875 MW/cm^2 2568 V 0.68A/mm NO_2ドープダイヤモンド MOSFET

875 MW/cm^2 2568 V 0.68A/mm NO_2-Doped Diamond MOSFETs

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1. Introduction

Diamond has higher electric breakdown field strength and thermal conductivity than GaN and SiC and is expected as a next-generation semiconductor material for power devices with low power consumption and high efficiency. We have been demonstrating high current and high voltage diamond MOSFETs with NO_2 p-type doping and Al_2O_3 layer on the heteroepitaxial diamond, where voltage handling capability was enhanced to 2608 V using a thick passivation layer [1-2]. In this study, NO_2 doped diamond MOSFET is fabricated on 200-hour chemical mechanical planarized (CMP) heteroepitaxial diamond substrate, and MOSFETs exhibit a high available output power of 875 MW/cm^2.

2. Growth and Fabrication

Diamond MOSFETs were fabricated on 200-hour chemical mechanical planarized (001) heteroepitaxial diamond (Kenzan diamond®). H-diamond was exposed to NO_2 gas and a 16-nm-thick Al_2O_3 layer was deposited on it.

3. Results and Discussion

Figure 1(a) shows the dc output characteristics of a diamond MOSFET. The maximum drain current density ($I_{D,max}$) was measured as 0.68 A/mm, and on-resistance was determined as 50 Ω·mm. By using the TLM method, contact resistance and sheet resistance were determined as 2.62 Ω·mm and 3.55 kΩ/sq., respectively. 200 hours of CMP on diamond surface improves the subsurface condition and owing to this reason, devices are exhibiting low resistance. In addition to these, the maximum effective mobility was obtained as 205 cm^2/Vs. Figure 1(b) shows the off-state drain current characteristics and the breakdown voltage was 2568 V. The specific on-resistance and lateral breakdown field were determined as 7.54 mΩ·cm^2 and 2.3 MV/cm. The MOSFET shows a Baliga's figure of merit (BFOM) of 875 MW/cm^2. This value is the highest reported for the diamond MOSFETs and about 40% of the maximum value of GaN HEMT.

4. Conclusion

In conclusion, NO_2 doped diamond MOSFET fabricated on 200-hour chemical mechanical planarized heteroepitaxial diamond substrate shows the highest BFOM of 875 MW/cm^2.

Acknowledgements

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References

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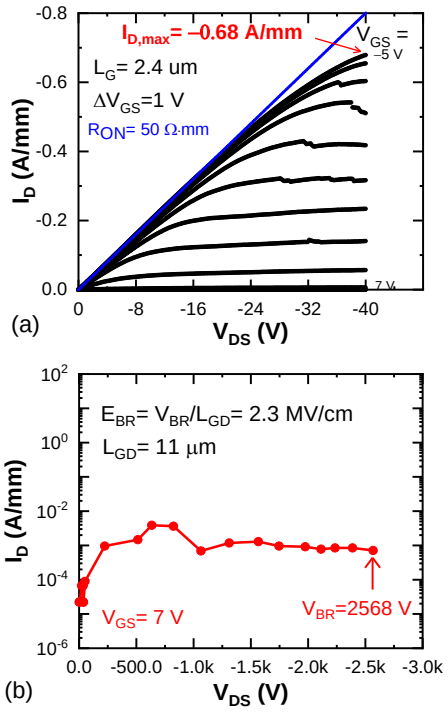

Fig. 1. (a) DC output characteristics and (b) off-state breakdown voltages of NO_2-doped diamond MOSFET.