron radiation were monochromated by a Si 111 double crystal monochromator and were incident on a GaAs single crystal. The topographs were taken on a nuclear plate set at 20mm behind the crystal and by a scintillation counter set at 150mm backward. The sample is a very low Si-doped GaAs crystal with its EPD value less than 500/cm^2.

Just below the Ga K-absorption edge, $|\chi_{hi}|$ is zero for GaAs200 reflection [2]. Diffraction topographs measured at this condition are shown in Fig. 1. The defect image in Fig. 1(a) is very clear and interference fringes are seen as indicated by an arrow. The defect image observed in Fig. 1(b), which is attributed to be an edge dislocation, shows fine structures in it. Fig. 2 shows diffraction topographs taken at the energy where $|\chi_{hr}|$ is zero and only $|\chi_{hi}|$ contributes to the diffraction. Figs. 2(a) and (b) show the images from the same area as those in Figs. 1(a) and (b), respectively. The image in Fig. 2(a) is blurred and no interference fringe can be seen. The image in Fig. 2(b) is also blurred and no fine structure can be clearly seen. These results show that topographs by resonant scattering with only $|\chi_{hr}|$ give rise to not only clear images of defects but also interference fringes due to local strain caused by the defects. Thus such high-quality topographs are potentially quite useful for detail analysis of defects and the properties of the defects such as local strain.



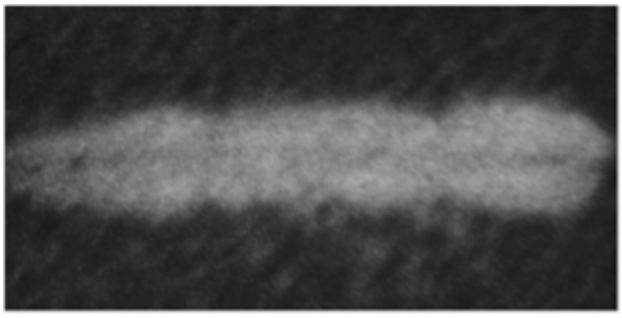
(a)



(b)

Fig.1: The observed topographs by only χ_{hr}.

(a)



(b)

Fig. 2: The observed topographs by only χ_{hi}.

[1] R. Negishi et al., Jpn. J. Appl. Phys. 40, L884(2001).
[2] R. Negishi et al., J. Synchrotron Rad. 11, 266(2004).
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