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Study for direction of Burgers vector by resonant scattering X-ray topography

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Recently, we have taken resonant scattering topographs for a GaAs crystal with the 200 reflection using synchrotron radiation near K-absorption edges of Ga and As[1]. As shown in Fig.1, values of u and v, which are parameters describing X-ray polarizability, change from –1 to 1 with change of the incident X-ray energy. The variations of contrasts in lattice defect images, reflecting characteristics of $(u, v) = (1,0)$, $(-1,0)$, $(0,-1)$ and $(0,1)$, were reported in reference [1]. In this report, we present results of the correlation between the sign change of v and Burgers vector $\boldsymbol{b}$. The optical system for the experiment is the same as that in [1]. Fig.2 shows topographs recorded for 020 and 220 reflections at the energy indicated by A in Fig.1, respectively. The darker region corresponds to the stronger intensity. Consequently, $\boldsymbol{b}$ is located in a plane perpendicular to $\boldsymbol{h}_{110}$, and this can be confirmed by the disappearance of an image indicated by a white arrow in Fig.2 (b).

The calculated rocking curves, corresponding to points B with $(u, v) = (0,-1)$ and D with $(0, 1)$ in Fig.1, are shown in Fig.3 (a) and (b). The transmitted rocking curve (P_d) is asymmetric with respect to the exact Bragg angle, although the diffracted one (P_h) is symmetric, and the both exhibit Borrmann effect conspicuously. There is a tail at higher angle side of the transmitted rocking curve in (a), but at lower angle side in (b).

The transmitted-beam images recorded at the conditions corresponding to the points of B and D are shown in Figs.4 (a) and (b). The images of the lattice defects turn into double white lines, because that Borrmann effect is disturbed by the shift of Bragg angle in the region with distorted lattices. It is noted that the image contrasts of the double line in the region enclosed by , the left side is brighter than the right side in (a), but the right side is brighter in (b). Although the contrast difference is much smaller in than that in , it still can be seen in that the left-upper side of the double lines is brighter in (a), and the right-lower side is brighter in (b). The lattice defect images comprising of double lines suggest that the defects belong to an edge dislocation. According to the changes in the contrasts of the left-upper and right-lower of the double line inside , it can be concluded that the direction of $\boldsymbol{b}$ is $[\bar{1}10]$, parallel to the crystal surface (paper surface) as indicated by the black-bold arrow. Here, $\boldsymbol{b}$ is defined by FS/RH (Finish Start/Right-Hand). On the other hand, as to the defect regions enclosed in , reflection surface at the left part in the double lines bends this side with respect to the reflection surface for the exact Bragg angle, but that at the right part bends the opposite side, and then the direction of $\boldsymbol{b}$ is estimated to be $[\bar{1}01]$. According to the aforementioned discussion, it is clear that direction of Burgers vector $\boldsymbol{b}$ can be determined by using contrast changes caused by sign change of v known as an effect of resonant scattering dynamical diffraction.

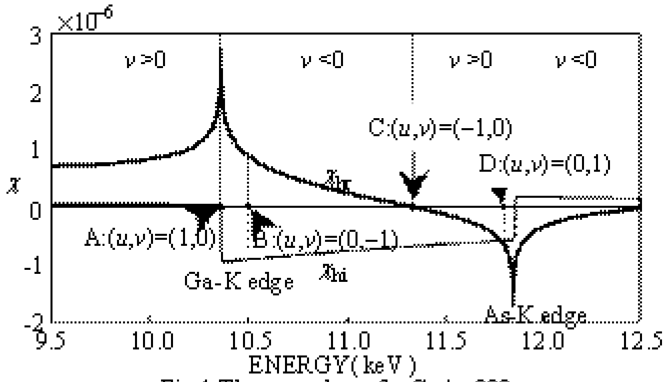

Fig.1 The χ_{hr} and χ_{hi} for GaAs 200.

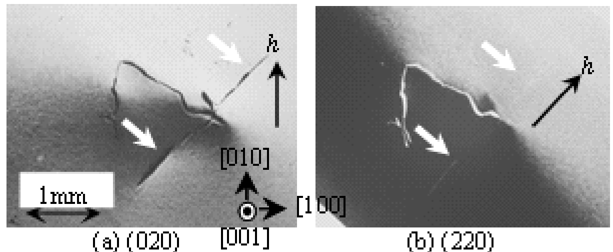

Fig.2 The diffracted images at the point A, where h is reciprocal lattice vector.

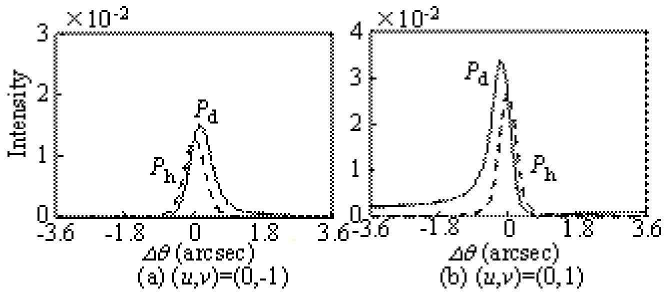

Fig.3 The calculated rocking curves of GaAs200 with crystal thickness 121 μm.

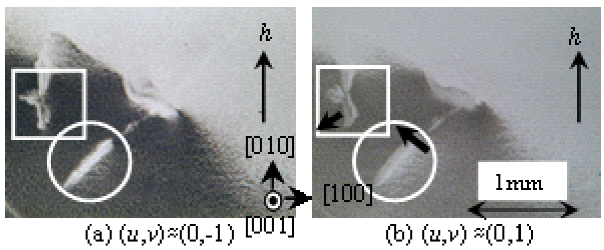

Fig.4 The transmitted-images.

References

[1] R. Negishi et al., Jpn. J. Appl. Phys. 40, L884 (2001).

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