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Increasing NV center density by shallow ^{12}C implantation in N delta-doped diamond[1] K. OHNO, B.A. MYERS, B.J. ALEMAN, C.A. MCLELLAN, A.C. BLESZYNSKI JAYICH, D.D. AWSCHALOM[2], Center for Spintronics and Quantum Computation, University of California, Santa Barbara, CA, 93106
— Scalable creation of solid-state single spins is important to nanoscale sensing. Nitrogen-vacancy (NV) centers created by the N delta-doping technique display long T_2 at depths <100 nm [1] which were exploited to demonstrate nm-scale nuclear magnetic resonance.[2] One issue of this technique is the low NV density, which prevents their incorporation into diamond nanostructures. This is caused by poor depth localization of vacancies by post growth electron irradiation. Here we use shallow ^{12}C implantation to localize them. By controlling annealing time and temperature, shallow vacancies diffuse into the N doped layer to selectively activate doped NV centers. We observe NV densities 10 times greater than in irradiated samples. Resulting NV centers display $T_2 > 500$ μs, suggesting C implantation damage to the N doped layer is minimized. The enhanced NV density is used to demonstrate NV center localization in a small volume. We find an average of 1.3 NVs confined to a volume of 150 nm in diameter and 50 nm in depth within an array of EB lithographically patterned pillars, useful for single photon sources and scanning probe based sensing. [1] K. Ohno et al., Appl. Phys. Lett. 101, 082413(2012). [2] H. J. Mamin et al., Science 339, 557(2013).

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[2]Current address: Institute for Molecular Engineering, University of Chicago, Chicago, IL, 60637

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

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