Researchers have found that certain organic semiconducting materials can transport spin faster than they conduct charge, a phenomenon which could eventually power faster, more energy-efficient computers.

The international team from the UK, Germany and the Czech Republic, have found that these materials could be used for 'spintronic' applications, which could make cheap organic semiconductors competitive with silicon for future computing applications. The results are reported in the journal *Nature Electronics*.

"To actually transfer information through spin, the electron's spin needs to travel reasonable distances and live for a long enough time before the information encoded on it is randomised," said Dr. Shu-Jen Wang, a recent Ph.D. graduate of the University of Cambridge's Cavendish Laboratory, and the paper's co-first author.

"Organic semiconductors have not been realistic candidates for spintronics so far because it was impossible to move spins around a polymer circuit far enough without losing the original information," said co-first author Dr. Deepak Venkateshvaran, also from the Cavendish Laboratory. "As a result, the field of organic spintronics has been pretty quiet for the past decade."

The internal structure of organic semiconductors tends to be highly disordered, like a plate of spaghetti. As such, packets of charge don't move nearly as fast as they do in semiconductors like silicon or gallium arsenide, both of which have a highly ordered crystalline structure. Most experiments on studying spin in organic semiconductors have found that electron spins and their charges move together, and since the charges move more slowly, the spin information doesn't go far: typically only a few tens of nanometres.

Now, the Cambridge-led team say they have found the conditions that could enable electron spins to travel far enough for a working organic spintronic device.

The researchers artificially increased the number of...
electrons in the materials and were able to inject a pure spin current into them using a technique called spin pumping. Highly conductive organic semiconductors, the researchers found, are governed by a new mechanism for spin transport that transforms them into excellent conductors of spin.

This mechanism essentially decouples the spin information from the charge, so that the spins are transported quickly over distances of up to a micrometre: far enough for a lab-based spintronics device.

"Organic semiconductors that have both long spin transport lengths and long spin lifetimes are promising candidates for applications in future spin-based, low energy computing, control and communications devices, a field that has been largely dominated by inorganic semiconductors to date," said Venkateshvaran, who is also a Fellow of Selwyn College.

As a next step, the researchers intend to investigate the role that chemical composition plays in an organic semiconductor's ability to efficiently transport spin information within prototype devices.


Provided by University of Cambridge

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