Investigation of Coherence Properties of NV Centers in Diamond by Photoelectrical Detection Technique

I Chuprina[1], C Findler[2], J Lang[1,2], P Siyushev[1,3], and F Jelezko[1]

[1]*Institute for Quantum Optics, Ulm University, Albert-Einstein-Allee 11, D-89081, Ulm, Germany*
[2]*Diatope GmbH, Buchenweg 23, D-88444 , Ummendorf, Germany*
[3]*University of Hasselt, Wetenschapspark 1, B-3590 , Hasselt, Belgium*
Contact Email: ilia.chuprina@uni-ulm.de

The nitrogen-vacancy (NV) center represents one of the most promising platforms for quantum sensing, particularly in the context of magnetic field sensing. However, the state readout protocols typically rely on the collection of red-shifted photoluminescence (PL), a technique that has been shown to have several limitations. For instance, it necessitates the use of bulky confocal microscopes and exhibits poor photon extraction efficiency from bulk diamond.

In this study, we focused on the novel photoelectrical (PE) readout technique, which has recently been applied to single and ensemble of NV centers in diamond and promises to overcome these limitations. The PE readout method employs the continuous generation and collection of charges under strong laser excitation of the NV center. This process leads to the continuous creation of electrons and holes with spin-dependent rates. We have applied this technique to study the coherent properties of the electron spin of NV centers. We have demonstrated pulsed PE-detected magnetic resonance measurements using a commercial photocurrent amplifier with a limited bandwidth of 200 Hz. A comparison is made between optically and photoelectrically detected T2*(Ramsey) and T2 (Hahn-Echo) of single and ensemble NV centers. The PE-detected coherences are in good agreement with PL-detected coherences, indicating that nearby pA current flow is not significantly influencing the coherence of NV ground state electron spin. These results represent an important step toward integrated magnetic field sensors in diamond with photoelectrical detection scheme.