Nanometer bridge combines magnetic and electronic worlds

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A gadolinium layer of no more than one nanometer in thickness is capable of combining the magnetic world with electronics. In this way, it will be possible to put a magnetic memory element directly to a silicon transistor: the basic building block of information technology. Memory that is directly coupled to processing power, is an attractive and energy efficient option.

In the October issue of *Nature Materials*, PhD-student Byoung-Chul Min, together with colleagues of the MESA+ Institute for Nanotechnology and led by dr. Ron Jansen, publish this novel way of bridging two disciplines.

Magnetic memories, like the hard disk, are based on technology that is totally different from the technology of electronic circuits. Until this moment, no one succeeded in combining a magnetic layer with electronics. This would be an interesting combination because a magnetic memory doesn't need additional energy to keep its content: once put into a memory state, it keeps this state. A magnetic layer, placed on a transistor, yields a powerful new component combining memory and processing power in a very direct way. This is good for cutting energy consumption, of vital importance in mobile devices.

The combination of magnetic material with silicon was not possible until now, although it was already done for other types of semiconductors like gallium arsenide. "We now demonstrate why it isn't going to work", Ron Jansen says. "If you put a layer of magnetic material directly on top of

silicon, a barrier will form and the resistance is a factor of 100 million too large. The magnetic information can in no way pass the barrier and get into the silicon."

With this in mind, the scientist tried to lower the barrier and come up with a solution that proves to be surprisingly effective. They have chosen the material Gadolinium, which has a special property: the so-called work function is very low. An electron can easily cross, out of the material an into the silicon. Electronics is in immediate contact with magnetics.

The thin layer of gadolinium is created via an evaporation process, enabling varying of the layer thickness with very high precision. The resistance can be varied over a large range, by a factor 100 million. The next step is to apply the magnetic material. Now that the contact problem has been solved, scientist can start designing new components in which electronic and magnetic technology is combined.

The research of Jansen c.s. has been done in the NanoElectronics group –still to be founded- of MESA+ Institute for Nanotechnology. It has been supported by Dutch national NanoNed programme. The scientists have closely cooperated with researchers of Sony Corporation.

The article, entitled, 'Tunable spin-tunnel contacts to silicon using low-workfunction ferromagnets' by B.C. Min, K. Motohashi, J.C. Lodder and R. Jansen is published in the October issue of *Nature Materials*.

Source: University of Twente

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