Homoepitaxy of *p*-type boron-doped Diamond power devices on heteroepitaxial diamond substrate using microwave plasma chemical vapor deposition

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With the increasing demand for high-power outputs in the expanding field of power electronics, high-performance electrical devices require improvement for covering wide ranges of breakdown voltage with low on-resistance. Diamond-based devices are among the most promising power electronic devices due to their excellent physical properties, such as high hole mobility (2000 $cm^2 \cdot V^{-1} \cdot s^{-1}$) and electrical breakdown field strength (10 MV cm^{-1}). Several studies have been conducted on diamond-based high-power SBDs, FETs, and power modules such as buck converters. However, several technical challenges and theoretical limits exist to commercializing diamond electronic devices. Diamond SBDs are typically fabricated on a diamond substrate using the high-pressure high-temperature (HPHT) method. The diamond substrate is expensive and commercially available in 4 × 4 mm^2. The diamond heteroepitaxial growth method was developed to overcome the above-mentioned technical challenges. As with the success of heteroepitaxial semiconductor materials such as group III-nitride, it is well-known that realizing the heteroepitaxial diamond wafer, with large-size and low-cost single crystal wafers, is an excellent strategy for commercializing diamond-based power electronics. With Kim's pioneering work of heteroepitaxial diamond growth, the two-inch sized free-standing diamond heteroepitaxial (001) diamond substrate was demonstrated [1]. Thus, a study on diamond power devices using heteroepitaxial diamond substrate is necessary. In this study, we report the electronic and device properties of diamond pseudo-vertical SBD and Metal-semiconductor FET (MESFET) fabricated on a heteroepitaxial (001) diamond substrate. Diamond SBD and MESFET exhibited a breakdown field strength of 2.1 $MV \cdot cm^{-1}$, and 0.8 $MV \cdot cm^{-1}$, respectively [2-3]. The detailed experimental results will be presented at the conference.

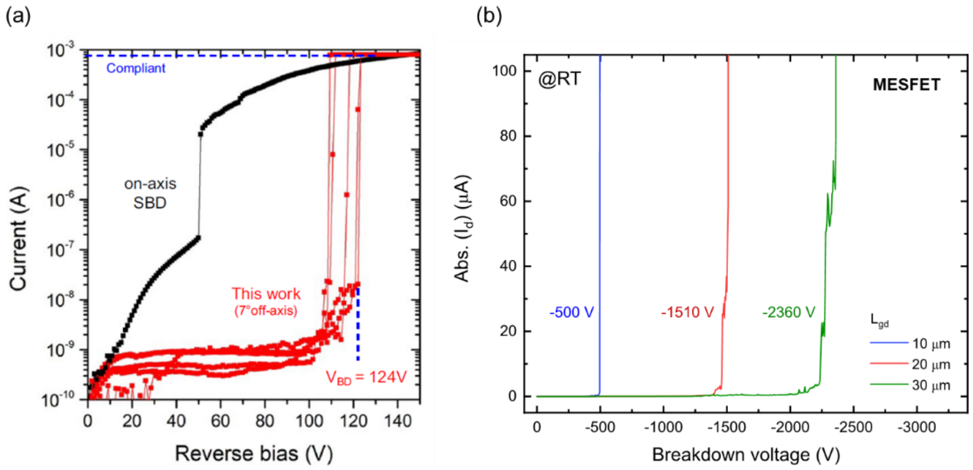

Fig 1. Breakdown characteristic of heteroepitaxial p-type boron-doped diamond on power devices of (a) pseudo-vertical SBD with or without misoriented angle, (b) MESFET with different gate-drain length.

Acknowledgments

This work was supported by Nano·Material Technology Development Program through the National Research Foundation of Korea (NRF) funded by Ministry of Science and ICT (No. 2022M3H4A1A04064600)

References

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