Diamonds and the holy grail of quantum computing

June 29 2010

Since Richard Feynman's first envisioned the quantum computer in 1982, there have been many studies of potential candidates -- computers that use quantum bits, or qubits, capable of holding an more than one value at a time and computing at speeds far beyond existing silicon-based machines for certain problems. Most of these candidate systems, such as atoms and semiconducting quantum dots, work for quantum computing, but only at very low temperatures.

Now a team of researchers from the Wuhan Institute of Physics and Mathematics, the Chinese Academy of Sciences and the Hefei National Laboratory for Physical Sciences at the Microscale at the University of Science and Technology of China has made a step toward a warmer solution.

As reported in the journal Applied Physics Letters, the team is exploring the capabilities of diamond nitrogen vacancy (NV) materials. In this material, a "molecule" at the heart of an artificially created diamond film consists of a nitrogen atom (present as in impurity amid all those carbon atoms) and a nearby vacancy, a place in the crystal containing no atom at all. These diamond structures offer the possibility of carrying out data storage and quantum computing at room temperature.

One of the challenges of this technology is the difficulty of coupling two of the NV centers in separate nanocrystals of diamond. To make a quantum computer, many diamond-NV centers need to be coupled (made quantum coherent with each other), encoding the information in

each, and operations based on their interactions (or couplings) must be undertaken. Mang Feng of the Wuhan Institute of Physics and Mathematics of the Chinese Academy of Sciences and his collaborators present an idea that could lead to a quantum mechanical coupling of these NV centers, called entanglement. This proof of principle is now ready to be extended to multiple operations, which is by no means a simple accumulation of the operations.

"Our research is another step in realizing the potential of the long-envisioned quantum computers with techniques available currently or in the near-future," states Dr. Feng, "Continued advances could stimulate further exploration in condensed matter physics, quantum information science and diamond making technology."

More information: The article, "One-step implementation of multi-qubit conditional phase gating with nitrogen-vacancy centers coupled to a high-Q silica microsphere cavity" by Wan-li Yang et al will appear in the journal Applied Physics Letters. See: apl.aip.org/

Provided by American Institute of Physics