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# Hole spin qubits in Silicon finFETs

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The greatest challenge in quantum computing is achieving scalability. Classical computing, which previously faced such issues, currently relies on silicon chips hosting billions of fin field-effect transistors (finFETs). These devices are small enough for quantum applications: an electron or hole trapped under the gate can serve as a spin qubit at low temperatures. This approach allows quantum hardware and its classical control electronics to be integrated on the same chip. However, this requires qubit operation at temperatures above 1 K, where the cooling overcomes heat dissipation of this control electronics. Here, we show that our industry-compatible silicon finFET devices [1] can host hole spin qubits above 4 K [2]. We achieve fast electrical spin control with operation speeds up to 150 MHz, single-qubit gate fidelities at the fault-tolerance threshold, and controllable exchange interaction, allowing a fast CROT (CX) gate with a conditional spin-flip in 32 ns. The strong spin-orbit interaction in these devices leads to anisotropies and coherence hotspots in the single and two-qubit gates, which we investigate to improve the quality of our qubits.
[1] Geyer et al., Appl. Phys. Lett. 118 (2021).
[2] Camenzind et al., Nature Electronics 5 (2022).

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