Diamond growth for power and quantum device applications

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Diamond is an ultra-wide bandgap semiconductor material which has high critical electric field (10 MVcm-1), high carrier mobility (e:4800 cm2/Vs, h:2000 cm2/Vs), and excellent thermal conductivity (2200 Wm-1K-1) and has the ideal properties for semiconductors. Therefore, the diamond-based power device is a next-generation promising material platform that can be used in an extreme environment requiring ultra-high power and frequency performance. The most significant limitations of the commercialization of diamond electronic devices are the small size and high price of diamonds grown by high-temperature and high-pressure methods.

In this study, a p-type pseudo-vertical diamond Schottky barrier diode was grown and fabricated on a large single-crystal heteroepitaxial diamond substrate to overcome these limitations. The device characteristics were analyzed, and the origin that deteriorates a device's performance was investigated [1]. Finally, to improve the performance of the device, it was shown that strategies of design and growth of high-performance diamond SBD [2].

In addition, the diamond nitrogen-vacancy (NV) center as an emerging platform, has been attracting much attention for quantum information technology since the first observation of magnetic resonance on a diamond single defect center at room temperature [3]. The diamond NV center consists of a substitutional nitrogen atom with an adjacent carbon vacancy which has outstanding properties such as good stability, long coherence time, and possibly working at room temperature conditions. In this paper, it is introduced the growth of ultra-high purity diamonds and the creation of NV center using ultra-high vacuum microwave plasma CVD (UHV-MPCVD) for quantum sensing applications [4].

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[3] A. Gruber et al., Science 276, 2012 (1997).

[4] T. Kwak & O. Nam et al., presented in the NDNC and ICDCM (2023).