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Nanoscale Engineering of Closely-Spaced Electronic Spins in Diamond DIEGO SCARABELLI, Rigetti Quantum Computing Columbia University, MATT TRUSHEIM, Massachusetts Institute of Technology, OPHIR GAATHON, Diamond Nanotechnologies Inc., DIRK ENGLUND, Massachusetts Institute of Technology, SHALOM WIND, Columbia University, MASSACHUSETTS INSTITUTE OF TECHNOLOGY COLLABORATION, COLUMBIA UNIVERSITY COLLABORATION — Spin systems in solid-state have been intensively investigated as an outstanding pathway towards quantum information processing. The negatively charged nitrogen vacancy (NV) center in diamond stands out because of its optically addressable electron spin, which shows long coherence time and viable initialization, manipulation and read-out at room temperature. In order to enable the use of this system for quantum information technology it's crucial to develop a procedure to deterministically engineer single artificial NV centers with nanometric positioning control and integrate them within an optoelectronic device. In this work, we demonstrate a method for chip-scale fabrication of arrays of single NV centers with record spatial localization of about 10 nm in all three dimensions and controllable inter-NV spacing as small as 40 nm, which approaches the length scale of strong dipolar coupling. Our approach uses masked implantation of nitrogen through nano-apertures in a thin gold film, patterned via electron-beam lithography and dry etching, which ensures excellent masking contrast for the implantation of 10 KeV nitrogen ions. We verified the position and spin properties of the resulting NVs through wide-field super-resolution optically detected magnetic resonance imaging.

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