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Engineered defect spin states in silicon carbide for sensing and computation[1]

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Crystal defects can confine isolated electronic spins and are promising candidates for solid-state quantum bits. Alongside research efforts focusing on nitrogen-vacancy centers in diamond, an alternative approach seeks to identify and control new spin systems with an expanded set of technological capabilities, a strategy that could ultimately lead to "designer" spins with tailored properties. We show that the 4H, 6H and 3C polytypes of silicon carbide are all hosts for optically addressable spin states, including states in all three whose long quantum coherence times persist up to room temperature[3] and states with highly spin-dependent photoluminescence. Atomic-scale sensing with SiC defects is also an exciting and developing area of research, particularly since the polar character of the Si-C bond enhances the sensitivity of defect spin transitions to electric fields. We show that SiC defects can be used for high-sensitivity electric- and strain- field measurements[4] and controlled on the nanometer scale through electrically driven spin resonance.[5] Moreover, we use double electron-electron resonance to measure magnetic dipole interactions between spin states occupying inequivalent lattice sites of the same crystal. Together with the distinct spin transition energies of such inequivalent states, these interactions provide a route to dipole-coupled networks of separately addressable spins.

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[2]In collaboration with I. A. Abrikosov, B. B. Buckley, G. Calusine, V. V. Dobrovitski, P. -X.L. Feng, Á. Gali, V. Ivády, P. V. Klimov, W. F. Koehl, C. A. Zorman, and D. D. Awschalom.
[3]A. L. Falk, B. B. Buckley, G. Calusine, W. F. Koehl, V. V. Dobrovitski, C. A. Zorman, P. X.-L. Feng, D. D. Awschalom. Polytype control of spin qubits in SiC. *Nat. Commun.*, **4**, 1819 (2013)
[4]A. L. Falk, P. V. Klimov, B. B. Buckley, V. Ivády, W. F. Koehl, I. A. Abrikosov, Á. Gali, and D. D. Awschalom. Strain and electric field sensing with defect spins in SiC. *Submitted* (2013).
[5]P. V. Klimov, A. L. Falk, B. B. Buckley, D. D. Awschalom, Electrically driven spin resonance in SiC color centers. *ArXiv*:1310.4844 (2013).