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Qubits made by advanced semiconductor manufacturing

Spin qubits that are hosted in electrically-controlled, silicon quantum dots are promising candidates for implementing quantum technology. Due to their small size, relatively long coherence times and their compatibility with the semiconductor industry they offer great promises, both for qubit performance and for scaling. To pave the road towards large-scale quantum computing, making use of common CMOS fabrication techniques, like optical lithography and chemical-mechanical polishing is key. Spin qubit devices to date, however, still rely on the flexibility of e-beam lithography and mostly lift-off techniques.

Here, we present the first qubits in isotopically enriched 28 Si-MOS fabricated entirely with optical lithography in an industrial 300 mm process line. These devices are fully fabricated with optical lithography and chemical-mechanical polishing techniques for patterning, compatible with state-of-the-art industrial fabrication. We demonstrate well-controlled single and double quantum dots with separate tunnel-barrier control in the multi-electron regime. The latter is a prerequisite to perform high-fidelity two-qubit gates. Moreover, we demonstrate charge sensing with a signal-to-noise ratio high enough for single shot readout. With this, we form high-quality qubits in the single-electron regime, comparable to qubits in academic devices.

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