PRESS RELEASE

Resetting the future of MRAM

Berlin, 6.3.2012

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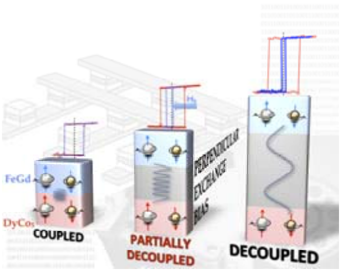
Helmholtz-Zentrum Berlin developed a magnetic valve that novel electronic devices can be realistic

In close collaboration with colleagues from Bochum and the Netherlands, researchers from the Helmholtz-Zentrum Berlin (HZB) have developed a novel, extremely-thin structure made of various magnetic materials. It is suitable as a kind of **magnetic valve for data-storage** units of the most recent generation and makes use of effects in the context of so-called spintronics, with which, in addition to the (re-)charging process, magnetic characteristics of the electrons can also be used for information-processing and -storage. The advantage of the new structure: data remain intact even after the electric current has been switched off and the memory can be re-written more or less indefinitely. The scientists published their results in the technical magazine Nature Communications (DOI: 10.1038/ncomms1728).



A pictorial view of the coupling mechanism between hard and soft ferrimagnetic alloys with perpendicular magnetization.
Foto: RUB/Abrudan

Everything began with basic academic curiosity; “First of all we just wanted to create a defined anisotropy with two thin, stacked ferrimagnetic layers”, says Florin Radu, physicist at the Institute for Complex Magnetic Materials of the Helmholtz-Zentrum Berlin (HZB) and principal author of the research paper. In other words, the researchers just wanted to create a structure in which a magnetic characteristic within the material changes in a well defined way. Experts in this field define this as magnetic hysteresis. It describes the behaviour of magnetic substances vis-à-vis an externally-applied magnetic field. However, the task proved to be much more difficult; the magnetic energies at the interfaces turned out to be so powerful that the magnetization of the films reverses together. It was necessary to place an additional, non-magnetic layer made of tantalum between the ferrimagnetic layers in order to diminish this effect.

What the scientists saw next was truly astounding; the system behaved fundamentally differently as compared to the conventional systems made of ferromagnetic and anti-ferromagnetic layers. The ferrimagnet described as magnetically “soft”, which consists of the chemical elements iron and gadolinium, unexpectedly indicated an alteration in the hysteresis, while the existing magnetism remained unaltered for the “hard” ferrimagnetic film that consists of the chemical elements dysprosium and cobalt.

This discovery paves the way for an even more vigorous research in the field of spintronics. “Know how, Show how!”, thus proclaims the research maxim of Radu. “I would not be surprised to see this discovery implemented into PC’s, smart phones and tablets in the future”, he predicts. For his invention the so-called spin-valve the HZB filed a patent application this week.

Nowadays, the data storage units are either volatile or non-volatile. For the former, the information is lost as soon as the device is switched off, and for the latter the information remain intact for many years. Due to thermal effects, they are also practically unusable after about ten years. In particular, when the bits are only a few nanometres in size, they lose stability. Once lost, the magnetization direction of the hard magnetic layer cannot easily be set again in the original direction. This leads to irretrievably loss of data.

This stability issue can now be addressed with the new spin-valve concept. By tunning the magnetic properties of the hard ferrimagnetic layer, the so-called RAM memory building-blocks (RAM stands for random access memory) can be manufactured with controlled life-time of the stored information of weeks, months or years. Thereafter, the magnetic orientation can be reset in the original state, which increases considerably the overall life expectancy of the information as compared to the existing non-volatile MRAM (Magnetoresistive Random Access Memory). These memory building-blocks are now certainly highly sought-after in the field of micro-electronics, but have not been able, to date, to be established in the markets due to high costs and technical problems.

With the spin-valve concept by Radu and his colleagues, electronic devices can now be developed that, similar to the MRAM technology, are operable immediately after being switched on and allow their data storage units to be re-written more or less indefinitely.

Scientific original publication:

F. Radu, R. Abrudan, I. Radu, D. Schmitz, H. Zabel: Perpendicular exchange bias in ferrimagnetic spin valves. Nature Communications, 2012. DOI: 10.1038/ncomms1728