

垂直 VB 成長と EFG 成長(001) β -Ga₂O₃ 結晶の X 線トポグラフィー観察 X-ray Topography Observation of Vertical Bridgman and Edge-Defined Film-fed Growth-Grown (001) Single β -Ga₂O₃ Crystals

佐賀大院工¹, 信州大工²

°(M2) ムヒドウル イスラム チャマン¹, 干川圭吾², (D2) スターン セイリブ¹, 嘉数 誠¹

Saga University¹, Shinshu Univ.²

°(M2) Muhidul Islam Chaman¹, Keigo Hoshikawa², (D2) Sayleap Sdoeung¹, Makoto Kasu^{1*},

*E-mail: kasu@cc.saga-u.ac.jp

1. Introduction

β -gallium oxide (β -Ga₂O₃) exhibits an ultrawide bandgap (4.8 eV) and a high breakdown field (8 MV/cm). Therefore, β -Ga₂O₃ is very promising for high-efficiency power devices. In addition, owing to its high growth rate, low-cost single-crystal β -Ga₂O₃ substrates can be synthesized readily using various melt growth techniques.

In this study, Synchrotron X-Ray topography (XRT) experiments were performed both in transmission and reflection geometry to determine $\mathbf{b}$ from $\mathbf{g}\cdot\mathbf{b}$ invisibility criteria for VB and EFG crystal.

2. Experimental Method

Synchrotron XRT experiments were performed using synchrotron radiation X-rays at the beamline BL09 in Kyushu Synchrotron Light Research center (SAGA-LS). We used (1) transmission geometry $\mathbf{g} = 400$ and 020 , which enabled us to observe the defect properties through the entire thickness of the crystal. (2) Reflection geometry (i) symmetric X-ray diffraction, $\mathbf{g} = 008$, enabled us to observe the defects inside the significant depth ($\sim 50 \mu\text{m}$) of the crystal, not only in the subsurface region. (ii) Asymmetric diffraction conditions, $\mathbf{g} = 603$, $\bar{1}005$, 224 , 623 , and 024 , where only the subsurface region ($\sim 10 \mu\text{m}$) could be observed.

3. Results and Discussion

Fig. 1 (a) and (b) show the XRT images at the same position of the (001) β -Ga₂O₃ VB and EFG single crystals for various $\mathbf{g}$ conditions. By using transmission and reflection geometry in synchrotron X-ray topography, we unambiguously determined the Burgers vector ($\mathbf{b}$) = [010] and [001]. For the VB crystal, screw dislocations with $\mathbf{b} = [010]$ and dislocation direction ($\mathbf{t}$) = [010] were observed. For the EFG crystal, edge dislocations with $\mathbf{b} = [001]$ and $\mathbf{t} = [010]$ were observed. In addition, wandering dislocations on the (001) plane with $\mathbf{b} = [010]$ for EFG and $\mathbf{b} = [001]$ for both EFG and VB were

observed. These phenomena indicate that the wandering dislocations were formed by a slip motion on the (001) slip plane.

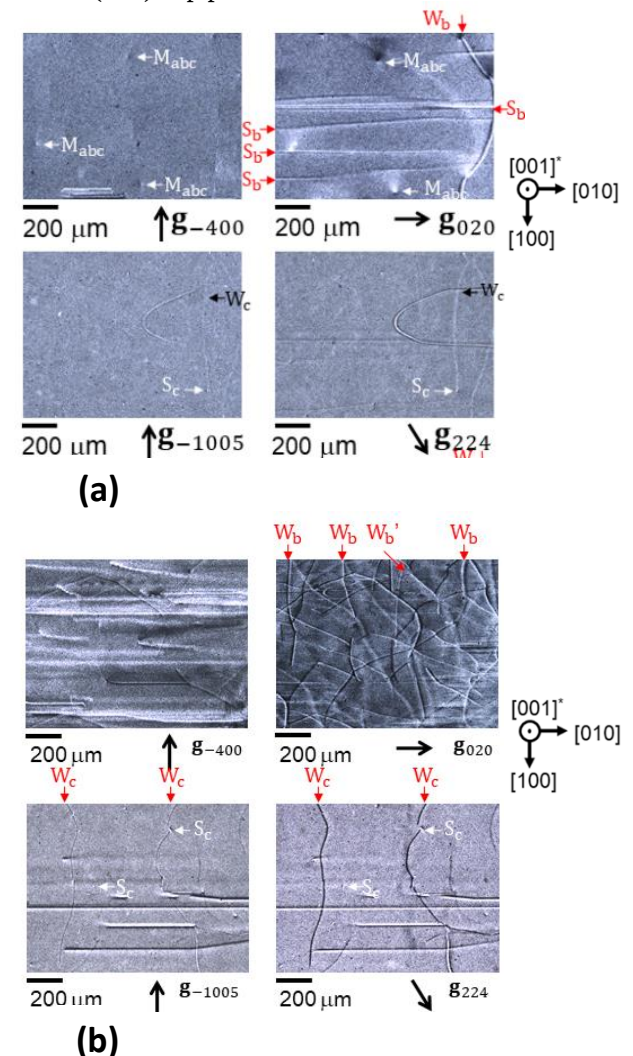


Fig. 1: X-ray topography images at the same position of the (a) VB and (b) EFG (001) β -Ga₂O₃ single-crystal wafer for $\mathbf{g} = 400, 020, \bar{1}005$, and 224 .

References

- [1] S. Masuya, K. Sasaki, A. Kuramata, S. Yamakoshi, O. Ueda, and M. Kasu, Jpn. J. Appl. Phys. **58**, 055501 (2019).