Electric control of aligned spins improves computer memory

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Researchers from Helmholtz-Zentrum Berlin (HZB, Germany) and the French research facility CNRS, south of Paris, are using electric fields to manipulate the property of electrons known as "spin" to store data permanently. This principle could not only improve random access memory in computers, it could also revolutionize the next generation of electronic devices.

This new kind of memory exploits a phenomenon called "tunnel magnetoresistance" or TMR. Two thin layers of a magnetic material are separated from each other by an insulator a mere millionth of a millimetre thick. Even though the insulator does not actually allow electrons to pass through it, some of the charge carriers still manage to sneak from one side to the other, as if by slipping through a tunnel. This is one of their quirky quantum behaviours. Another property it exploits is the intrinsic angular momentum of all electrons, which physicists call "spin". There are two spin states an electron can be in: either "up" or "down".

If most of the spins are oriented the same way in both magnetic layers of this TMR sandwich, then electrons tunnel much more easily than if one magnetic layer has mostly "up" spins and the other has mostly "down" spins. Such a component is used to build memory capable of rapid and repeated data writes, much like conventional memory, but also capable of permanently storing this data.

TMR-based memory known as MRAM has so far required relatively

strong magnetic fields to write data, and therefore a lot of energy. As CNRS researchers Vincent Garcia and Manuel Bibes show in their work presented in journal *Science*, however, this could change. They made their insulator out of the compound barium titanate. HZB researchers Sergio Valencia and Florian Kronast used X-ray absorption spectroscopy (XAS) to study the chemical composition of the magnetic layers of this sandwich.

The scientists can use an electric field to switch the insulator in a way that influences the electron spins in the magnetic layers either side of it, thereby influencing the electron tunnelling as well. Since the insulator keeps the same switched state when all current is removed, this model could be used to build PC memory that draws very little power and still stores data permanently.

More information: *Science* online, DOI: 10.1126/science.1184028

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