

Breakdown electric field of each layer in AlGa_N/Ga_N high-electron-mobility transistors on Si substrates

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1. Introduction

Vertical direction breakdown voltage (VDBV) of AlGa_N/Ga_N high-electron-mobility-transistors (HEMTs) on Si substrates varies depending on the characteristics of the initial AlN layer [1]. In this study, for improving the VDBV, the breakdown electric field (BEF) of each layer in AlGa_N/Ga_N HEMTs was investigated. VDBV values of samples, measured at each layer of the entire epitaxial structure by using the growth stop technique, were used for this purpose.

2. Experiments

All samples considered in this study were grown on 8-inch p-type Si substrates using the MOCVD system (Taiyo Nippon Sanso Corp., UR26K). Figure 1 shows the four types of sample structures considered in this study. Each layer of the HEMT structure had the same growth conditions; moreover, an ohmic electrode was formed on each sample under the same conditions. The VDBV was measured as the voltage that corresponds to a vertical leakage current density of 1.0×10^{-4} (A / mm²). The BEF of the AlGa_N layer was calculated by subtracting the VDBV of sample (b) from that of sample (a). Similarly, the BEF of the strained-layer superlattice (SLS) layer and Ga_N layer were calculated.

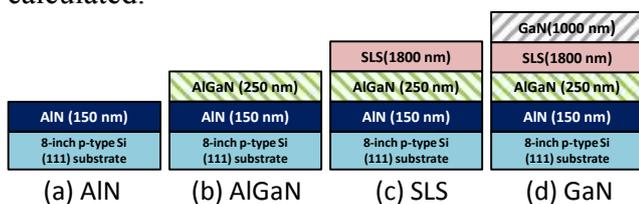


Fig. 1. Sample structures.

3. Results and discussion

Figure 2 shows the BEF of each layer in the HEMT structure. The increase in the BEF suggests that the crystal quality improves as the film thickness increases [2]. The BEF of the SLS layer is 2.47 (MV/cm); however, the BEF of the Ga_N layer, which is on top of the SLS layer, is 1.66 (MV/cm). The SLS layer, composed of thin AlGa_N and AlN, has a higher BEF because of the higher average Al composition compared with the Ga_N layer.

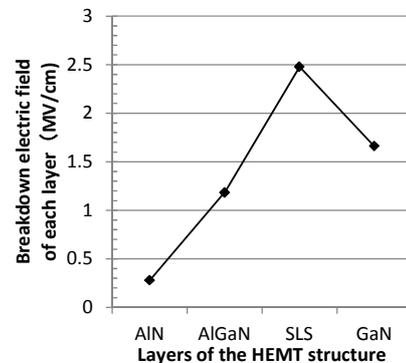


Fig. 2. Breakdown electric field of each layer in the HEMT structure.

4. Conclusion

HEMTs with SLS layer of higher thickness have improved VDBV.

References

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- [2] S. L. Selvaraj, et al.: Electron Device Letters, IEEE 30 (6) (2009), 587-589,