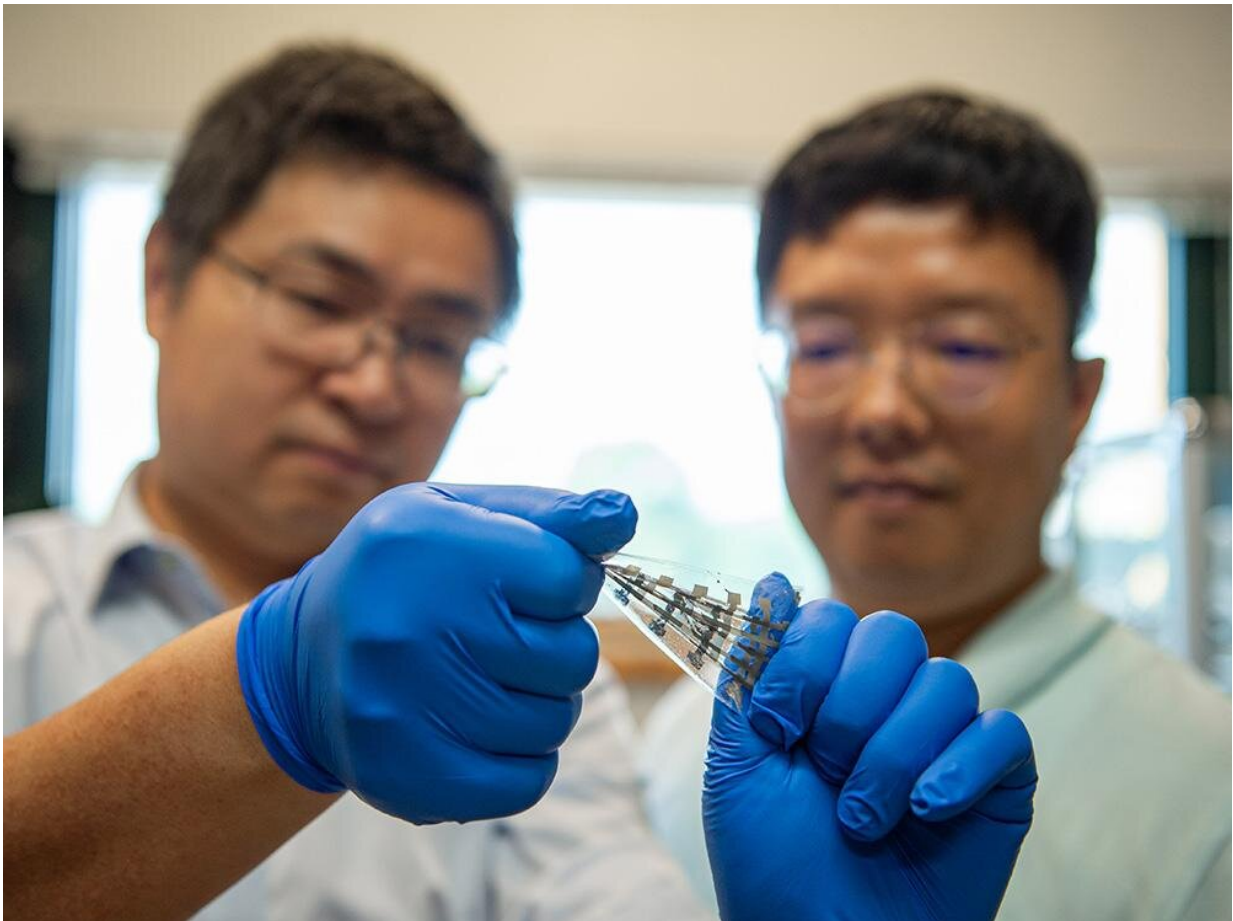


Stretchy, bio-inspired synaptic transistor can enhance or weaken device memories

September 30 2022, by Mariah Chuprinski



The synaptic transistor is reconfigurable, meaning it can be twisted and bent, yet still remain functional, as researchers Cunjiang Yu (left), Dorothy Quiggle Career Development Associate Professor of Engineering Science and Mechanics (ESM), and ESM graduate student Hyunseok Shim demonstrate in this photo. Conventional transistors, on the other hand, are rigid and can break after being bent. Credit: Kelby Hochreither/Penn State. All Rights Reserved.

Robotics and wearable devices might soon get a little smarter with the addition of a stretchy, wearable synaptic transistor developed by Penn State engineers. The device works like neurons in the brain to send signals to some cells and inhibit others in order to enhance and weaken the devices' memories.

Led by Cunjiang Yu, Dorothy Quiggle Career Development Associate Professor of Engineering Science and Mechanics and associate professor of biomedical engineering and of [materials science](#) and engineering, the team designed the synaptic transistor to be integrated in robots or wearables and use [artificial intelligence](#) to optimize functions. The details were published Sept. 29 in *Nature Electronics*.

"Mirroring the human brain, robots and [wearable devices](#) using the synaptic transistor can use its [artificial neurons](#) to 'learn' and adapt their behaviors," Yu said. "For example, if we burn our hand on a stove, it hurts, and we know to avoid touching it next time. The same results will be possible for devices that use the synaptic transistor, as the artificial intelligence is able to 'learn' and adapt to its environment."

According to Yu, the artificial neurons in the device were designed to perform like neurons in the ventral tegmental area, a tiny segment of the [human brain](#) located in the uppermost part of the brain stem. Neurons process and transmit information by releasing neurotransmitters at their synapses, typically located at the neural cell ends. Excitatory neurotransmitters trigger the activity of other neurons and are associated with enhancing memories, while inhibitory neurotransmitters reduce the activity of other neurons and are associated with weakening memories.

"Unlike all other areas of the brain, [neurons](#) in the [ventral tegmental area](#) are capable of releasing both excitatory and inhibitory neurotransmitters

at the same time," Yu said. "By designing the synaptic transistor to operate with both synaptic behaviors simultaneously, fewer transistors are needed compared to conventional integrated electronics technology, which simplifies the system architecture and allows the device to conserve energy."

To model soft, stretchy biological tissues, the researchers used stretchable bilayer semiconductor materials to fabricate the device, allowing it to stretch and twist while in use, according to Yu. Conventional transistors, on the other hand, are rigid and will break when deformed.

"The transistor is mechanically deformable and functionally reconfigurable, yet still retains its functions when stretched extensively," Yu said. "It can attach to a robot or wearable device to serve as their outermost skin."

More information: Hyunseok Shim et al, An elastic and reconfigurable synaptic transistor based on a stretchable bilayer semiconductor, *Nature Electronics* (2022). [DOI: 10.1038/s41928-022-00836-5](https://doi.org/10.1038/s41928-022-00836-5)

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