Simple copper becomes an effective spintronic component thanks to molecular film

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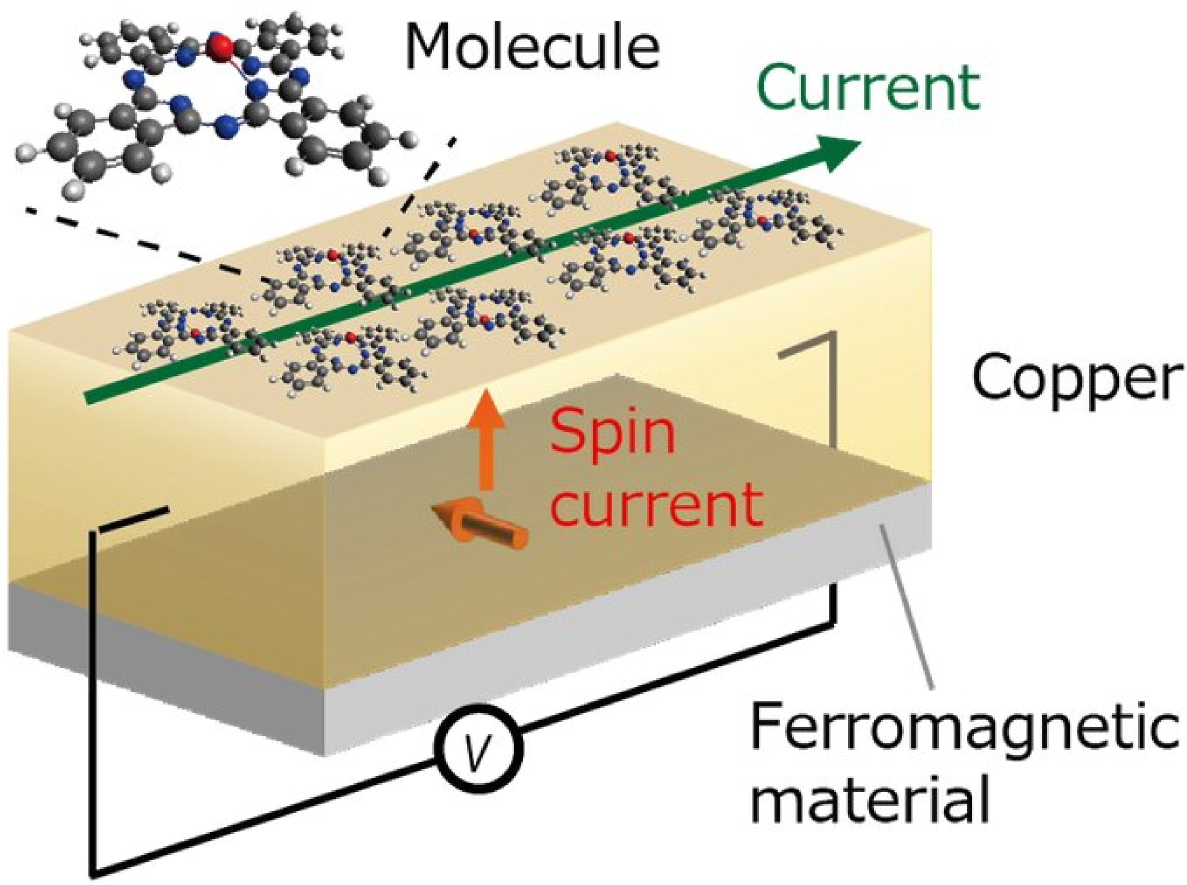


A diagram to show the composition of the experimental samples used in the study. Credit: © 2019 Isshiki et al.

Physicists have created a fabricate technique for spintronic devices. These high-performance, low-power devices have a promising future, so efficient ways to make them are highly sought after. The new fabrication method uses organic molecules that are relatively easy to configure for many purposes. Layers of molecules could be painted or printed onto metals to create new electronic functions.

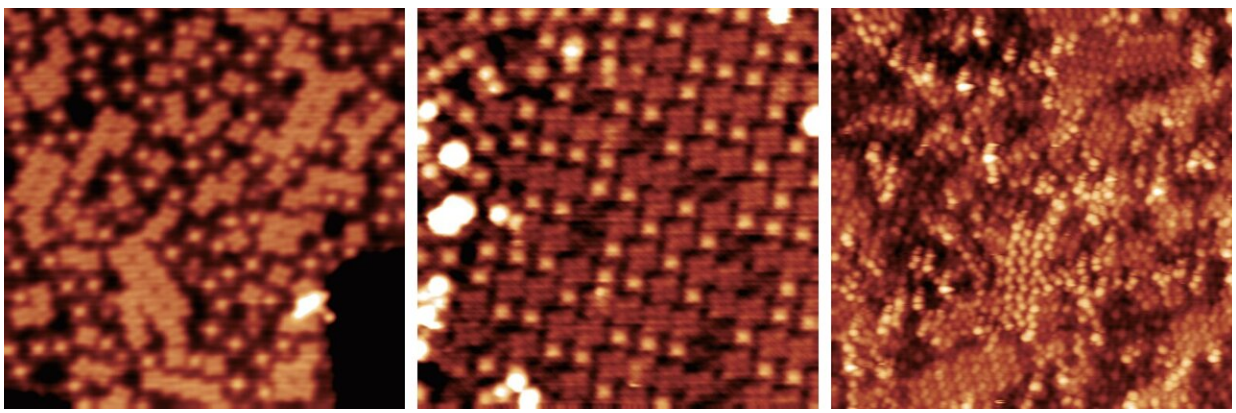
Spintronic devices may one day supersede current electronic devices. Whereas electronic devices depend on a flow of charge in the form of electrons in motion, spintronic devices exploit a different property of electrons known as spin. This is related to the electron's angular momentum, and the flow of spin is called a spin current.

There are several challenges to realizing useful spintronic devices. Among these are inducing a spin current, and then to imbue spintronic components with useful functions such as the ability to retain data for use as high-speed memory. Research Associate Hironari Isshiki and his team from the University of Tokyo's Institute for Solid State Physics have found a novel and elegant way to tackle both of these complex challenges.

"We successfully demonstrated an efficient conversion of spin current to charge current in a copper sample thanks to a simple coat of 'paint.' This layer is only one molecule thick, and comprises an organic substance," said Isshiki. "The device's conversion efficiency is comparable to that of devices made with inorganic metallic materials such as platinum or bismuth. However, in comparison to the inorganic materials, organic materials are much easier to manipulate in order to produce different functionality."

This organic layer is made of a substance called lead(II) phthalocyanine. A spin current injected into the surface covered by the molecule is efficiently converted to a familiar charge current. The researchers experimented with layers of different thickness to see which would be most effective. When the layer was a single molecule thick, the molecules aligned into an ordered arrangement that yielded the most efficient spin-to-charge current conversion.

"Organic molecules in particular offer spintronic researchers a high degree of design freedom as they are relatively easy to work with. The kinds of functional components we hope to see are things that could be useful in the field of high-performance computing or in low-power devices," explained Isshiki. "The incredibly thin layers required also mean we might one day create flexible devices or even devices you could create with a special kind of printer."



Scanning tunneling microscopy images of the organic layer at 0.6 molecule thick (left), 1.0 molecule thick (center) and 1.9 molecules thick (right). Credit: © 2019 Isshiki et al.

The next steps for Isshiki and colleagues are to explore other configurations of organic layers on conductive materials to realize novel spin functionalities. They also wish to investigate conversion of charge into spin current, the reverse process to that seen in this demonstration. This area of research aims to greatly accelerate the study of spintronics with organic molecules.

More information: Hironari Isshiki et al, Realization of spin dependent functionality by covering a metal surface with a single layer of molecules, *Nano Letters* (2019). DOI: 10.1021/acs.nanolett.9b02619

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