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Engineering shallow spins in diamond with nitrogen delta-doping[1]

K. OHNO, F.J. HEREMANS, L.C. BASSETT, B.A. MYERS, D.M. TOYLI, A.C. BLESZYNSKI JAYICH, C.J. PALMSTROM, D.D. AWSCHALOM, Center for Spintronics and Quantum Computation, University of California, Santa Barbara, CA, 93106 — The excellent spin properties of diamond nitrogen-vacancy (NV) centers motivate applications from sensing to quantum information processing. Still, external electron and nuclear spin sensing are limited by weak magnetic dipole interactions, requiring NVs be within a few nm of the surface and retain long spin coherence times (T_2). We report a nitrogen delta-doping technique to create artificial NVs meeting these requirements. Isotopically pure $^{15}N_2$ gas is introduced to form a thin N-doped layer (1–2 nm thick) during chemical vapor deposition of a diamond film. Post growth electron irradiation creates vacancies and subsequent annealing forms NVs while mitigating crystal damage. We identified doped NVs through the hyperfine signature of the rare ^{15}N isotope in electron spin resonance measurements. We confirm the doped NV depth dispersion is less than 4 nm by doping NVs in the ^{12}C layer of an isotopically engineered $^{13}C/^{12}C/^{13}C$ structure and probing the coupling between the doped NVs and the ^{13}C nuclear spins. Furthermore, despite their surface proximity, doped NVs embedded in ^{12}C films 5 (52) nm below the surface show T_2 greater than 100 (600) μs [1].

[1] K. Ohno *et al.*, Appl. Phys. Lett. **101**, 082413 (2012).

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Kenichi Ohno
Center for Spintronics and Quantum Computation,
University of California, Santa Barbara, CA, 93106

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