HELMHOLTZ ZENTRUM BERLIN
für Materialien und Energie

Press Release

Data at the end of the Tunnel

Electric control of aligned Spins improves Computer Memory

Researchers from Helmholtz-Zentrum Berlin (HZB) 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.

Articel in Science, DOI: 10.1126/science.1184028

Ferroelectric control of spin polarization: V. Garcia, M. Bibes, L. Bocher, S. Valencia, F. Kronast, A. Crassous, X. Moya, S. Enouz-Vedrenne, A. Gloter, D. Imhoff, C. Deranlot, N. D. Mathur, S. Fusil, K. Bouzehouane and A. Barthélémy

The **Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)** operates and develops large scale facilities for research with photons (synchrotron beams) and neutrons. The experimental facilities, some of which are unique, are used annually by more than 2,500 guest researchers from universities and other research organisations worldwide. Above all, HZB is known for the unique sample environments that can be created (high magnetic fields, low temperatures). HZB conducts materials research on themes that especially benefit from and are suited to large scale facilities. Research topics include magnetic materials and functional materials.

In the research focus area of solar energy, the development of thin film solar cells is a priority, whilst chemical fuels from sunlight are also a vital research theme. HZB has approx.1,100 employees of whom some 800 work on the Lise-Meitner Campus in Wannsee and 300 on the Wilhelm-Conrad-Röntgen Campus in Adlershof.

HZB is a member of the Helmholtz Association of German Research Centres, the largest scientific organisation in Germany.

Berlin, 19.01.2010

Further information:

Helmholtz-Zentrum Berlin
Hahn-Meitner-Platz 1
14109 Berlin
Germany

Dr. Sergio Valencia Molina
Institute Complex Magnetic Materials
Tel.: +49-30-6392-5750
sergio.valencia@helmholtz-berlin.de

Dr. Florian Kronast
Department of Magnetic Dynamics
Tel.: +49-30-6392-4620
florian.kronast@helmholtz-berlin.de

Press office:
Dr. Ina Helms
Tel.: +49-30-8062-2034
ina.helms@helmholtz-berlin.de