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A new type of spin valve that uses graphene

July 9 2007, By Miranda Marquit

"Some people think that graphene, a form of carbon, is the material of the future," Allen Goldman tells *PhysOrg.com*. "It's of high scientific interest because of its unusual electronic properties."

Goldman is a scientist at the University of Minnesota in Minneapolis. Working with Masaya Nishioka, also at the University of Minnesota, Goldman has found new insight into spin transport in graphene. Their findings are published in an article titled "Spin transport through multilayer graphene," published in *Applied Physics Letters*.

Goldman and Nishioka have created a spin valve, and also observed a magnetic field controlled resistance change of 0.39%. "It's not a huge effect," Goldman admits, "but it is a step." He explains that this is not the first spin valve, but that it is the first that is "reasonably well characterized." He continues: "This isn't a huge breakthrough, but it is an incremental step in understanding graphene, and also a step in understanding whether this material has use in spin dependent electronics."

Spin dependent electronics, or "spintronics," makes use of quantum spin states of electrons. Applications for spintronic devices, and spin valves in particular, are currently limited to mass-storage systems. However, the technology and science is so emergent, that further applications are possible. The spin valve, which is what Goldman and Nishioka's work describes, makes use of magnetic thin films to control the resistive state of graphene: "We're talking about a memory device that doesn't have to be refreshed, and that is not volatile."

Because of its high electron mobility and low atomic number, graphene is of special interest in spintronics, and this is why Goldman and Nishioka chose to work with it. “The process seems really very simple,” says Goldman. He then writes via email to explain the process: “We take a substrate of silicon, which is doped and coated with silicon oxide. Then we place graphene flakes on the surface, and after selecting a suitable flake, fabricate a pair of cobalt electrodes to contact the flake. We can then switch the resistive state of the flake by controlling the relative orientations of the magnetizations of the electrodes.”

But there are caveats. “Even though the set up is simple, it can be hard to make these devices,” Goldman says over the phone. “And even though we can make graphene, it is a difficult process, especially to make single-layer graphene, which is why use multilayer graphene.” He emphasizes again that the effect he and Nishioka observed was quite small.

The goal, Goldman says, is to be able to master graphene to an extent that it would become possible to produce technologically useful devices. “Right now, we are at a point where we deal with little flakes. We need to work with films that are ordered over macroscopic distances,” he says.

Goldman feels that there is potential in graphene. “I don’t really know if it is the material of the future,” he explains, “but this experiment brings us a step closer to understanding it better. If the problems with graphene can be solved, there is a very good chance that it could be very useful.”

Citation: A new type of spin valve that uses graphene (2007, July 9) retrieved 19 April 2024 from https://phys.org/news/2007-07-valve-graphene.html