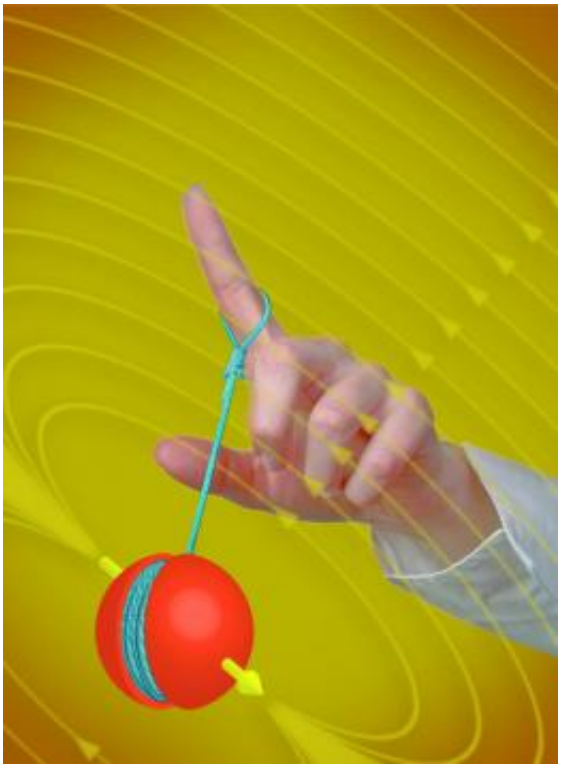
Better control of building blocks for quantum computer

December 23 2010

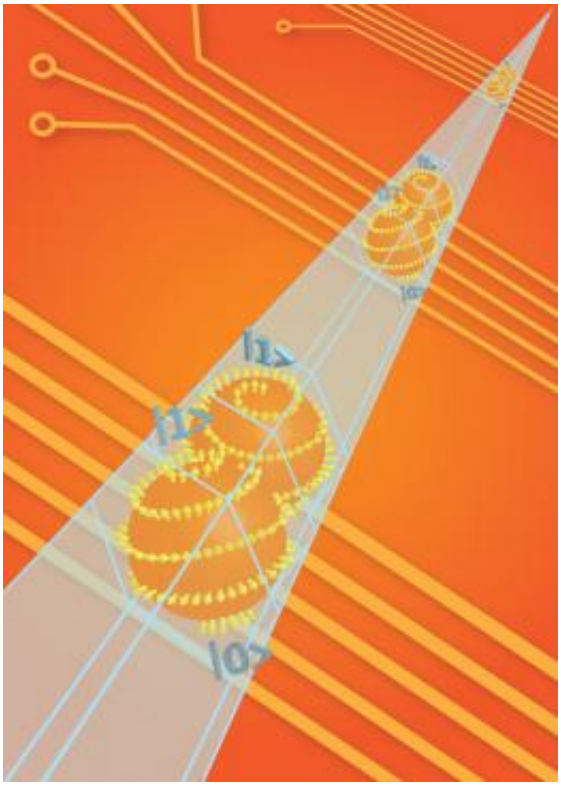


Artist's impression of the spin-orbit qubit. Like in a yo-yo toy, by moving the electron one controls its spin. Credit: Gemma Plum

Dutch scientists from the Kavli Institute of Nanoscience at Delft University of Technology and Eindhoven University of Technology have succeeded in controlling the building blocks of a future super-fast quantum computer. They are now able to manipulate these building

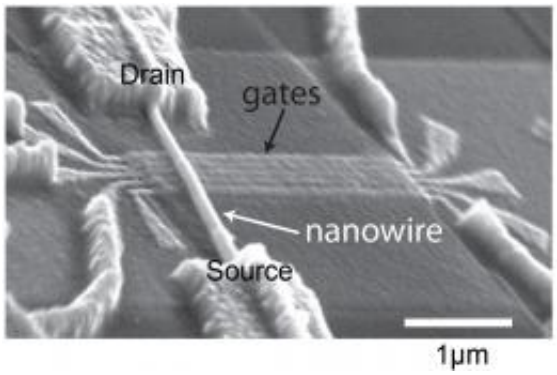
blocks (qubits) with electrical rather than magnetic fields, as has been the common practice up till now. They have also been able to embed these qubits into semiconductor nanowires. The scientists' findings have been published in the current issue of the science journal *Nature* (23 December).

A qubit is the building block of a possible, future quantum computer, which would far outstrip current computers in terms of speed. One way to make a qubit is to trap a single electron in semiconductor material. A qubit can, just like a normal computer bit, adopt the states '0' and '1'. This is achieved by using the spin of an electron, which is generated by spinning the electron on its axis. The electron can spin in two directions (representing the '0' state and the '1' state).



Nanowire-1-WEB: Artist's impression of nanowire qubits. Credit: Gemma Plum

Until now, the spin of an electron has been controlled by magnetic fields. However, these field are extremely difficult to generate on a chip. The electron spin in the qubits that are currently being generated by the Dutch scientists can be controlled by a charge or an electric field, rather than by magnetic fields. This form of control has major advantages, as Leo Kouwenhoven, scientist at the Kavli Institute of Nanoscience at TU Delft, points out: "These spin-orbit qubits combine the best of both worlds. They employ the advantages of both electronic control and information storage in the electron spin."



Scanning electron image of the nanowire device with gate electrodes used to electrically control qubits, and source and drain electrodes used to probe qubit states.

There is another important new development in the Dutch research: the scientists have been able to embed the qubits (two) into nanowires made of a semiconductor material (indium arsenide). These wires are of the order of nanometres in diameter and micrometres in length. Kouwenhoven: "These nanowires are being increasingly used as convenient building blocks in nanoelectronics. Nanowires are an excellent platform for quantum information processing, among other applications."

More information: Nadj-Perge, S, et al. (2010) Spin-Orbit qubit in a semiconductor nanowire. *Nature* 468, 1084 – 1087.

Provided by Delft University of Technology