Characterization of optically activated magnesium vacancy centers in bulk diamond

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Magnesium vacancy (MgV) centers have strong potential to be used as single photon sources applied in quantum radiometry as they provide stable emission and possess a high Debye-Waller factor [1]. These properties are advantageous for quantum-based radiometric applications, such as e.g., calibrating single photon detectors.

To form MgV centers, the implantation of magnesium ions into bulk diamond is commonly followed by thermal annealing. Due to the high implantation density of Mg ions, individually located MgV emitters are only found randomly distributed at the edge of the highly implanted areas.

In this work we present the optical characterization of MgV centers in bulk diamond that were, instead by means of thermal annealing, activated optically by a laser irradiation. This method enables the activation of individual MgV centers demonstrating single photon emission [2, 3]. The investigated sample was implanted with two different ion fluences in different areas. Subsequently the areas were exposed to a laser beam. The centers activated by this were characterised in a confocal microscope setup.

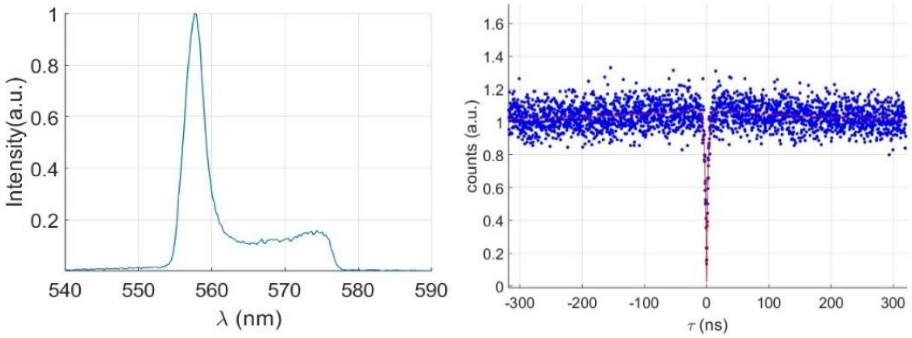

Fig. 1: *(Left): Spectrum of an individual optically activated MgV center. The zero phonon line lays at 557.9 nm, the phonon sideband is cut off by a spectral filter. (Right): Measurement of the second order correlation function of the same emitter shows single photon emission:* $g^2(0) = 0.02^{+0.08}_{-0.02}$.

The characterization includes photoluminescence scans, spectral analysis, measurements of the second order correlation function, excited state lifetime measurements, saturation measurements and measurements of the temporal stability.

The comparison of the characterizations of the photoactivated sample and a thermally activated sample showed no significant difference [3]. Consequently, the ability to activate MgV centers using a laser enables an alternative approach that aims to simplify the identification of single centers by enabling their reliable activation within a defined area through an appropriate balance of implantation density and laser parameters.

References

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