Cavity-enhanced emission from Germanium Vacancy centers in Diamond - DTU Orbit
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The unique correlations in quantum systems, i.e. superposition and entanglement, enable quantum technologies to outperform classical technologies. Quantum networks is a quantum technology in fast development with many promising applications. An essential building block in a quantum network is the interface between matter nodes and quantum channels. A color center in diamond coupled to a micro-cavity is a promising route to achieve an efficient interface.

In this thesis we investigate the coupling of a single germanium vacancy (GeV) center to a Fabry-Pérot optical micro-cavity at room temperature. The Fabry-Pérot optical micro-cavity was formed by a macroscopic flat mirror and a fiber-based concave microscopic mirror. The concave mirror was created on the end-facet of a fiber with short high power laser pulses from a CO2-laser. High quality dielectric coating allowed us to achieve a finesse of 11,000 with a~1 µm thin diamond membrane incorporated in the cavity. We achieved a cavity length of only a few µm and a small mode volume $V = 2.7\mu m$, which was essential for good coupling between the GeV center and the optical cavity mode.

By studying the same GeV center in a confocal microscope setup, i.e. outside of the micro-cavity, and in the micro-cavity setup, we were able to measure an improved optical coherence of the GeV emission in the cavity. We determined an enhancement of the spectral density by a factor of ~15. Furthermore, we determined the emission efficiency into the cavity mode $\beta$ and compared it with the theoretical modelling. From the theoretical modelling, we predict the expected Purcell factor $F_p = 200$ for the zero phonon line in future experiments at cryogenic temperatures.

Going to cryogenic temperatures is necessary to achieve efficient spin-photon interfaces. This work provides valuable information for realizing efficient spin-photon interfaces, which is critical for the practical implementation of a quantum network.

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