高感度エミッション顕微鏡による HVPE (001) β型酸化ガリウム SBD のリーク電流の起源の同定ー多結晶欠陥

Polycrystalline Defects−Origin of Reverse Leakage Current in HVPE (001) β-Ga_2O_3 SBDs Identified by High Sensitive Emission Microscope

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1. Introduction

β-Ga_2O_3 has a bandgap of 4.43–4.8 eV, which is wider than that of SiC and GaN; hence, it can be used to develop high-efficient high-power electronic devices. Recently, Sasaki et al. developed 20 A class SBDs with a low on-resistance of 6 mΩ·cm^2.[1] However, it has been observed that in the SBDs fabricated on a single 2" wafer, some show a higher reverse current and a lower breakdown voltage than their neighbors. Therefore, in this study we investigate the killer defects that are responsible for the reverse leakage current in HVPE (001) β-Ga_2O_3 SBDs via high-sensitive emission microscopy.[2]

2. Fabrication

An n-type β-Ga_2O_3 epitaxial layer grown by HVPE on a 2" EFG-grown (001) single-crystal wafer substrate. The net donor doping density, $N_D - N_A$, is 1.4 × 10^{16} cm^{-3}. The epitaxial thickness is ca. 10 μm. For the ohmic contact, Ti/Au was evaporated on the entire back face, whereas for the Schottky barrier (SB) contacts, Ni/Au was evaporated on the surface.

3. Results and discussion

Emission microscope image of the SBD #B1205 with a 500 μm diameter with a high reverse leakage current (density) of −38 μA (−19.3 mA·cm^{-2}) at −30 V [Fig. 1(a)] shows two emission patterns, #1 and #2. AFM images [Fig. 1(b)] shows that emission pattern #1 is polycrystalline defect which contains numerous domains. In cross-sectional SEM image [Fig. 1(c)] shows a porous particle containing highly dense voids observed below the defect. In synchrotron X-ray topography [Fig. 1(d)] the polycrystalline defect was seen as a butterfly contrast.

4. Conclusion

Polycrystalline defect is found to be one of the main reverse leakage current paths of HVPE (001) β-Ga_2O_3 SBDs.

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References

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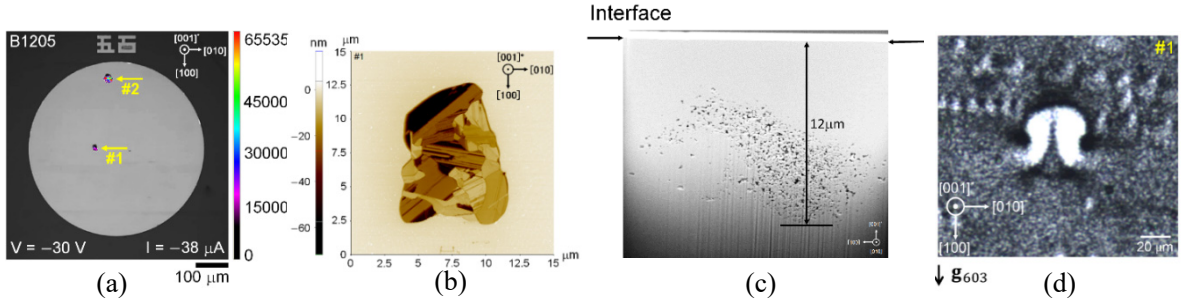

Fig. 1. (a) Emission microscope image of SBD #B1205, (b) AFM image, (c) cross-sectional SEM image, (d) synchrotron X-ray topography image of an emission pattern.