Investigation of the tin vacancy center in diamond for realization of spin-photon interfaces

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Solid state emitters like color centers in diamond are promising systems to provide advantageous features for quantum information processing, such as enabling the manufacturing of quantum photonic circuits and providing stable spin and optical properties [1,2]. The most intensively studied color center in diamond is the nitrogen vacancy center (NV). While showing outstanding room temperature coherence times of milliseconds, the NV center suffers from an emission into its zero phonon line (ZPL) of only 4% of its total fluorescence [3]. In contrast, centers based on group-IV elements have been found to show more favorable optical properties. The silicon vacancy center (SiV) exhibits for instance a ZPL emission of 80% of its total fluorescence, but, as a tradeoff, reaches millisecond spin coherence times only at millikelvin temperatures due to phonon-driven decoherence processes [4,5]. For these reasons, there have been ongoing efforts to find a color center in diamond with both excellent optical and spin properties. One promising candidate is the tin vacancy center (SnV) emitting at 619nm and showing a similar fine structure splitting as the SiV center, consisting of four lines at cryogenic temperatures, but with a much larger ground and excited state splitting (850GHz and 3000GHz respectively) [6], potentially enabling long spin coherence times even at liquid helium temperatures.

Here, we present our recent results on spectroscopy of both single and ensembles SnV centers in unstructured bulk diamond, from room temperature down to liquid helium temperature. We explore their optical and spin properties, including lifetime, polarization, spectral features from photoluminescence and photoluminescence excitation, single photon emission properties and spin coherence times, paving the way for assessing the suitability of the SnV center in diamond for spin-based photonic quantum technologies.

References

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