Diamond regrowth for high-performance near-surface NV using ultra-high vacuum microwave plasma chemical vapor deposition

Taemyung Kwak[1], Seongmin Kang[1], Seolyoung Oh[1] and Okhyun Nam[1]*

[1]*Department of Nano & Semiconductor Engineering, Tech University of Korea, Siheung-si, Gyeonggi-do 429-793, Republic of Korea*

ohnam@tukorea.ac.kr

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 [1]. 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 without a vacuum system. It is efficiently created through nitrogen ion implantation and subsequent annealing process. Nitrogen ions can be precisely localized with low implantation energy to fabricate large-scale NV center arrays. Therefore, NV centers were placed a few nanometers from the diamond top surface, hampering its spin properties due to surface magnetic and electric noise. [2] Hence, it has faced a trade-off situation between the precise localization using low energy implanted near-surface NVs with lower spin properties and large area distributed NVs with good spin performance. In this study, we demonstrated a high-performance NV center by in-situ etching of damaged layer during ion implantation and high-purity diamond regrowth reducing surface noises by using an ultra high-vacuum microwave plasma chemical vapor deposition system (UHV-MPCVD). The detailed experimental results will be presented at the conference [3].

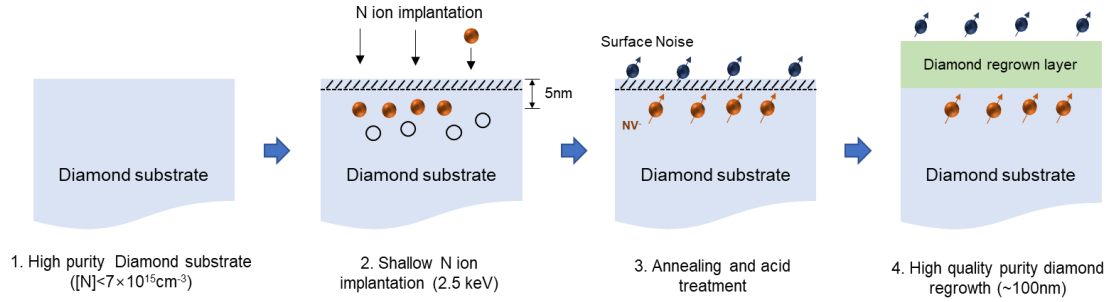

Fig 1. The schematic image of process flow of diamond NV etching & regrowth

Acknowledgments

This work was supported by the KIST Institutional Program (Project No. 2E32241-23-017), by Institute of Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government (MSIT) (No.81) and by the Nano & Material Technology Development Program through the National Research Foundation of Korea (NRF) funded by Ministry of Science and ICT (No. 2022M3H4A1A04064600)

References

[1] Science 276, 2012 (1997)
[2] Phys. Rev. X 9, 031052 (2019)
[3] The 30th korean conference on semiconductor (2023)