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Coherent control of single spins in diamond[1]

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Diamond-based materials have recently emerged as a unique platform for quantum science and engineering[2]. Spins of single Nitrogen-Vacancy (N-V) color centers in diamond can be imaged, initialized and read out optically. These N-V center spins may allow for quantum information processing at room temperature, as measurements have shown long room-temperature electron spin coherence times well into the microsecond regime. We have investigated single N-V center spins that are coupled to electron spins of nearby nitrogen (N) defects, using magneto- optical imaging and coherent single-spin control at room temperature. Some of the N-V centers are strongly coupled to only one single N spin, allowing the controlled polarization and readout of this single 'dark' N spin. In contrast, other N- V centers couple to many N spins. We use these latter systems to study the canonical decoherence model of a single central spin coupled to a spin bath. By tuning the internal bath dynamics as well as the spin-bath coupling, we gain access to regimes with strikingly different behaviour. Finally, we have fabricated and characterized photonic crystal microcavities in poly-crystalline diamond and observed quality factors up to 600 [3]. These structures are a first step towards controllable coupling of single N-V spins to single photons in a cavity-QED system in diamond.

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