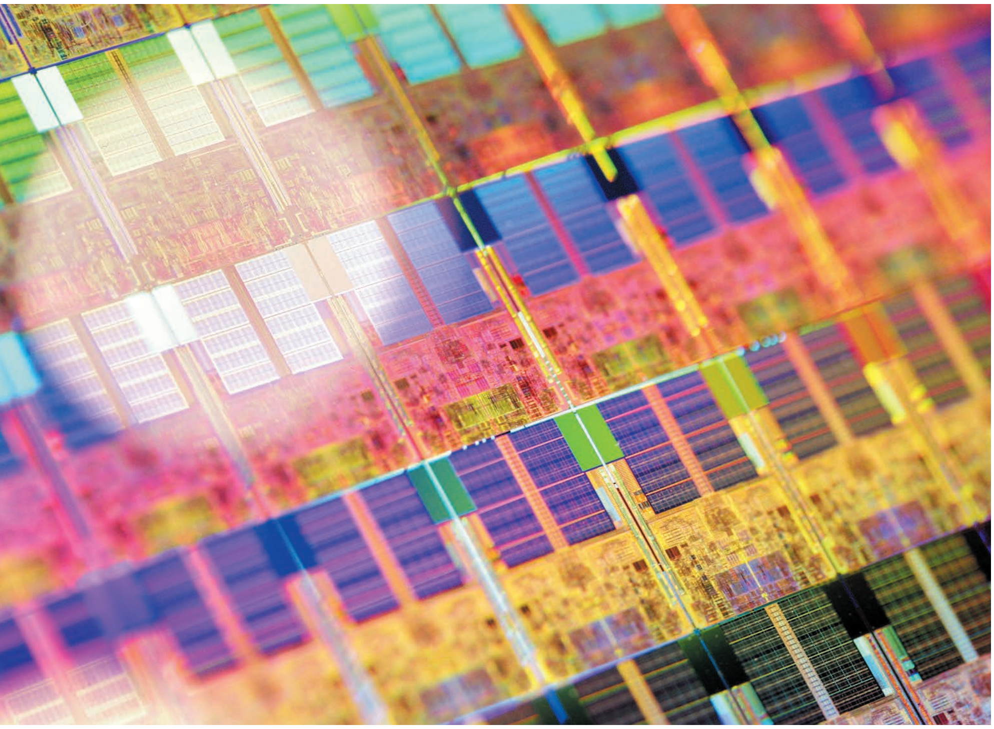

Techniques for fabricating conventional silicon chips could be used to make quantum devices.

YOSHIKAZU TSUNO/AFP/GETTY

Proponents of the silicon technique see major advantages in using a semiconductor to code qubits. They can be manipulated much more simply using microscopic electric leads etched right onto the chip. And if the same large-scale manufacturing techniques for making chips could be transferred to the quantum realm, it could become easier to turn the technology into commercial products.

A LONG ROAD

The idea of building quantum computers out of silicon is not new. Bruce Kane, an experimental physicist now at the University of Maryland in College Park, first suggested encoding qubits in the magnetic orientation, or 'spin', of phosphorus nuclei embedded in silicon 20 years ago[1]. At about the same time, David DiVincenzo, a theoretical physicist then at IBM in Yorktown Heights, New York, and his collaborator Daniel Loss at the University of Basel in Switzerland proposed a way of storing information in the spins of mobile electrons inside semiconductors[2]. Both proposals led to a number of experimental demonstrations but, for a long time, the quality of the materials limited progress.

Building a quantum computer using silicon took years of "not very flashy" developments in materials science and engineering, says physicist Jason Petta of Princeton University in New Jersey. Physicists at the UNSW Centre for Quantum Computation and Communication Technology, which Simmons directs, have done much of that groundwork. And Simmons developed a manufacturing technique that requires fewer control leads, preventing inevitable issues of crowding once quantum devices scale up, she says. "I want to engineer everything out that isn't essential and make things as simple as possible."

In 2017, two groups reached a milestone when they designed the first fully controllable two-qubit devices in silicon. Petta and his collaborators achieved that feat[3], as did a separate team[4] led by Lieven Vandersypen at Delft.

> *"I want to engineer everything out that isn't essential and make things as simple as possible."*

Intel, which is investing US$50 million over 10 years at Delft, is now manufacturing multiple-qubit electron-spin devices for Vandersypen, in the same type of factory where it develops microprocessor-fabrication techniques. Industrial partners can help by providing reliably identical devices, he says.

"We hope that we can accelerate spin qubits to compete" with the more mature approaches, Clarke says. Simmons' start-up aims to build a ten-qubit machine within five years. Google, IBM and a number of other companies and academic labs are all using different techniques to build quantum computers with around 50 superconducting qubits — and so is Intel itself, which is hedging its bets by supporting more than one technical approach. ■

1. Kane, B. E. *Nature* **393,** 133–137 (1998).
2. Loss, D. & DiVincenzo, D. P. *Phys. Rev. A* **57,** 120–126 (1998).
3. Zajac, D. M. *et al. Science* http://dx.doi.org/10.1126/science.aao5965 (2017).
4. Watson, T. F. *et al.* Preprint at https://arxiv.org/abs/1708.04214 (2017).

PUBLISHING

Elsevier grants a reprieve

It allows German institutions continued journal access.

BY QUIRIN SCHIERMEIER

The Dutch publishing giant Elsevier has granted uninterrupted access to its paywalled journals for researchers at around 200 German universities and research institutes that had refused to renew their individual subscriptions at the end of 2017.

The institutions had formed a consortium to negotiate a nationwide licence with the publisher. They sought a collective deal that would give most scientists in Germany full online access to about 2,500 journals at roughly half the price that individual libraries have paid in the past. But talks broke down and, by the end of 2017, no deal had been agreed. Elsevier now says that it will allow the country's scientists to access its paywalled journals without a contract until either a national agreement is reached or 200 individual contracts are hammered out.

The two sides had "constructive conversations well into December", says Harald Boersma, a spokesman for Elsevier. "We will continue our conversations in the first quarter of 2018 to find an access solution for German researchers in 2018 and a longer-term national agreement," he says. "Where access agreements ended, we have informed these institutions that we would maintain access to our content while we continue to work with the German Rectors' Conference [which leads negotiations for the consortium] on a solution and specifically a one-year extension to existing contracts, covering 2018."

Günter Ziegler, a mathematician at the Free University of Berlin and a member of the consortium's negotiating team, says that German researchers have the upper hand in the talks. "Most papers are now freely available somewhere on the Internet, or else you might choose to work with preprint versions," he says. "Clearly our negotiating position is strong."

Academic-publishing experts around the world are keenly observing the situation in Germany. The nationwide deal sought by scientists includes a open-access option, under which all corresponding authors affiliated with German institutions would be allowed to make their papers free to read and share for anyone in the world. This would be a milestone for global efforts to make the results of publicly funded research immediately and freely available to scientists and the wider public, they say. ■