NATURE | NEWS

Lab-made supermaterial that could boost computing exists in nature too

Naturally occurring topological insulator is cleaner than synthetic samples.

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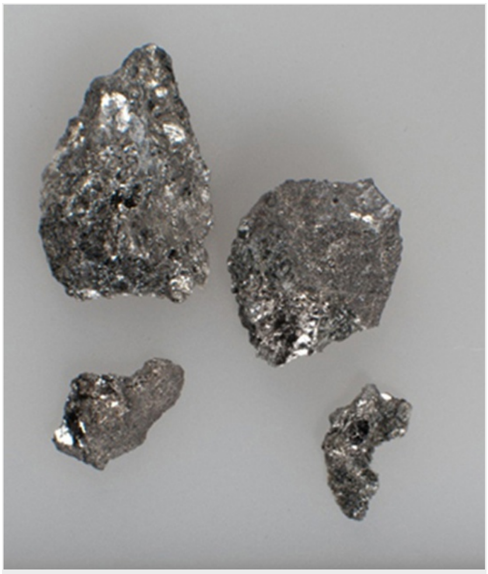
They say it's what is on the inside that counts. But that is not true for topological insulators — exotic materials that conduct electricity only along their surfaces. Physicists have now demonstrated this property in a naturally occurring mineral for the first time[1].



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Like some advanced artificial materials, kawazulite conducts electricity at its surface but not in its bulk.

Their findings could boost efforts to build spintronic devices — in which currents are driven by an intrinsic property of electrons called spin, rather than by voltages. The results could also help the design of quantum computers that would use spin to encode information.

Predicted to exist in 2005[2], topological insulators were first synthesized from heavy elements in 2008[3]. Their odd conducting abilities arise because each electron's spin becomes coupled to its motion. This relationship compels the electrons to circle around on the spot, preventing them from moving through the bulk material, so that they cannot conduct electricity.

But at the material's edge, the electrons do not have enough space for this circling motion; instead, they are forced to hop along the surface in semicircular jumps, enabling conduction.

Round and round

The thin conducting layer of a topological insulator makes it relatively easy for physicists to manipulate the spin current. "Topological insulators raise the possibility of building spintronic devices that use electron spin, rather than charge," says Pascal Gehring, a solid-state physicist at the Max Planck Institute for Solid State Research in Stuttgart, Germany, and a co-author of the latest study. Spins can be rotated quickly without expending much energy, so spintronic devices should be more efficient than their electronic counterparts, in which energy is required to change charges, he adds.

Physicists attempting to construct quantum computers that would outperform the best current machines are also interested in encoding information in electron spins, rather than whether a current is on or off. In theory, it is difficult to corrupt these values in a topological insulator, because of the link between spin and motion. To flip the spin value accidentally, you would have knock the system hard enough to cause the electron to make a complete U-turn, explains Gehring.

Gehring and his colleagues examined a natural sample of the mineral kawazulite, which contains bismuth, tellurium, selenium and sulphur, found at a former gold mine in the Czech Republic. They cleaved off single crystalline sheets 0.7 millimetres wide, and subjected them to the standard test for a topological insulator: photoelectron spectroscopy. This involves measuring the properties of electrons dislodged from a material when ultraviolet light is fired at its surface.

Their results, published in *Nano Letters*[1], confirm that the electrons' energy and momentum distribution matches predictions for a topological insulator.

Feng Liu, a materials scientist at the University of Utah in Salt Lake City, notes that kawazulite has been synthesized in the past, but that topological insulators built in the lab always have structural defects that create unwanted conduction in the bulk.

"Surprisingly, the team's natural sample is cleaner than synthesized samples — even though you would expect it to be more dirty," says Liu. "It may turn out to be cheaper to use a natural supply of topological insulators than it is to make, process and clean them in the lab.”

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References

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3. Hsieh, D. *et al*. *Nature* **452**, 970–974 (2008).