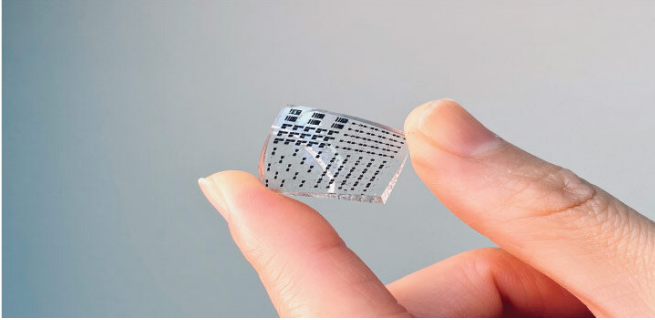


# Electronic skin has a strong future stretching ahead

27 November 2020



KAUST researchers have developed a durable "electronic skin" that can mimic natural functions of human skin, such as sensing temperature and touch. Credit: © 2020 KAUST

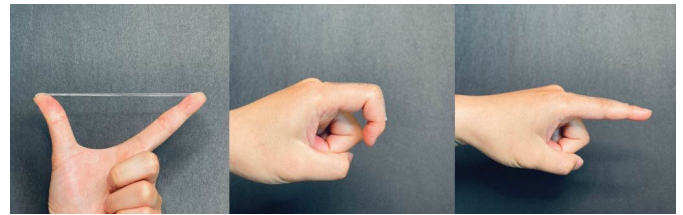
A material that mimics human skin in strength, stretchability and sensitivity could be used to collect biological data in real time. Electronic skin, or e-skin, may play an important role in next-generation prosthetics, personalized medicine, soft robotics and artificial intelligence.

"The ideal e-skin will mimic the many natural functions of human skin, such as sensing temperature and touch, accurately and in real time," says KAUST postdoc Yichen Cai. However, making suitably flexible electronics that can perform such delicate tasks while also enduring the bumps and scrapes of everyday life is challenging, and each material involved must be carefully engineered.

Most e-skins are made by layering an active nanomaterial (the sensor) on a stretchy surface that attaches to human skin. However, the connection between these layers is often too weak, which reduces the durability and sensitivity of the material; alternatively, if it is too strong, flexibility becomes limited, making it more likely to crack and break the circuit.

"The landscape of skin electronics keeps shifting at a spectacular pace," says Cai. "The emergence of 2-D [sensors](#) has accelerated efforts to integrate these atomically thin, mechanically strong materials into functional, durable artificial skins."

A team led by Cai and colleague Jie Shen has now created a durable e-skin using a hydrogel reinforced with silica nanoparticles as a strong and stretchy substrate and a 2-D titanium carbide MXene as the sensing layer, bound together with highly conductive nanowires.



A durable e-skin developed at KAUST using a hydrogel reinforced with silica nanoparticles forms a strong and stretchy substrate. Credit: © 2020 KAUST

"Hydrogels are more than 70 percent water, making them very compatible with human skin tissues," explains Shen. By prestretching the hydrogel in all directions, applying a layer of nanowires, and then carefully controlling its release, the researchers created conductive pathways to the sensor layer that remained intact even when the material was stretched to 28 times its original size.

Their prototype e-[skin](#) could sense objects from 20 centimeters away, respond to stimuli in less than one tenth of a second, and when used as a pressure sensor, could distinguish handwriting written upon it. It continued to work well after 5,000 deformations, recovering in about a quarter of a second each time. "It is a striking achievement for

an [e-skin](#) to maintain toughness after repeated use," says Shen, "which mimics the elasticity and rapid recovery of [human skin](#)."

Such e-skins could monitor a range of biological information, such as changes in blood pressure, which can be detected from vibrations in the arteries to movements of large limbs and joints. This data can then be shared and stored on the cloud via Wi-Fi.

"One remaining obstacle to the widespread use of e-skins lies in scaling up of high-resolution sensors," adds group leader Vincent Tung; "however, laser-assisted additive manufacturing offers new promise."

"We envisage a future for this technology beyond biology," adds Cai. "Stretchable sensor tape could one day monitor the structural health of inanimate objects, such as furniture and aircraft."

The research is reported in *Science Advances*.

**More information:** "Mixed-dimensional MXene-hydrogel heterostructures for electronic skin sensors with ultrabroad working range" *Science Advances* (2020).

[advances.sciencemag.org/lookup ...  
.1126/sciadv.abb5367](https://advances.sciencemag.org/lookup...1126/sciadv.abb5367)

Provided by King Abdullah University of Science and Technology

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