Coherent control of Tin-Vacancy centers in diamond using superconducting waveguides at 50 mK

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Robust quantum networks require an interface between photons and long-lived spin degrees of freedom. Group-IV color centers exhibit an inversion symmetry protecting them from surface charge noise. For high fidelity control, the use of microwave fields is required. However, the magnetic transitions are heavily suppressed in unstrained emitters. This limitation can be overcome by inducing strain and precisely aligning the DC magnetic field orientation. Recent work has shown the manipulation of the electron spin using aluminum wire bonds [1] and on-chip gold waveguides [2]. Both methods suffer from Ohmic losses in the microwave line, restricting coherence through heat induction. To overcome this challenge, we fabricate a superconducting coplanar waveguide on a diamond membrane and strain is induced by specific sample mounting. We demonstrate high fidelity coherent manipulation of the electron spin at 50 mK temperature and further determine pure dephasing times by Ramsey interferometry and spin coherence times by Hahn-Echo measurements under varying magnetic fields. Spin coherence is extended by three orders of magnitude by using standard dynamical decoupling sequences.

References

[1] Rosenthal et al., Phys. Rev. X, 13 (2023), 031022
[2] Guo et al., Phys. Rev. X, 13 (2023), 041037

Figures

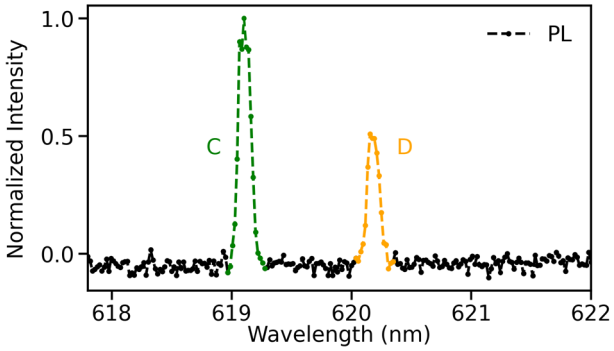

Figure 1: Photoluminescence spectrum of an unstrained Tin-Vacancy center.

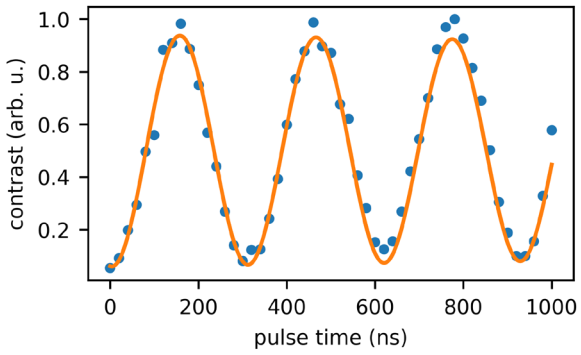

Figure 2: Coherent Rabi oscillations using microwave control pulses.

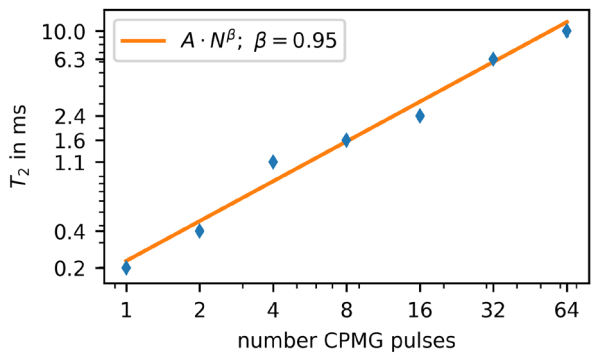

Figure 3: Scaling of the coherence time with increasing number of CPMG pulses.