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Creating and Controlling Single Spins in Silicon Carbide[1]

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Silicon carbide (SiC) is a well-established commercial semiconductor used in high-power electronics, optoelectronics, and nanomechanical devices, and has recently shown promise for semiconductor-based implementations of quantum information technologies. In particular, a set of divacancy-related point defects have improved coherence properties relative to the prominent nitrogen-vacancy center in diamond, are addressable at near-telecom wavelengths, and reside in a material for which there already exist advanced growth, doping, and microfabrication capabilities. These properties suggest divacancies in SiC have compelling advantages for photonics and micromechanical applications, yet their relatively recent discovery means crucial aspects of their fundamental physics for these applications are not well understood.

I will review our progress on manipulating spin defects in SiC, and discuss efforts towards isolating and controlling them at the single defect limit[1]. In particular, our most recent experimental results demonstrate isolation and control of long-lived ($T_2 = 0.9\,\mathrm{ms}$) divacancies in a form of SiC that can be grown epitaxially on silicon. By studying the time-resolved photoluminescence of a single divacancy, we reveal its fundamental orbital structure and characterize in detail the dynamics of its special optical cycle. Finally, we probe individual divacancies using resonant laser techniques and reveal an efficient spin-photon interface with figures of merit comparable to those reported for NV centers in diamond. These results suggest a pathway towards photon-mediated entanglement of SiC defect spins over long distances.

[1] D. J. Christle, A. L. Falk, P. Andrich, P. V. Klimov, J. ul Hassan, N. T. Son, E. Janzén, T. Ohshima, and D. D. Awschalom, Nature Materials **14**, 160163 (2015).

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