A platinum and yttrium iron garnet-based structure produces a new magnetoresistance effect

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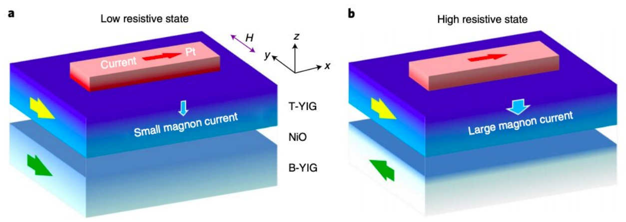

Figures showing the YIG/NiO/YIG/Pt heterostructure and the MNSMR effect. Credit: Guo et al.

In recent years, several research teams worldwide have been trying to develop a new class of devices known as spintronics or spin transport electronics. These devices can encode, store, process and transmit data using the spin of electrons in certain materials.

The operation of spintronics relies on magneto-transport effects, such as giant magnetoresistance (GMR) and tunneling magnetoresistance (TMR), which enable the transport of electrons through a given material in the form of a magnetic field. A spintronic device is generally made of two conductive ferromagnetic layers separated by a non-magnetic metal layer (i.e., a spin valve) or an insulator layer (i.e., a magnetic tunnel junction).

Magneto-transport effects, which occur in a device's spin valves and magnetic tunnel junctions, result in a relatively low resistance when the two magnetic layers are parallel and a relatively high resistance state when they are not. These effects are crucial to the functioning of many contemporary storage devices, including hard disk drives and magnetic random access memories (MRAMs).

Researchers at the Chinese Academy of Sciences in Beijing have recently carried out a study investigating magnetoresistance in spintronic device made of two platinum layers, a magnon junction and two insulating magnetic yttrium iron garnet (YIG) layers, separated by an antiferromagnetic nickel oxide layer. Their paper, published in *Nature Electronics*, outlines a magnetoresistance effect occurring in this system that could be leveraged to develop new spintronic devices.

"We report a magnetoresistance effect that occurs in a platinum layer deposited on a magnon junction consisting of two insulating magnetic yttrium iron garnet (YIG) layers separated by an antiferromagnetic nickel oxide spacer layer," the researchers wrote in their paper.

Essentially, the researchers found that the resistance of the platinum layer in their system depends on the magnetization of the YIG layer that it is directly in contact with, an effect that is known as spin Hall magnetoresistance. It also depends, however, on the magnetization of the YIG adjacent to it within the junction.

"The resistance of the platinum layer is higher when the two YIG layers are antiparallel than when parallel," the researchers wrote in their paper. "We assign this behavior to a magnonic nonlocal spin Hall magnetoresistance in which spin-carrying magnon propagation across the junction affects spin accumulation at the metal interface and hence modulates the spin Hall magnetoresistance."

The novel magnetoresistance effect unveiled by this team of researchers could prove very valuable for the development of spintronic devices. In fact, it could enable the fabrication of devices with capabilities similar to those of systems in which

TMR and GMR effects occur, but in which spin transport properties are controlled by an all-insulating magnon junction. This unique quality would ultimately free the devices from Joule heating effects.

Joule heating is a process that takes place when the electric current passing through a conducting material produces heat, affecting a device's overall energy efficiency. Devices that are free from the Joule heating effect could thus attain significantly higher energy efficiencies than those impacted by it.

More information: C. Y. Guo et al. A nonlocal spin Hall magnetoresistance in a platinum layer deposited on a magnon junction, *Nature Electronics* (2020). DOI: 10.1038/s41928-020-0425-9

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