Diamonds could store millions of times more information

Precious stones have potential to process information dozens of times faster than current silicon-based systems

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Diamond sheets filled with holes could be the key to the next generation of supercomputers.

Scientists in California have used commercially available technology to pattern large sheets of diamonds with tiny, nitrogen-filled holes. The nitrogen-vacancy diamonds, as the sheets are called by scientists, could store millions of times more information than current silicon-based systems and process that information dozens of times faster.

Exactly how diamond-based computing would be used has yet to be determined, but applications could range from designing more efficient silicon-based computers to drug development and cryptography.

Nitrogen has been in diamonds for as long as their have been diamonds; it's why some diamonds have a yellow hue. For years scientists have used these natural, nitrogen-infused diamonds to study various aspects of quantum mechanics.

"We've used well-known techniques to create atomic-size defects in otherwise perfect diamonds," said David Awschalom, a scientist at the University of California, Santa Barbara and co-author of a new article in the journal *ACS Nano Letters*.

A supercomputer based on quantum mechanics requires more precision than nature can provide, so scientists have searched for a way to artificially implant arrays of precisely patterned nitrogen holes inside sheets of diamond.

Scientists from the University of California, Santa Barbara, along with colleagues from the Lawrence Berkeley National Laboratory, created such an array by using an ion beam to first knock out two carbon atoms, and then replace them with one nitrogen atom. In one second, the scientists could inject about 4,000 glowing nitrogen atoms. In about one minute, the scientists had patterned several inches of flat diamond.

The scientists didn't use any overly complicated techniques to accomplish this. "You can buy it online, send it to another company for the patterning, and then explore it yourself," said Awschalom, whose students did exactly that to demonstrate the ease of the technology.

The key to a diamond-based quantum mechanical computer is an extra electron in the hole. In a traditional computer, information is encoded as either a "0" or a "1." In a diamond-based quantum computer, information could be stored in the spin of that electron. This means information could be stored as not only a "0" or "1," but also the direction the electron is spinning.

An exact number is hard to come by, but scientists say this would dramatically increase the computing power compared with existing silicon computers.

Diamonds likely wouldn't replace the silicon used in today's consumer computers, said Ray Beausoleil, a fellow in Information and Quantum Systems at HP. "A quantum computer won't help you add two numbers faster," said Beausoleil.

However, that doesn't mean consumers won't benefit from a diamond-based quantum computer. What it will do is help model certain extremely complex problems, says Beausoleil and David DiVincenzo, a scientist at IBM who is also familiar with the *Nano Letters* article.

"This points to the fruitful end of a very long search of all the things that you could put in diamond to make it electronically active," said DiVincenzo.

Diamonds aren't a sure bet for a quantum computer, said DiVincenzo, but they're certainly in the running because of this research.