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Quantum control and nanoscale placement of single spins in diamond[1]

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Diamond is a unique solid state platform for fundamental studies of spintronics and quantum information science that has recently enabled control, readout, and storage of quantum states at the single spin level. Nitrogen-vacancy (NV) center spins can be individually addressed and have remarkably long spin coherence times at room temperature. We show that the spin of single NV centers in both the orbital ground[3] and excited state[4] can be controlled on sub-nanosecond time scales using intense microwave fields. Moreover, coherent light-matter interactions enable non-destructive spin measurement and localized single spin manipulation with near-resonant light.[5] An associated quantum memory is also demonstrated using the intrinsic nuclear spin of nitrogen.[6] Scaling these findings toward a spin network is a key challenge - to this end we present a simple method for patterning NV center formation on 50 nm length scales.[7] These results represent progress toward control, coupling, and scaling of single spins for future spin and photon based quantum information processing.

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