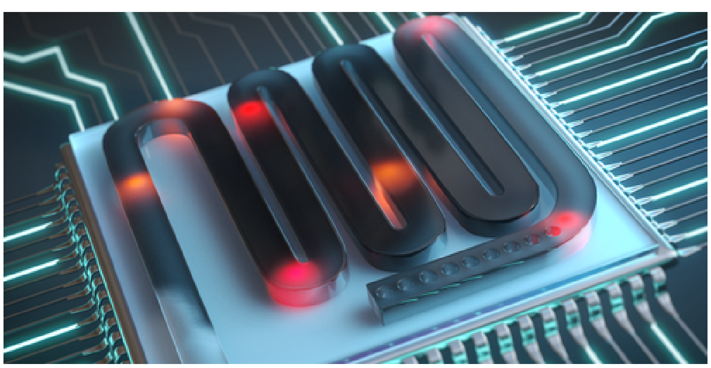
Atom-Implanted Silicon Waveguides Get an Upgrade

Improved fabrication methods for qubits made from erbium-doped silicon waveguides give these qubits the key prerequisites for becoming a contender for future quantum computers.

By Katie McCormick

From superconducting circuits to single atoms, there are many quantum-bit—or "qubit"—systems to choose from when building a quantum computer. New to the game are qubits made from individual erbium atoms implanted in silicon waveguides. Each of these qubits can be controlled and measured with telecom-wavelength light, making the platform practical to implement. But the platform has unfavorable properties that have put that implementation on hold. Now Andreas Reiserer of the Max Planck Institute of Quantum Optics in Germany and his colleagues have improved the qubit's fabrication and detection methods, such that it is viable for near-future use in quantum computing technologies [**1**]. The results suggest that erbium-doped silicon waveguides could make more promising qubits than previously thought.

One problem with previous erbium-doped silicon waveguides came from the uneven clustering of erbium atoms around impurities in the waveguide. This clustering meant that the erbium atoms had different transition frequencies, making it difficult to simultaneously address multiple atoms and to perform basic operations between them—a necessary component of quantum information processing.



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To solve this problem, Reiserer and his colleagues use pure silicon and an optimized erbium-integration procedure that distributes the atoms evenly along the waveguide, giving the system a single transition frequency. The resulting qubits are stable enough to use resonant telecom light to address them—a first for erbium-doped silicon.

The team plans to work on building other elements needed for an erbium-doped silicon waveguide quantum computer, for example, those required to get two erbium atoms to interact with one another to perform basic logic-gate operations.

Katie McCormick is a freelance science writer based in Seattle, Washington.

REFERENCES

1. A. Gritsch *et al.*, "Narrow optical transitions in erbium-implanted silicon waveguides," Phys. Rev. X 12, 041009 (2022).