高耐圧(2608 V)NO_2 ドープ p チャネルダイヤモンド MOSFET

2608 V Operation of NO_2-Doped p-channel Diamond MOSFETs

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1. Introduction

Diamond possesses a very high breakdown field of >10 MV/cm and thermal conductivity of 22 W/cm·K. These properties could enable diamond for high power operation. Using NO_2 p-type doping, the hole sheet concentration of H-diamond can be increased up to ~1 × 10^{14} cm^{-2}. [1] Recently, we demonstrated NO_2-doped p-channel diamond MOSFETs with both high current and voltage operation that leads to an available output power density of 145 MW/cm^2. [2] In this work, by using a passivation layer, we demonstrate NO_2-doped p-channel diamond MOSFETs with a greatly increased breakdown voltage (2608 V).

2. Growth and Fabrication

Diamond MOSFETs were fabricated on (001) heteroepitaxial diamond (Kenzan diamond®). H-diamond was exposed to NO_2 gas and 16-nm-thick Al_2O_3 layer was deposited on it. A gate was formed, and the hole channel was passivated by the 100-nm-thick Al_2O_3 layer over the gate. The channel length was 15 µm, and the gate length was 1.5 µm.

3. Results and Discussion

The maximum drain current ($I_{D,max}$) of diamond MOSFETs without any passivation layer was measured as 181 mA/mm as shown in Fig. 1(a). After the deposition of the 100-nm thick Al_2O_3 passivation layer over the gate, $I_{D,max}$ reduced to 144 mA/mm [see Fig. 1(b)]. Figure 2 compares the off-state high voltage characteristics of MOSFETs with and without passivation layer measured at gate bias of 9 V. The MOSFET without passivation layer can sustain until 1280 V. However, the MOSFET with the passivation layer reached the breakdown voltage of 2608 V and this value is the highest for the diamond MOSFETs. The lateral breakdown field of the MOSFETs increased from 1.2 to 2.37 MV/cm.

4. Conclusion

In conclusion, by using Al_2O_3 passivation layer, we have demonstrated the high voltage (2608 V) operation of NO_2-doped p-channel diamond MOSFETs.

Acknowledgements

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References

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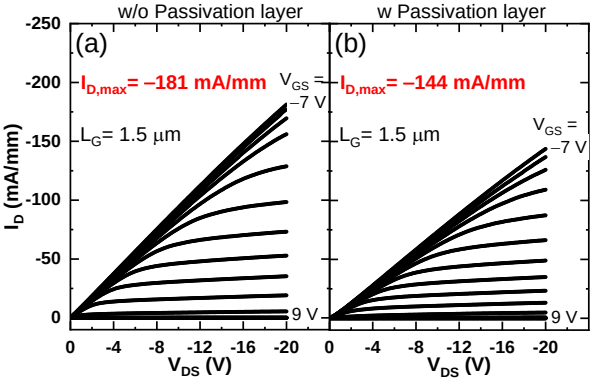

Fig 1. DC output characteristics of NO_2-doped p-channel diamond MOSFETs (a) without and (b) with Al_2O_3 passivation layer.

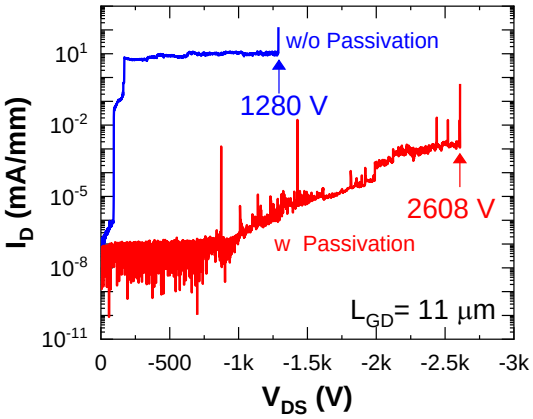

Fig. 2. Off-state breakdown voltages of NO_2-doped p-channel diamond MOSFETs with and without Al_2O_3 passivation layer.

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