natural candidates to extend MRI to themolecular scale. However, making full use of the potential capabilities of this approach brings certain challenges. Because the write head sits on a macroscopic sled that rests in contact with the diamond, the distance from the NV centre is not well-controlled, depending on the overall topography of the interface and the pressure. Technical artefacts like background photoluminescence and remanent magnetic fields can distort the results and must be considered. Implementing a nano-MRI setup will require ingenuity to bring the NV centre, the write head and the object under study into sufficiently close proximity. ❐

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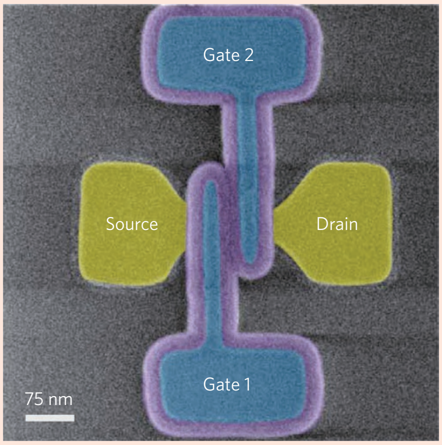
QUANTUM COMPUTATION

Towards on-chip qubits

In recent years, research on quantum information has achieved a series of remarkable results. In particular, single spins in silicon have been exploited as high-fidelity quantum bits (qubits) with dephasing times in the order of hundreds of μs and coherence times in the order of hundreds of ms. Such long values could be observed thanks to the isotopic purification of Si — that is, the minimization of the content of ^{29}Si and of the detrimental hyperfine interaction with its non-zero nuclear spin. Eventually, this led to the implementation of logic gates based on two in-series qubits in isotopically-purified Si.

All these breakthroughs have naturally contributed to raise concrete prospects for the realization of quantum computing tasks based on hardware devices ready for large-scale production. Along these lines, a further remarkable result has been published recently in *Nature Communications* by R. Maurand *et al.* (**7**, 13575; 2016). The researchers fabricate a silicon-nanowire two-gate transistor based on complementary metal-oxide-semiconductor conventional technologies



NPG

(pictured). At dilution-fridge temperatures, the gate electrodes define in the undoped Si channel two in-series multi-hole quantum dots, which are exploited as encoding and read-out qubits, respectively. At the same time, the gate voltages control the hole occupancies at the two quantum dots independently and allow the researchers to reach a Pauli-spin-blockade-like regime for the electron transport. That is, a spin-triplet configuration for the two quantum dots inhibits source–drain transport processes because of the Pauli principle.

The transport-blockade condition can be modulated by the application of properly tuned microwave radiation at the encoding qubit, where coherent Rabi oscillations are induced. After a qubit initialization, the researchers exploit single microwave pulses with variable length and power to map the resulting source-drain current. This current is also modulated by the Rabi oscillations in the encoding qubit, whose frequency value — up to 85 MHz — is quantified in turn. Multi-pulses Ramsey and Hahn sequences are then exploited by the researchers with the aim of quantifying the dephasing time (~60 ns) and the intrinsic coherence time (~250 ns), respectively. Although these values are much shorter than what has been reported for isotopically purified Si, the work is still a brilliant proof-of-principle demonstration of the possibility to define qubits by means of conventional industrial fabrication processes.

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