

Quantum computing with diamonds

By using lasers to create precisely engineered crystal defects, a group at the universities of Oxford and Warwick is learning to turn diamonds into the building blocks of a quantum computer.

- Diamond could be an ideal material for quantum information processing
- Laser pulses can create precise arrays of qubits
- Lack of damage to crystal lattice means qubits are high quality

A quantum computer has the potential to solve many problems that no ordinary computer could tackle. This great promise is driving several different approaches to building such a machine.

One idea is to use a type of microscopic defect that occurs in diamonds, where among the usual carbon atoms, a nitrogen atom and a vacancy sit next to one another. At these nitrogen-vacancy (NV) centres, a pair of electrons can form a qubit. A qubit is the basic element of any quantum computer which can be manipulated using laser light.

For a quantum computer chip, these vacancies should be arranged in a regular pattern. One way to do this is bombard the diamond with nitrogen ions, but this can cause damage to the surrounding crystal which makes the qubits low-quality – less able to store quantum information for very long or to operate reliably.

The Oxford/Warwick team take another approach known as laser writing. They use brief, intense laser pulses to create vacancies, and then heat the diamond so each vacancy drifts around until it meets a nitrogen atom.

In the latest work, this step is also induced by the laser, which should help the team optimise individual qubits. The process could be used to make chips containing 10,000 or more qubits, as components in a scalable, fault-tolerant quantum computer.

This work has been made possible through UKRI funding as part of the National Quantum Technologies Programme (NQTP), as well as EPSRC studentships. The team also work closely with Element Six, a company producing synthetic diamonds, which is a partner in the National Programme.

For more information, visit uknqtp.epsrc.ac.uk or contact quantumtechnologies@epsrc.ukri.org

The UK National Quantum Technologies Programme aims to ensure the successful transition of quantum technologies from laboratory to industry. The programme is delivered by EPSRC, Innovate UK, BEIS, NPL, GCHQ, Dstl and KTN.