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Spintronics

Room-Temperature Quantum Magnets

Colloidal semiconducting quantum dots become magnetized by light

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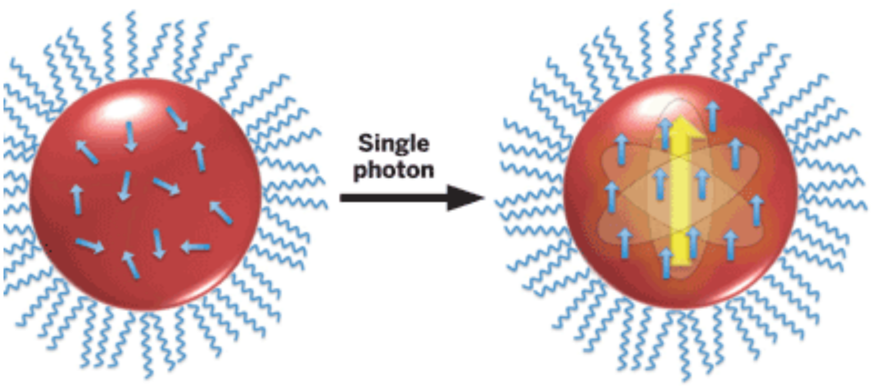

Exposing this quantum dot to one photon creates an electron-hole pair known as an exciton (yellow arrow), causing manganese impurities (gray arrows) to line up at room temperature.

In a breakthrough for spintronics—research that aims to use the magnetic moments of electrons to process information—scientists have discovered that chemically prepared, impurity-laced quantum dots can spontaneously line up their magnetic fields with the application of light. Notably, this process can occur at up to room temperature (*Science* **2009,** *325,* 973).

Chemistry professor Daniel R. Gamelin of the University of Washington, Seattle, and colleagues there and at the University of Duisburg-Essen, in Germany, doped cadmium-selenide quantum dots with manganese, then bombarded them with laser light, causing the dots to generate large magnetic fields.

Quantum dots—collections of ions only a few nanometers across—behave like giant atoms, with electrons delocalized over the entire dot. The goal of Gamelin's work was to use an "exciton," an electron-hole pair that simultaneously affects all the impurities in a quantum dot, lining up their spins. Such quantum dot magnets are expected to function as tunable, hybrid electronic/magnetic components of information processing and storage devices that work much faster and use less power than traditional charge-based devices (C&EN, Aug. 28, 2006, page 30).

Many researchers have triggered this magnetic lineup in doped quantum dots by applying large magnetic fields; and a few researchers have reported accomplishing it with laser light, but only partially, and at frigid temperatures of only a few Kelvin.

The new process, which works at room temperature, "represents an exciting development for spin-based electronics," notes spintronics pioneer David Awschalom, a physics professor at the University of California, Santa Barbara.

Spintronics research is starting to attract more chemists, who bring their own special skills to the table. Gamelin's strategy of preparing magnetic semiconducting quantum dots as colloids, rather than epitaxially, offers some unique advantages. For example, the process allows them to use traditional chemical purification techniques, as well as making it possible to evenly distribute dopants throughout the quantum dot, rather than clumping together.

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