Chemical Vapor Deposition of Silicon Vacancy Ensembles in Low Strain Diamond with a NIRIM Type Reactor

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Diamond is a promising platform for optically active defects for quantum information processing (QIP) applications, able to host hundreds of different color centers within its wide bandgap. It is transparent from infrared to ultraviolet wavelengths and growth with 12C-enriched methane allows for nuclear spin-free material, suppressing spin-spin interactions to improve coherence times. The silicon vacancy (SiV) color center in diamond has particularly favorable properties for broadband quantum memories based on off-resonant Raman transitions. The storage time of a quantum memory in a dense SiV ensemble is determined by its inhomogeneous broadening, and therefore the growth of high-quality material is needed. Diamond growth through chemical vapor deposition (CVD) will allow for the production of high quality SiV ensembles with high optical density to achieve state-of-the-art high bandwidth optical quantum memories. Growth of this material will be made possible through a custom NIRIM type diamond reactor, modified from an existing design [1] by switching to CF flanges and adding a turbomolecular pump for purity, and adding the capability for an automatically adjustable sample height. As opposed to the MSU type reactors, which feature bell jar reaction chambers [2], the NIRIM reactor utilizes a thin cylindrical quartz tube which can be easily and inexpensively swapped if it becomes contaminated. Additionally, laminar flow through the reaction chamber allows for precise control over gas concentrations and improved purity leading to improved sample quality required for quantum memory applications. In this presentation, I will introduce the properties of the SiV and the potential of in-situ silicon doping during CVD.

References

[1] E.L.H Thomas, et al, AIP Adv 8, 035325 (2018)
[2] Y. Gu, et al, Diam Relat Mater, 24, 210-241 (2012)