Semiconductors with electric and magnetic properties

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European scientists developed solid-state semiconductor components with magnetic properties, a prerequisite for a new generation of electronic devices exploiting both the charge and the spin of electrons.

Conventional electronics are based on the flow of electrons, negative charge carriers. Magnetic systems rely on principles governing electron spin, a quantum physical phenomenon related to angular momentum.

The angular momentum associated with spin produces a magnetic field. In most materials, magnetic fields of individual atoms cancel one another. In magnetic materials of various types, generally metals, atomic dipole moments become aligned (polarised) producing macroscopic magnetic fields.

Magnetic storage devices are based on the use of different patterns of magnetisation corresponding to information in stored data. With the advent of nanotechnology and the interest in building functional systems on the scale of atoms and molecules, a new field known as spintronics has emerged.

Spintronics, short for spin electronics and also known as magnetoelectronics, exploits electron spin in addition to charge. It uses them together to lay down and read back bits of data on semiconductor (solid-state) material and could provide the foundation for entirely new computational paradigms.

One of the most direct methods of introducing spin-polarised electrons into a semiconductor is by adding metal 'dopants' (impurities that modify the semiconductor's properties) to produce co-called dilute magnetic semiconductors (DMS).

European scientists seeking to develop a suitable electro-deposition process to synthesise DMS nanowire structures and semiconductor junctions initiated the 'Doped magnetic ZnO p-n junction heterostructures for nano-spintronic devices' (MAJIC-SPIN) project.

The consortium successfully produced doped nanowires via a direct electro-deposition technique. They then studied their compositions, structures and magnetic properties via a variety of advanced experimental techniques including X-ray absorption-based methods and a superconducting quantum interference device (SQUID).

In the case of cobalt (Co)-doped nanowires, scientists demonstrated full incorporation of Co into the lattice and the presence of a magnetically ordered phase.

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