Demonstration of room temperature spin transport in germanium

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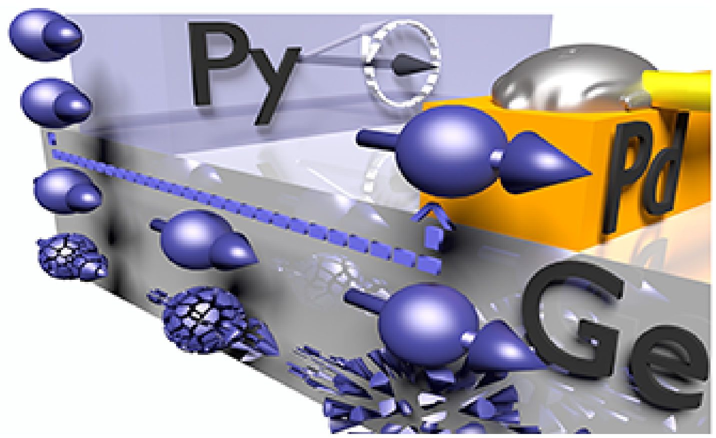

Credit: Sergei Dushenko/Osaka University and Masashi Shiraishi/Kyoto University

(Phys.org)—A team of researchers working in Japan has demonstrated that it is possible to conduct a spin current through a short segment of germanium at room temperature. In their paper published in the journal *Physical Review Letters*, the team describes their technique which could help lead to the development of spintronic devices.

Spintronics is the science of searching for and using materials that can sustain a spin-polarized current. The hope is that devices based on spintronics could allow for faster and more efficient computers. Some have even suggested they could play a role in the development of true quantum computers. But for this to happen, materials must be found that can overcome spin–orbit interaction—where fluctuations in magnetic fields present in materials causes scattering, resulting in changes to spin, destroying the possibility of it carrying useful information. In this new effort, the research team describes their analysis of germanium as a possible useful material for spintronics.

Prior research has suggested that germanium could carry spin current for a short distance if the material was in a very cold state—to find out if it might work also at room temperature, the researchers doped a layer of germanium with phosphorous (to serve as an electron donor) which grew on a silicon substrate. A spin current was injected (using microwaves) into the germanium via a ferromagnetic strip (which caused the spins to be aligned) placed on one side of the germanium layer. The current moved through the material towards a strip made of metal on the other side of the germanium layer, where it was subsequently detected by a device able to note spin polarization. The team reports that the current moved successfully through the strip, which was 660 nanometers thick, a distance comparable to other materials that are being tested and which is actually larger than the distance between size features in integrated circuits. That means a circuit could conceivably be made with information passing between two or more spintronic devices.

The team also noted that cooling a germanium sample down to 130 K doubled the distance the spin current was able to travel before degradation grew to the point of significance.

More information: Experimental Demonstration of Room-Temperature Spin Transport in n-Type Germanium Epilayers, *Phys. Rev. Lett*. 114, 196602 – Published 13 May 2015. journals.aps.org/prl/abstract/ … ysRevLett.114.196602 . On *Arxiv*: arxiv.org/abs/1501.06691

ABSTRACT

We report an experimental demonstration of room-temperature spin transport in n-type Ge epilayers grown on a Si(001) substrate. By utilizing spin pumping under ferromagnetic resonance, which inherently endows a spin battery function for semiconductors connected with a ferromagnet, a pure spin current is generated in the n−Ge at room temperature. The pure spin current is detected by using the inverse spin-Hall effect of either a Pt or Pd electrode on n−Ge. From a theoretical model that includes a geometrical contribution, the spin diffusion length in n−Ge at room temperature is estimated to be 660 nm. Moreover, the spin relaxation time decreases with increasing temperature, in agreement with a recently proposed theory of donor-driven spin relaxation in multivalley semiconductors.