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Stretchable silicon set to revolutionize electronics

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Stretchable silicon set to revolutionize electronics

Washington: Stretchable silicon could be the next wave in electronics, with University of Illinois researchers developing a fully stretchable form of single-crystal silicon with micron-sized, wave-like geometries that can be used to build high-performance electronic devices on rubber substrates.

“Stretchable silicon offers different capabilities than can be achieved with standard silicon chips,” said John Rogers, co-author of study published in the journal Science.

Functional, stretchable and bendable electronics could be used in applications such as sensors and drive electronics for integration into artificial muscles or biological tissues, structural monitors wrapped around aircraft wings, and conformable skins for integrated robotic sensors.

To create their stretchable silicon, the researchers begin by fabricating devices in the geometry of ultrathin ribbons on a silicon wafer using procedures similar to those used in conventional electronics. Then they use specialized etching techniques to undercut the devices. The resulting ribbons of silicon are about 100 nanometers thick - 1,000 times smaller than the diameter of a human hair.

In the next step, a flat rubber substrate is stretched and placed on top of the ribbons. Peeling the rubber away lifts the ribbons off the wafer and leaves them adhered to the rubber surface. Releasing the stress in the rubber causes the silicon ribbons and the rubber to buckle into a series of well-defined waves that resemble an accordion.

“The resulting system of wavy integrated device elements on rubber represents a new form of stretchable, high-performance electronics. The amplitude and frequency of the waves change, in a physical mechanism similar to an accordion bellows, as the system is stretched or compressed," said Young Huang, the Shao Lee Soo Professor of Mechanical and Industrial Engineering.

As a proof of concept, the researchers fabricated wavy diodes and transistors and compared their performance with traditional devices. Not only did the wavy devices perform as well as the rigid devices, they could be repeatedly stretched and compressed without damage, and without significantly altering their electrical properties.

"These stretchable silicon diodes and transistors represent only two of the many classes of wavy electronic devices that can be formed. In addition to individual devices, complete circuit sheets can also be structured into wavy geometries to enable stretchability," Rogers said.

Besides the unique mechanical characteristics of wavy devices, the coupling of strain to electronic and optical properties might provide opportunities to design device structures that exploit mechanically tunable, periodic variations in strain to achieve unusual responses.