New magnetic semiconductor material holds promise for 'spintronics'

September 10 2013

Researchers at North Carolina State University have created a new compound that can be integrated into silicon chips and is a dilute magnetic semiconductor – meaning that it could be used to make "spintronic" devices, which rely on magnetic force to operate, rather than electrical currents.

The researchers synthesized the new compound, strontium tin oxide (Sr_3SnO), as an epitaxial thin film on a silicon chip. Epitaxial means the material is a single crystal. Because Sr3SnO is a dilute magnetic semiconductor, it could be used to create transistors that operate at room temperature based on magnetic fields, rather than electrical current.

"We're talking about cool transistors for use in spintronics," says Dr. Jay Narayan, John C. Fan Distinguished Professor of Materials Science and Engineering at NC State and senior author of a paper describing the work. "Spintronics" refers to technologies used in solid-state devices that take advantage of the inherent "spin" in electrons and their related magnetic momentum.

"There are other materials that are dilute magnetic semiconductors, but researchers have struggled to integrate those materials on a silicon substrate, which is essential for their use in multifunctional, smart devices," Narayan says. "We were able to synthesize this material as a single crystal on a silicon chip."

"This moves us closer to developing spin-based devices, or spintronics,"

says Dr. Justin Schwartz, co-author of the paper, Kobe Steel Distinguished Professor and Department Head of the Materials Science and Engineering Department at NC State. "And learning that this material has magnetic semiconductor properties was a happy surprise."

The researchers had set out to create a material that would be a topological insulator. In topological insulators the bulk of the material serves as an electrical insulator, but the surface can act as a highly conductive material – and these properties are not easily affected or destroyed by defects in the material. In effect, that means that a topological insulator material can be a conductor and its own insulator at the same time.

Two materials are known to be topological insulators – bismuth telluride and bismuth selenide. But theorists predicted that other materials may also have topological insulator properties. Sr3SnO is one of those theoretical materials, which is why the researchers synthesized it. However, while early tests are promising, the researchers are still testing the Sr3SnO to confirm whether it has all the characteristics of a topological insulator.

More information: The paper, "Epitaxial integration of dilute magnetic semiconductor Sr3SnO with Si (001)," was published online Sept. 9 in *Applied Physics Letters*.

Provided by North Carolina State University