A novel platform for future spintronic technologies

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Spintronics is an emerging field of technology where devices work by manipulating the spin of electrons rather than their charge. The field can bring significant advantages to computer technology, combining higher speeds with lower energy consumption. Spintronic circuits need ways to control electron spin without interference from electron charge. Scientists at Ecole Polytechnique Federale de Lausanne, working with Université Paris-Sud and Paul Scherrer Institut, have discovered that a common insulating material behaves as a perfect spintronic conductor because it is not affected by background electron charge. In addition, the material's properties make it an ideal platform for directly observing a strange subatomic particle that could one day lead to a different, more stable type of quantum computers.

Spintronics

Spintronics (spin-transport or spin-based electronics) is a technology that exploits a quantum property of electrons called spin. Although difficult to describe in everyday terms, electron spin can be loosely compared to the rotation of a planet or a spinning top around its axis. Spin exists in either of two directions: "up" or "down", which can be described respectively as the clockwise or counter-clockwise rotation of the electron around its axis. Ultimately, spin is what gives electrons their magnetic properties, influencing the way they behave when they enter a magnetic field.

The different directions of electron spin can be used to encode information, much like the binary code used in digital communication. Spintronics can therefore open up a new generation of devices that combine conventional microelectronics with spin-dependent effects, overcoming the limitations of today's electronics like speed and energy consumption. The main challenge is being able to actually control electron spin, turning "up" or "down" as needed. This can be achieved with certain materials, but the problem is that these are often susceptible to interference from the charge of electrons.

An ideal material for spintronics

The team of Hugo Dil at EPFL, working with scientists from Paris and the PSI, has shown that a transparent insulating material, which normally does not conduct electrical charge, shows spin-dependent properties. The scientists used a method called SARPES, which has been perfected by Hugo Dil's group. The data showed that the electron gas at the surface of strontium titanate (SrTiO3) is spin-polarized, which means that it could be used to control the spin of electrons.

"This is interesting because it is the first evidence of a large spin polarization effect on a truly insulating substrate", says Hugo Dil. The discovery has significant implications for the future of spintronics, because it can lead to the development of spin-polarized materials that are not susceptible to interference from non spin-polarized electrical charge, allowing for finer and better control of electron spin.

A new particle for a different kind of quantum computer

Beyond spintronics, this insulating material might also be important for quantum computing, as it could be used to directly observe an elusive, strange particle called the Majorana fermion. This particle is unique because it actually is its own antiparticle as well. Sometimes referred to as the "ghost particle", the Majorana fermion has zero energy, zero moment, zero spin, and, so far, has never been observed unambiguously. In the future, Majorana fermions could become the foundation for a different kind of quantum computer that would, in theory, be exceptionally stable, as it would not be susceptible to external interference and noise.

More information: Santander-Syro AF, Fortuna F, Bareille C, Rödel TC, Landolt G, Plumb NC, Dil JH, Radović M. Giant spin splitting of the two-dimensional electron gas at the surface of SrTiO3. *Nature Materials* DOI: 10.1038/nmat4107

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