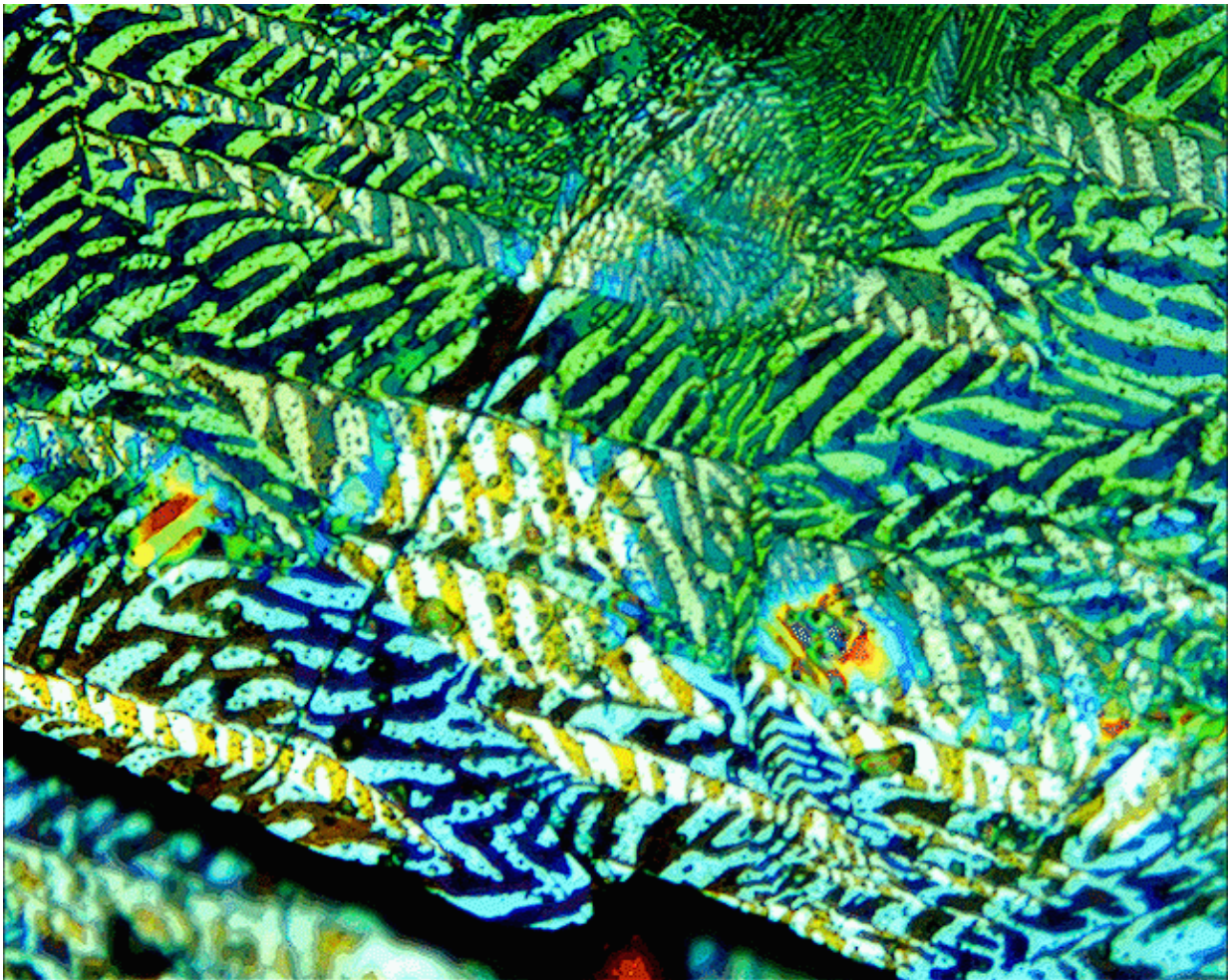


Researchers identify rare 2-D insulator with ferromagnetic properties

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Credit: Ames Laboratory

Collaborating scientists at the U.S. Department of Energy's Ames Laboratory, Brookhaven National Laboratory, and Princeton University have discovered a new layered ferromagnetic semiconductor, a rare type of material that holds great promise for next-generation electronic technologies.

As the name implies, semiconductors are the Goldilocks of electrically [conductive materials](#)— not a metal, and not an insulator, but a "just-right" in-between whose conducting properties can be altered and customized in ways that create the basis for the world's modern electronic capabilities. Especially rare are the ones closer to an insulator than to a metal.

The recent discovery of ferromagnetism in semiconducting materials has been limited to a handful of mostly chromium-based compounds. But here, the researchers discovered ferromagnetism in a vanadium-iodine [semiconductor](#), a material which has long been known but ignored; and which scientist Tai Kong compared to finding a "hidden treasure in our own backyard." Now a postdoctoral researcher in the lab of Robert J. Cava, the Russell Wellman Moore Professor of Chemistry at Princeton University, Kong completed Ph.D. research at the Ames Laboratory under supervision of Paul C. Canfield. And when new material could have ferromagnetic response, Kong turned to Ames Laboratory for the magneto-optical visualization of magnetic domains that serves as the definitive proof of ferromagnetism.

"Being able to exfoliate these materials down into 2-D layers gives us new opportunities to find unusual properties that are potentially useful to electronic technology advances," said Kong. "It's sort of like getting a new shape of Lego bricks. The more unique pieces you have, the cooler the stuff you can build."

The advantage of ferromagnetism in a semiconductor is that electronic

properties become spin-dependent. Electrons align their spins along internal magnetization.

"This creates an additional control knob to manipulate currents flowing through a semiconductor by manipulating magnetization, either by changing the [magnetic field](#) or by other more complex means, while the amount of current that can be carried may be controlled by doping (adding small amount of other [materials](#))," said Ames Laboratory Scientist Ruslan Prozorov. "These additional ways to control behavior and the potential to discover novel effects are the reason for such high interest in finding insulators and semiconductors that are also ferromagnets."

More information: Tai Kong et al. Ferromagnetic Semiconductors: VI 3 —a New Layered Ferromagnetic Semiconductor (Adv. Mater. 17/2019), *Advanced Materials* (2019). [DOI: 10.1002/adma.201970126](https://doi.org/10.1002/adma.201970126)

Provided by Ames Laboratory

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