In it for the long haul: Longer transmission lengths boost spin electronic applications

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Measuring spin propagation. Two magnetic contacts (left) are used to create a spin polarization (red arrows) at one end of a silver nanowire (yellow), whose value after travelling a defined distance is measured by a third contact. Credit: 2012 Nature Publishing Group

All modern electronics are based on the fundamental concept of electrical charges moving through a circuit. There are, however, alternative schemes that promise faster and more efficient types of computing. An example is spintronics, which is based on the use of the electron's magnetic property—its spin—instead of its electric charge.

Researchers at the RIKEN Advanced Science Institute in Wako have moved a step closer to realizing spintronic devices by showing that 'spin information' in various materials can travel much further than previously thought1. "Our experimental results could be useful for developing new devices such as the spin transistor and spin-logic devices," explains Yasuhiro Fukuma from the Quantum Nano-Scale Magnetics Team.

The basis for spintronics is to use the direction of the electron spins—up or down—in computing. The difference to conventional electronics is that there is no need for electrons to travel in order to pass on information about spin. Instead, the polarization of spin in one direction cascades along the device as the electrons influence their neighbors, one by one. However, measuring this spin diffusion in detail has been challenging. The spin signals are small and difficult to detect because their creation in spintronic devices is generally very inefficient. The research team has solved this problem by using two magnetic contacts to inject the spin signal into a thin silver wire, enhancing the amount of spin polarization present in the wire. This degree of polarization can then be measured at several distances along the wire by using a third contact that picks up the signal.

In the experiments, spin currents could even be detected at distances of over 10 micrometers. Even though the absolute magnitude of the spin signal may have decreased, the quality of the spin precession signal, the so-called coherence, is improved as travel distances increase. This is due to the fact that the collective coherent precession of the spins has a beneficial effect on the overall spin polarization over time, which recovers the output signal of the precession at greater distances. Moreover, the coherence of the spin precession as a function of the travel distance shows a universal behavior that is independent of the material used. This is welcome news for the realization of future devices, says Fukuma. "The universal behavior will be beneficial for designing spin current-based memory and logic devices by using a variety of metallic and semi-conductive materials, including graphene."

More information: Idzuchi, H., Fukuma, Y. & Otani, Y. Towards coherent spin precession in pure-spin current. *Scientific Reports* 2, 628 (2012). www.nature.com/srep/2012/12090 … /full/srep00628.html

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