Characterization of Defects in SiC Substrates for Power Device Applications by Birefringence Imaging

Harada S[1,2]*, Matsubara Y[1], Murayama K[3].
*shunta.harada@nagoya-u.jp
1 Institute of Materials and Systems for Sustainability (IMaSS), Nagoya University, Japan
2 Department of Materials Process Engineering, Nagoya University, Japan
3 Mipox Corporation, Japan

Birefringence imaging using polarized light microscope (PLM) have been utilized for the observation of crystals. Recently, defect characterization by birefringence imaging was applied to the semiconductor substrates for advanced power semiconductor materials such as SiC and GaN [1,2]. Different from silicon wafers, which was produced with dislocation-free, various kinds of defects are included in SiC wafers, which affect the performance, reliability, and yield of the SiC power devices and the non-destructive defect characterization is required. More recently, we have revealed that the PLM observation under the condition slightly deviated from the crossed-Nicol condition can image the in-plane shear stress distribution in SiC wafer [3]. In the present study, we have characterized the edge-component Burgers vector of threading dislocations in SiC wafers by PLM observation.

Figure 1 shows the PLM image and the calculated in-plane shear stress field for threading edge dislocations (TEDs) with the different direction of the Burgers vectors. The Burgers vectors of TEDs were identified by the X-ray topography observation at the same position. Although the magnitude of birefringence image intensity was varied, the characteristic features of birefringence-image contrasts were all corresponding to the calculated in-plane shear stress field. This verifies our theoretical considerations, in which the birefringence image contrast is almost proportional to the in-plane shear stress field [4]. Furthermore, the current results indicate that the XRT observation accommodating with the birefringence observation can evidently revealed the edge-component of the Burgers vector for threading dislocation since the screw component of the Burgers vector generates no in-plane shear stress around the dislocation in ideal case. Although the identification of threading mixed dislocations only in XRT is very difficult, it is possible to identify the edge-component of the Burgers vector for threading mixed dislocation combined with the PLM observation.

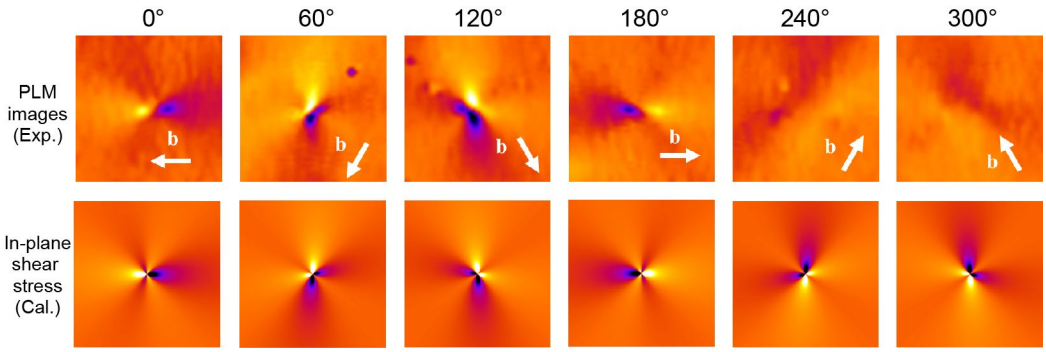

Figure 1. PLM image and calculated in-plane shear stress field for TEDs with the different direction of the Burgers vectors. Size of the images is 200 μm-square.

References

[1] Tanaka A et al. Demonstration of Observation of Dislocations in GaN by Novel Birefringence Method. Phys Status Solid (b). 2020;257:1900553.
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[3] Harada S, and Murayama K, Observation of in-plane shear stress fields in off-axis SiC wafers by birefringence imaging. J Appl Crystallogr. 2022;55:1029-1032.