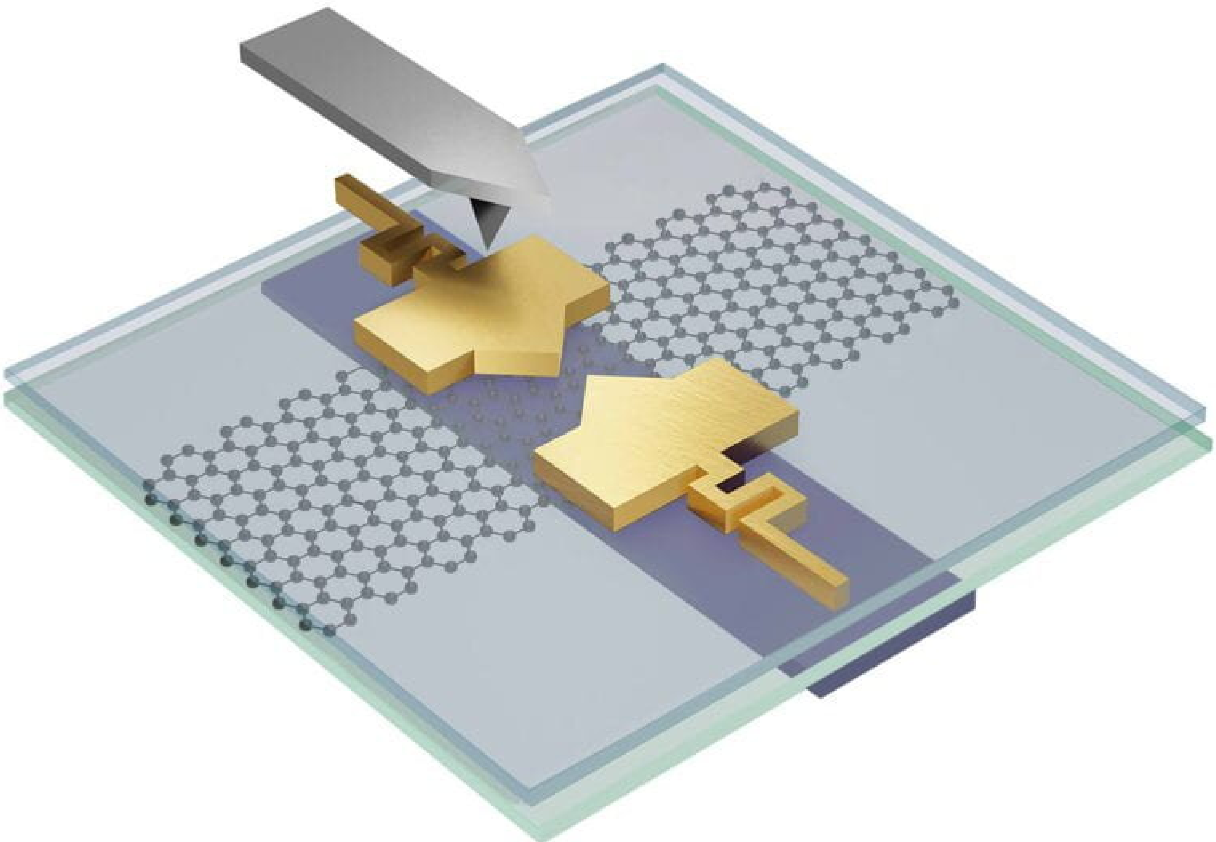
Physicists discover first transformable nanoscale electronic devices

April 17 2023



The golden parts of the device depicted in the above graphic are transformable, an ability that is "not realizable with the current materials used in industry," says Ian Sequeira, a Ph.D. student who worked to develop the technology in the laboratory of Javiar Sanchez-Yamahgishi, UCI assistant professor of physics & astronomy. Credit: Yuhui Yang / UCI

The nanoscale electronic parts in devices like smartphones are solid, static objects that once designed and built cannot transform into anything else. But University of California, Irvine physicists have reported the discovery of nanoscale devices that can transform into many different shapes and sizes even though they exist in solid states.

It's a finding that could fundamentally change the nature of electronic devices, as well as the way scientists research atomic-scale quantum materials. The study is published in *Science Advances*.

"What we discovered is that for a particular set of materials, you can make nanoscale electronic devices that aren't stuck together," said Javier Sanchez-Yamagishi, an assistant professor of physics & astronomy whose lab performed the new research. "The parts can move, and so that allows us to modify the size and shape of a device after it's been made."

The electronic devices are modifiable much like refrigerator door magnets—stuck on but can be reconfigured into any pattern you like.

"The significance of this research is that it demonstrates a new property that can be utilized in these materials that allows for fundamentally different types of devices architectures to be realized, including mechanically reconfigure parts of a circuit," said Ian Sequeira, a Ph.D. student in Sanchez-Yamagishi's lab.

If it sounds like science fiction, said Sanchez-Yamagishi, that's because until now scientists did not think such a thing was possible.

Indeed, Sanchez-Yamagishi and his team, which also includes UCI Ph.D. student Andrew Barabas, weren't even looking for what they ultimately discovered.

"It was definitely not what we were initially setting out to do," said

Sanchez-Yamagishi. "We expected everything to be static, but what happened was we were in the middle of trying to measure it, and we accidentally bumped into the device, and we saw that it moved."

What they saw specifically was that tiny nanoscale gold wires could slide with very low friction on top of special crystals called van der Waals materials.

Taking advantage of these slippery interfaces, they made electronic devices made of single-atom thick sheets of a substance called graphene attached to gold wires that can be transformed into a variety of different configurations on the fly.

Because it conducts electricity so well, gold is a common part of electronic components. But exactly how the discovery could impact industries that use such devices is unclear.

"The initial story is more about the basic science of it, although it is an idea which could one day have an effect on industry," said Sanchez-Yamagishi. "This germinates the idea of it."

Meanwhile, the team expects their work could usher in a new era of quantum science research.

"It could fundamentally change how people do research in this field," Sanchez-Yamagishi said.

"Researchers dream of having flexibility and control in their experiments, but there are a lot of restrictions when dealing with nanoscale materials," he added. "Our results show that what was once thought to be fixed and static can be made flexible and dynamic."

Other UCI co-authors include Yuhui Yang, a senior undergraduate at

UCI, and postdoctoral scholar Aaron Barajas-Aguilar.

More information: Andrew Z. Barabas et al, Mechanically reconfigurable van der Waals devices via low-friction gold sliding, *Science Advances* (2023). DOI: 10.1126/sciadv.adf9558

Provided by University of California, Irvine