Color centers in diamond as optically addressable spin qubits

D. Hunger[1,2]

1. Physikalisches Institut, Karlsruher Institut für Technologie, Wolfgang Gaede Str. 1, 76131 Karlsruhe

Optically addressable spins in the solid state are promising candidates for realizations of quantum networks and quantum computing nodes.

We study NV centers in diamond coupled to an optical microcavity to enhance the optical emission and get efficient access to the spin degree of freedom. Studying small ensembles, we observe collectively enhanced emission and non-trivial photon statistics, despite the presence of inhomogeneities and spatial separation between emitters [1].

As an alternative color center, we study SnV centers in diamond, which can possess superior optical coherence properties. We observe hour-long spectral stability and Fourier-limited emission linewidths of individual emitters. Due to its strong spin-orbit splitting, SnV centers also possesses long electron spin lifetimes at temperatures around 1K. To control the electron spin with high fidelity, 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. To avoid Ohmic losses in the microwave line, which restricts coherence through heat induction, we fabricate a superconducting coplanar waveguide on a diamond membrane. We induce strain in the diamond by using a polymer with a high coefficient of thermal expansion for fixation. We demonstrate coherent manipulation of the electron spin and evaluate the decoherence properties for different magnetic field orientations at mK temperature. Prospects for integration into a microcavity for efficient spin-photon interfacing are discussed [2].

References

[1] Pallmann et al., arxiv:2311.12723

[2] Körber et al., Phys Rev Appl. 19, 064057 (2023)

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* david.hunger@kit.edu