

Researchers invent a switch that could improve electronics

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Researchers at the University of Pittsburgh have invented a new type of electronic switch that performs electronic logic functions within a single molecule. The incorporation of such single-molecule elements could enable smaller, faster, and more energy-efficient electronics. The research findings, supported by a \$1 million grant from the W.M. Keck Foundation, were published online in the Nov. 14 issue of *Nano Letters*.

"This new switch is superior to existing single-molecule concepts," said Hrvoje Petek, principal investigator and professor of physics and chemistry in the Kenneth P. Dietrich School of Arts and Sciences and codirector of the Petersen Institute for NanoScience and Engineering (PINSE) at Pitt. "We are learning how to reduce electronic circuit elements to single molecules for a new generation of enhanced and more sustainable technologies."

The switch was discovered by experimenting with the rotation of a triangular cluster of three [metal atoms](#) held together by a [nitrogen atom](#), which is enclosed entirely within a cage made up entirely of [carbon atoms](#). Petek and his team found that the metal clusters encapsulated within a hollow carbon cage could rotate between several structures under the stimulation of electrons. This rotation changes the molecule's ability to conduct an electric current, thereby switching among multiple logic states without changing the spherical shape of the carbon cage. Petek says this concept also protects the molecule so it can function without influence from outside chemicals.

Because of their constant spherical shape, the prototype molecular switches can be integrated as atom-like building blocks the size of one nanometer (100,000 times smaller than the diameter of a human hair) into massively parallel computing architectures.

The prototype was demonstrated using an $\text{Sc}_3\text{N}@C_{80}$ molecule sandwiched between two electrodes consisting of an atomically flat [copper oxide](#) substrate and an atomically sharp tungsten tip. By applying a voltage pulse, the equilateral triangle-shaped Sc_3N could be rotated predictably among six logic states.

The research was led by Petek in collaboration with chemists at the Leibniz Institute for Solid State Research in Dresden, Germany, and theoreticians at the University of Science and Technology of China in Hefei, People's Republic of China. The experiments were performed by postdoctoral researcher Tian Huang and research assistant professor Min Feng, both in Pitt's Department of Physics and Astronomy.

Provided by University of Pittsburgh

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