Quantum race accelerates development of silicon quantum chip

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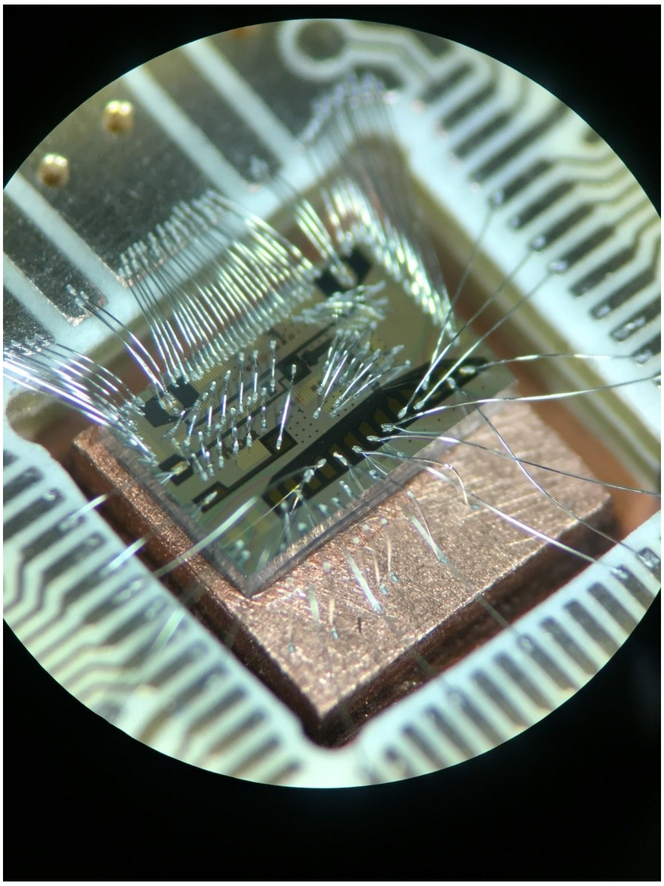


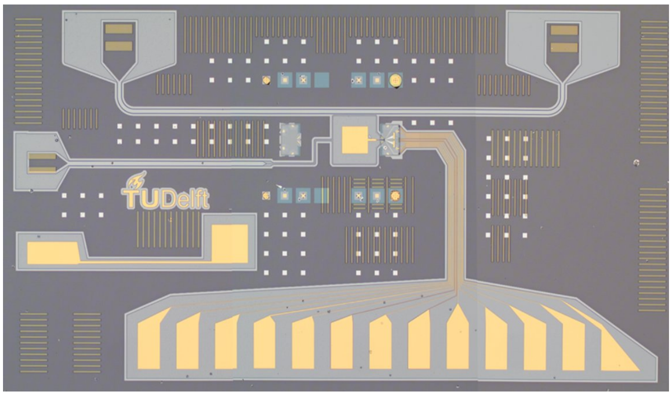
Credit: TU Delft

A team of TU Delft scientists led by Professor Vandersypen seeks to create better and more reliable quantum processors. In a neck-and-neck race with competitors, they showed that quantum information of an electron spin can be transported to a photon in a silicon quantum chip. This is important in order to connect quantum bits across the chip and to scale up to large numbers of qubits. Their work was published today in *Science*.

Quantum computers of the future will be able to carry out computations far beyond the capacity of today's computers. Quantum superpositions and entanglement of quantum bits (qubits) make it possible to perform parallel computations.

Quantum chips are made of silicon. "This is a material that we are very familiar with," explains Professor Lieven Vandersypen of QuTech and the Kavli Institute of Nanoscience Delft, "Silicon is widely used in transistors and so can be found in all electronic devices." But silicon is also a very promising material for quantum technology. Ph.D. candidate Guoji Zheng says, "We can use electrical fields to capture single electrons in silicon for use as quantum bits (qubits). This is an attractive material as it ensures the information in the qubit can be stored for a long time."

Making useful computations requires large numbers of qubits, and it is this upscaling to large numbers that is providing a challenge worldwide. "To use a lot of qubits at the same time, they need to be connected to each other; there needs to be good communication", explains researcher Nodar Samkharadze. At present the electrons that are captured as qubits in silicon can only make direct contact with their immediate neighbours. Nodar: "That makes it tricky to scale up to large numbers of qubits."



Credit: TU Delft

Other quantum systems use photons for long-distance interactions. For years, this was also a major goal for silicon. Only in recent years have scientists made progress, here. The Delft scientists have now shown that a single electron spin and a single photon can be coupled on a silicon chip. This coupling makes it possible in principle to transfer quantum information between a spin and a photon. Guoji Zheng says, "This is important to connect distant quantum bits on a silicon chip, thereby paving the way to upscaling quantum bits on silicon chips."

In a separate study published in the same issue of *Science* today, other researchers from the Kavli institute of Nanoscience at TU Delft also describe a way to transfer spin information to photons.

More information: "Strong spin-photon coupling in silicon" *Science* (2018). science.sciencemag.org/lookup/ … 1126/science.aar4054

Provided by Delft University of Technology

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