Three-dimensional characterization of defects in synthetic diamond by means of synchrotron X-ray topography

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Diamond crystal is a promising material for electronic device for high-current or optical device for synchrotron X-ray under heavy loading because of high thermal conductivity. Recently, nearly perfect crystals of diamond were supplied from the Sumitomo Electric Industries using high temperature high pressure method. We have observed defects in a synthetic diamond crystal using step-scanning topography with monochromatic X-rays and examined the features of defect images reconstructed by stacking about 200 shots of sectional topographs in three-dimensions. The topographs were obtained from 004 reflection and four equivalent 111 and 12 12 8 reflections with an asymmetric Laue case using 17.7 or 23.8 (004) keV X-rays during the top-up operation of the synchrotron storage ring. In conventional topography, it is impossible to take useful topographs under certain diffraction condition that the diffraction plane is orthogonal to the plane defect, because plane defects are observed as a penetration line in the topograph images. However, the reconstructed topography images clearly show the plane defects under the above condition. Figure 1 shows the cross section of the reconstructed image parallel to the (1-10) plane. Line images on (111) and (33-2) were observed in Fig.1. Figure 2 (a) and (b) show the cross section parallel to the (1-11) plane obtained from sectional topographs of the (1-11) and (-111) reflections, respectively. Image of defects on (111) was invisible in Fig.2 (a) in contrast with Fig.2 (b). Therefore, plane defect on (111) was identified to be a stacking fault. In the same way, defect on (33-2) was identified to be a growth mark.

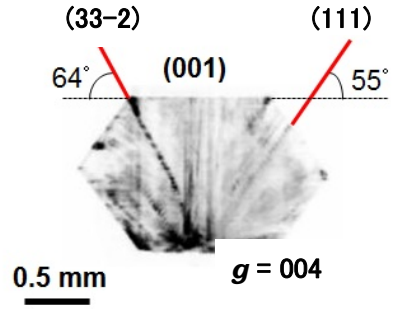

Fig. 1. Cross section of the reconstructed three-dimensional image.

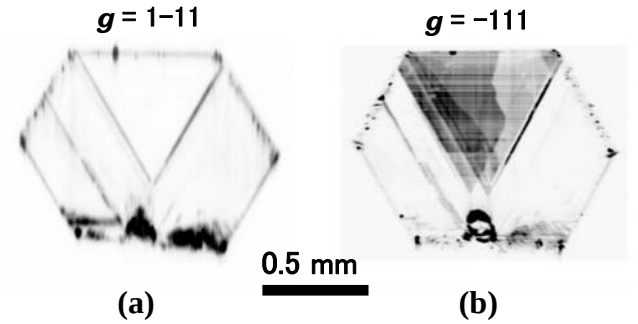

Fig. 2. (1-11) cross section of the three-dimensional image with different diffraction plane (1-11) (a) and (-111) (b).

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