Resonant Spectroscopy of Blue Quantum Emitters in Hexagonal Boron Nitride

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Two dimensional materials are becoming increasingly popular as a platform to produce prototype quantum technologies and to study foundational quantum phenomena. Quantum emitters in 2D materials can host two level systems that can act as single photon sources for quantum information processing [1]. The large band gap material hexagonal boron nitride (hBN) has attracted particular attention, yet the systematic analysis of defect-based single photon emitters in this material has been limited due to the stochastic nature of the methods used to create such defects [2]. Recently, a new quantum emitter in hBN has been identified that can be reliably fabricated using precision electron beam irradiation [3]. These so-called blue emitters are an emerging testbed for the potential of hBN as a quantum technology platform.

In this work, we performed an in-depth cryogenic spectroscopy study on dozens of the blue emitters, amassing valuable statistics that will inform future work on the structure of these and other defects in hBN. We observe an ultra-narrow distribution of the zero phonon line, together with strong linearly polarized emission. Under resonant excitation, a characterisation of the emission lineshape showed that spectral diffusion and phonon broadening contribute to linewidths on the order of 1 GHz. At two different emitters, Rabi oscillations were observed at a range of resonant excitation powers, providing an estimate of the duration in which a superposition of energy eigenstates was maintained. Our results are promising for future employment of quantum emitters in hBN for scalable quantum technologies.

[1] Castelletto, S.; Inam, F. A.; Sato, S.-i.; Boretti, A. *Beilstein J. Nanotechnol.* **11**, 740–769 (2020).

[2] Mendelson, N., Chugh, D., Reimers, J.R. *et al.* Identifying carbon as the source of visible single-photon emission from hexagonal boron nitride. *Nat. Mater.* **20,** 321–328 (2021).

[3] Fournier, C., Plaud, A., Roux, S. *et al.* Position-controlled quantum emitters with reproducible emission wavelength in hexagonal boron nitride. *Nat Commun* **12,** 3779 (2021).