Spintronic -- the new electronic?

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European researchers have developed novel concept devices using ferromagnetic semiconductors.

Spintronic devices have created enormous advances in microelectronics, leading to faster, instant-on start times and orders-of-magnitude increases in data storage capacity. Spintronics is short for spin transport electronics - electronic devices that use the spin of an electron to carry information.

Currently, semiconductor devices work using charge, with positive and negative charges denoting the 1s and 0s of binary language, the lingua franca of computing. “But electrons have another degree of freedom,” says Charles Gould, co-coordinator of Nanospin, “and you can also control their spin, or their magnetic orientation.”

Spin then becomes another information carrier. There are numerous advantages to the technique. Information stored by charge is volatile; it disappears as soon as the current is cut off. This is why people can lose hours of work if there is a power cut and they forgot to save.

Instant-on devices

But in the proper environment, spin is non-volatile. In magnetic material, once you switch spin to up or down it stays in that orientation until you switch it back.

“It means that when you cut the current, everything stays as it is,” explains Gould. This could lead to instant-on devices.

Spintronic devices also use little power. “It takes a very low current to switch spin, which makes these devices very efficient,” Gould notes. And, at least theoretically, spintronic devices could have very high switching speed.

“We have not proven this in the lab yet, but many results in the theory have already been proven so high switching speeds [are quite likely],” Gould states. It could mean spintronic devices reach the terahertz range, which is pretty fast.

Reusing the wheel

Finally, spintronic devices have excellent scalability, because they are based on ferromagnetic semiconductors, and semiconductor manufacturing technologies are well established.

“There would still be engineering challenges - you would have to adapt current manufacturing techniques to these materials - but we would not have to reinvent the wheel,” reveals Gould.

Most existing spintronic devices use metals rather than semiconductors, mainly because researchers have yet to find a semiconducting material that works at room temperatures. The search is on, and researchers are confident they will find an appropriate material.

“Currently, the record is 185 Kelvin (-88°C), held by one of Nanospin’s partners, the University of Nottingham,” Gould explains. “But we are reasonably sure the temperature problem can be solved, because the theory has predicted values in the 100s of degrees centigrade for some materials.”

Spintronic devices are sufficiently compelling to deserve sustained research, and Nanospin set out to develop device demonstrators. Rather than tackling the room temperature problem directly, Nanospin intended to prepare the way for when an appropriate room temperature material is found.

Four strands

“Normally, you find a property or material and then develop a device to exploit it. We wanted to speed up the process by developing the concept devices in a lab now so they are ready when the appropriate material is found,” says Gould.

There were four strands to the team’s work: writing information to ferromagnetic semiconductors, retrieving it, high-speed switching between different states and the theoretical modelling of the devices to explain their operation and allow for optimisation.

“We were essentially looking at devices for memory and storage of information using ferromagnetic semiconductors,” Gould notes. The project was very successful, and generated a lot of interest from industry.

“IBM, Seagate, Hitachi and Western Digital have all expressed interest in our work, and Hitachi was a partner in Nanospin,” says Gould. For now, work continues and, while the Nanospin project is over, the partners are continuing to collaborate through a Marie Curie European network called SemiSpinNet.

“Currently, we are looking at logic schemes for spintronics, so we are moving from memory and storage to processing,” says Gould.

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