高分解能 X 線回折法による VB 成長した β-Ga_2O_3 の結晶品質評価

Crystal Quality of VB-Grown β-Ga_2O_3 Investigated by High Resolution X-ray Diffraction

佐賀大院工 [1], 信州大工 [2]

(M2) チャマン　イスラム [1], 干川圭吾 [2], ○嘉数 誠 [1]

Saga Univ.[1], Shinshu Univ. [2]

○(M2) Chaman Islam[1], Keigo Hoshikawa[2], Makoto Kasu[1*],

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

1. Introduction

Beta-Gallium Oxide (β-Ga_2O_3) is an ultra-wide band gap semiconductor material which has the bandgap energy of about 4.5 eV and breakdown electric field of about 8 MV/cm, which makes this material preferable for high-power electronic devices. Besides, large size single crystal β-Ga_2O_3 can be achieved from melt growth techniques that are economically beneficial for large-scale device fabrication. Vertical Bridgman (VB) is the preferred β-Ga_2O_3 bulk growth method [1-3], where crystals grow in low temperature gradient and arbitrary growth directions, compared with Czochralski (CZ) or Edge-defined Film-fed Growth (EFG) method. In addition, during crystal growth period of VB method, decomposition of Ga_2O_3 is suppressed and high-quality crystals grow in ambient air.

In this study, we have examined the crystal quality of VB grown β-Ga_2O_3 and compared the result with EFG grown one by X-ray diffractometer (XRD).

2. Experimental Method

VB and EFG grown (001) wafers were cut from bulk crystals and polished by chemical mechanical polishing (CMP) technique. Here, high resolution X-ray diffraction system (RIGAKU SmartLab) is used where Ge (220) 4-bounce monochromator is installed. X-ray diffraction rocking curve is measured for symmetrical and asymmetrical reflections to find out full-width at half-maximum (FWHM) values.

3. Results and Discussion

Fig. 1 shows X-ray diffraction rocking curves of the 002 symmetrical reflection for (001) VB and (001) EFG grown crystals for incident X-ray direction [010]. FWHM measured 14.04 and 15.84 arcsec, respectively and therefore, VB shows slightly better crystallinity than EFG for this condition. In Fig. 2, FWHM for X-ray incident direction of [010] were 14.76 and 14.40 arcsec, respectively; that indicates EFG is slightly better than VB.

These trends can be explained in terms of growth direction; [001] direction for VB and [010] direction for EFG.

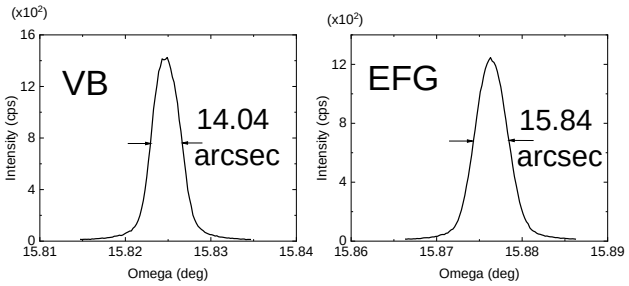

Fig. 1: X-ray rocking curves of symmetrical (002) reflection of (001) VB and EFG samples for X-ray direction of [010].

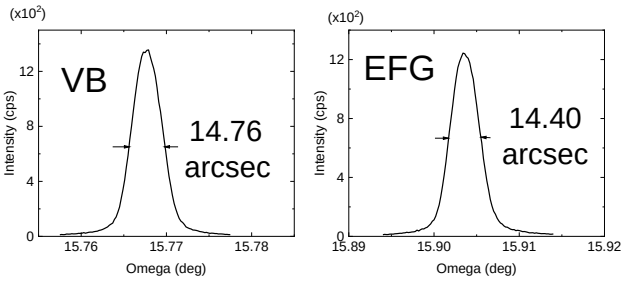

Fig. 2: X-ray rocking curves of symmetrical (002) reflection of (001) VB and EFG samples for X-ray direction of [100].

References

[1] K. Hoshikawa et al., J. Crystal Growth 447 (2016) 36.

[2] E. Ohba et al., Jpn. J. Appl. Phys. 55 (2016) 1202BF.

[3] E. Ohba et al., J. Crystal Growth 556 (2021) 125990.