Researchers synthesize half-metal with zero magnetization

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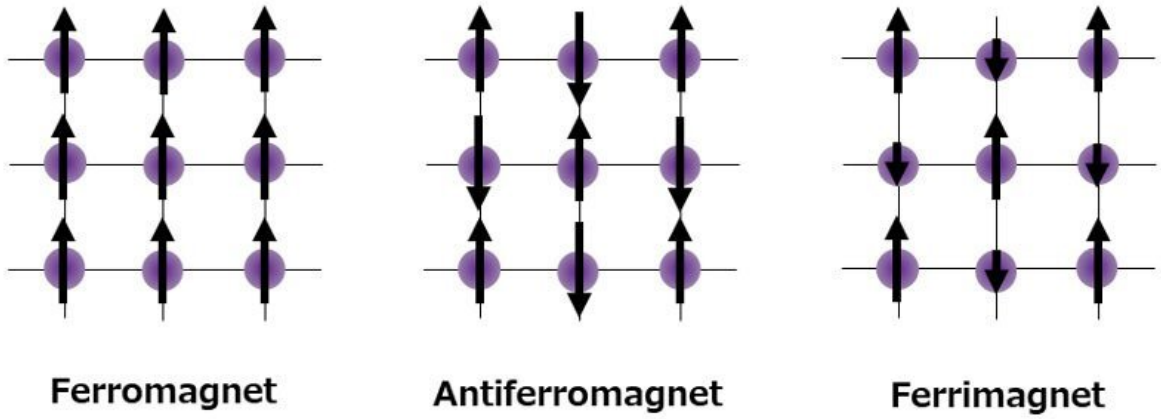


Spin arrangement of magnetic moments in ferromagnetic, antiferromagnetic, and ferrimagnetic materials. Credit: Rie Umetsu

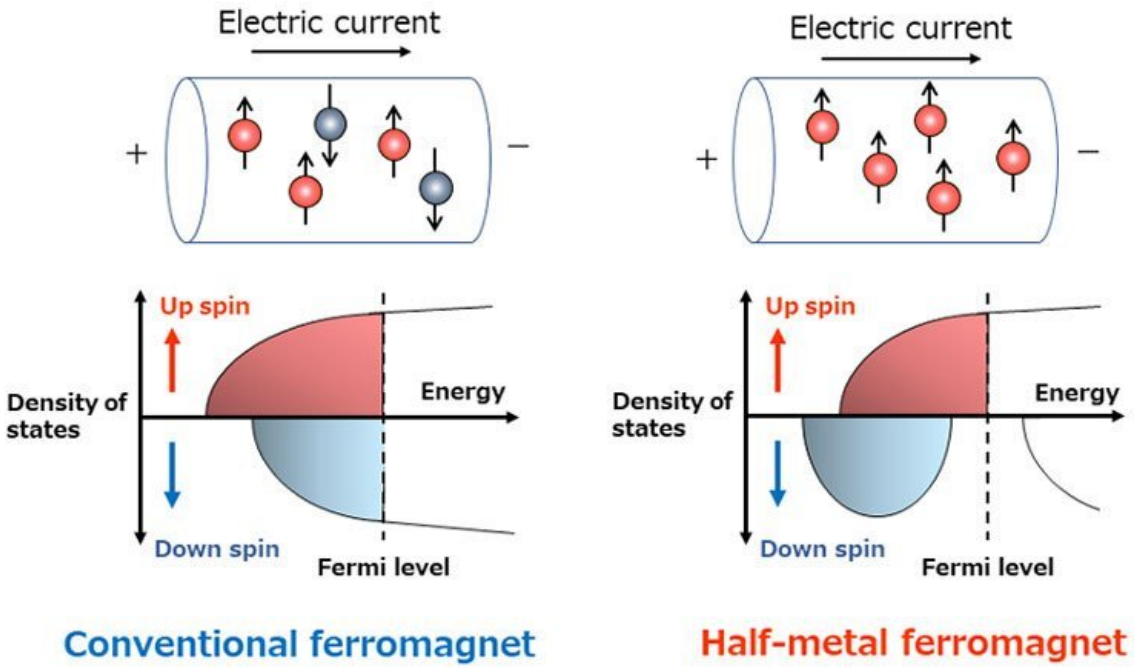
A research group has successfully synthesized a "half-metal" material, achieving a rare feat in the pursuit of zero magnetization.

Half-metals can dramatically enhance the performance of electronic devices. This is due to their 100% spin-polarization, which allows them to behave as metals in one spin direction, and insulators/semiconductors in the other. Most successful instances of half-metals are ferromagnetic, meaning their spin arrangement is aligned.

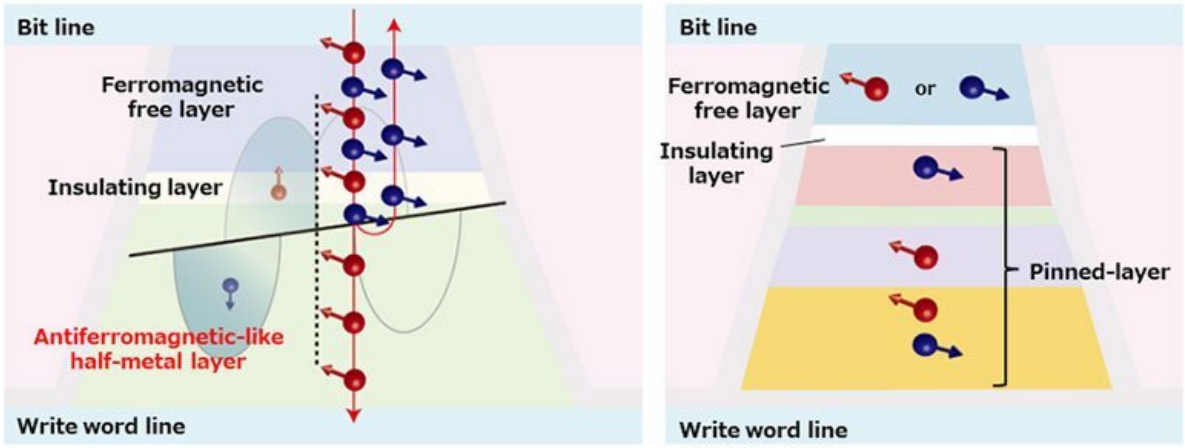
Antiferromagnetic-like half metals, where the spin aligns in an antiparallel nature, are desirable since no magnetic stray field can disturb it, even if integrated at high density. To date, only two cases of antiferromagnetic-like half-metals have been reported.

Following a development guideline, the research group created a compound consisting of iron, chromium, and sulfur. The new material completely loses its magnetization at low temperatures.

"The developed half-metal material possesses excellent properties, and the material development guidelines played a pivotal role in our success," said Satoshi Semboshi, paper co-author and professor at Tohoku University's Institute for Materials Research (IMR).



The electronic states and electric charge flow of general ferromagnets and half-metal ferromagnets. Credit: Rie Umetsu



(Left) A schematic illustration of tunnel magnetoresistance (TMR) multilayer using antiferromagnetic-like (full compensated ferrimagnetic) half-metal (left) and conventional TMR multilayer (right). In the latter, several layers, including a ferromagnetic layer and an antiferromagnetic layer, pin the direction of the magnetic moment of the ferromagnetic layer. By replacing these several layers with one layer of antiferromagnetic-like half-metal, high characteristics and low leakage magnetic field are realized, and enable high density. Credit: Rie Umetsu

Colleague and fellow co-author Rie Umetsu added, "We believe the results will improve the efficiency of future materials research and accelerate the innovation of electronic devices."

Details of their research were published in the journal *Scientific Reports* on June 23, 2022.

More information: S. Semboshi et al, A new type of half-metallic fully compensated ferrimagnet, *Scientific Reports* (2022). DOI: 10.1038/s41598-022-14561-8

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