Fine-tuning magnetic spin for faster, smaller memory devices

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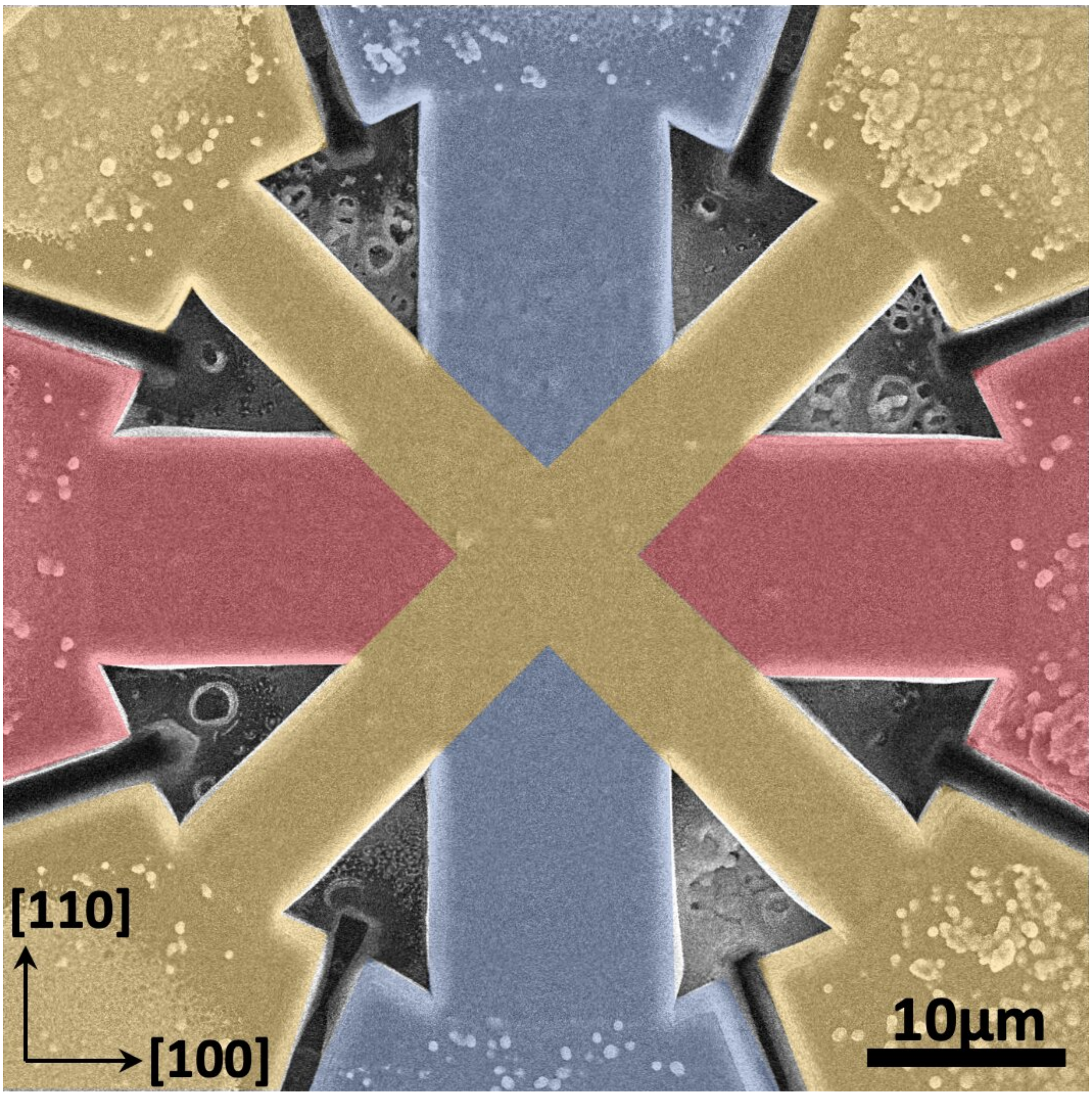

A team of researchers at Berkeley Lab and UC Berkeley have developed an antiferromagnetic switch for computer memory and processing applications. Credit: James Analytis/Berkeley Lab

Unlike the magnetic materials used to make a typical memory device, antiferromagnets won't stick to your fridge. That's because the magnetic spins in antiferromagnets are oppositely aligned and cancel each other out.

Scientists have long theorized that antiferromagnets have potential as materials for ultrafast stable memories. But no one could figure out how to manipulate their magnetization to read and write information in a memory device.

Now, a team of researchers at Berkeley Lab and UC Berkeley working in the Center for Novel Pathways to Quantum Coherence in Materials, an Energy Frontier Research Center funded by the U.S. Department of Energy, have developed an antiferromagnetic switch for computer memory and processing applications. Their findings, published in the journal *Nature Materials*, have implications for further miniaturizing computing devices and personal electronics without loss of performance.

Using a focused ion beam instrument at Berkeley Lab's Molecular Foundry, the scientists—led by James Analytis, a faculty scientist in Berkeley Lab's Materials Sciences Division and associate professor and Kittel Chair of Condensed Matter Physics at UC Berkeley—fabricated the device from atomically thin sheets of niobium disulfide, a transition metal dichalcogenide (TMD). To form an antiferromagnetic TMD, they synthesized layers of iron atoms between each niobium disulfide sheet.

Study co-authors Nityan Nair and Eran Maniv discovered that applying small pulses of electrical current rotates the spins of the antiferromagnet, which in turn switches the material's resistance from high to low.

To their surprise, they also found that "these magnetic spins can be flipped or manipulated with small applied currents, around 100 times smaller than those used in any other materials with a similar response," said Analytis.

The researchers next plan to test different antiferromagnetic TMDs in the hope of identifying a system that operates at room temperature and thus further develop the field of spin-based electronics or spintronics, where information is transported by the electrons' magnetic spin.

More information: Nityan L. Nair et al. Electrical switching in a magnetically intercalated transition metal dichalcogenide, *Nature Materials* (2019). DOI: 10.1038/s41563-019-0518-x

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