Ultra-narrow inhomogeneous spectral distribution of telecom-wavelength vanadium centres in isotopically enriched silicon carbide

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Abstract

Spin-active quantum emitters have emerged as a leading platform for quantum technologies [1]. However, one of their major limitations is the large spread in optical emission frequencies, which typically extends over tens of GHz.

Here, we investigate single vanadium (V^{4+}) centres in 4H-SiC [2], which feature telecom-wavelength emission and a coherent S = 1/2 spin state. We perform spectroscopy on single emitters and report the observation of spin-dependent optical transitions, a key requirement for spin-photon interfaces. By engineering the isotopic composition of the SiC matrix, we reduce the inhomogeneous spectral distribution of different emitters down to 100 MHz, significantly smaller than any other single quantum emitter. Additionally, we tailor the dopant concentration to stabilise the telecom-wavelength V^{4+} charge state, thereby extending its lifetime by at least two orders of magnitude.

Our results reveal the potential of single vanadium emitters in SiC as material nodes in scalable telecom quantum networks [3].

References

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Figures

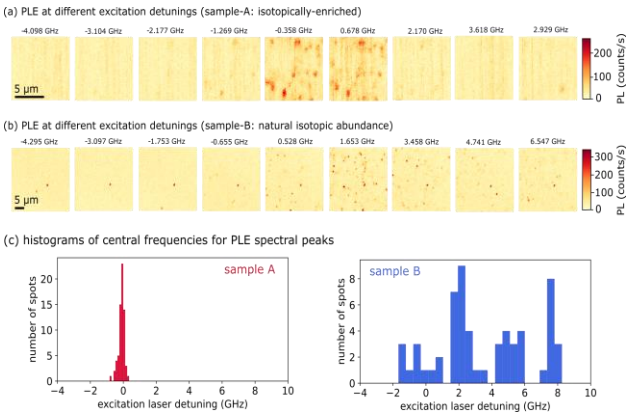

Figure 1: (a), (b) Sequence of PLE maps at different detunings of the excitation laser, respectively for the isotopically enriched sample (A) and the natural-abundance sample (B). In the isotopically enriched sample, the vast majority of emitters appear only in a narrow frequency range. **(c)** Histograms for the central frequencies of 181 PL spots associated to vanadium centres in the natural-abundance (right) and 61 spots in isotopically enriched (left) samples. In the sample with a natural abundance of silicon and carbon isotopes, the vanadium centres are spectrally spread over several GHz, presenting a distribution with multiple peaks. In contrast, the distribution is much narrower in the isotopically enriched sample, with a standard deviation of about 100 MHz. Figure taken from Ref. [2].