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News

'Electronic skin' could replace bulky electrodes

Wearable sensor could help monitor health, amplify speech or control prosthetics.

Ed Yong

The sensor patch is stretchy, flexible, and the width of a human hair.J. A. Rogers

'Electronic skin' has been developed that records heartbeats, brain activity and muscle contractions as accurately as bulky conventional electrodes, yet is no thicker than a human hair.

The patch, created by John Rogers, a materials scientist at the University of Illinois, Urbana-Champaign, and his colleagues, consists of a flexible and stretchy lattice of sensor-laden circuits. It can be applied and removed like a temporary tattoo, and sticks to skin without adhesives.

So far, it can only be used for a few days at a time, but researchers hope that the technology could one day allow doctors to monitor patients' health without wires or clunky equipment.

The electronic skin can also do things that conventional medical sensors cannot. When placed on the throat, for example, it senses spoken words well enough to control a simple computer game.

"We focused on the throat because it really highlights the mechanical invisibility of these epidermal electronics, even on a sensitive part of the body," says Rogers. The study is published today in the journal Science[1].

The device might be used to help people with laryngeal diseases communicate, to monitor premature babies, or to enhance the control of prosthetics. Rogers is also collaborating with physical therapists to use the skin to induce muscle contractions in regions of the body that have degenerated.

Stéphanie Lacour, an engineer at the University of Cambridge, UK, says it's exciting work. "This is a key demonstration that high-performance electronics can be designed to mechanically mimic biological tissues and yet function reliably. It will be likely to help in designing unnoticeable yet high-tech wearable systems."

Thin skinned

Rogers's team has worked on flexible electronic circuits for around 15 years, and recently turned to creating machines that mimic human skin. "It was a natural evolution of what we've been doing," says Rogers. "Skin is just an interesting material."

The electronic skin consists of sensors, antennae, light-emitting diodes and other components, sandwiched between two protective layers. It is powered by embedded solar cells or by inductive coils that can be used to generate current wirelessly.

The sandwich sits on a stretchy sheet of polyester designed to match the physical properties of skin. "To my knowledge, this is the softest substrate ever to carry complex, functional electronic circuitry," says Lacour.

The device is less than 40 micrometres thick, making it far more flexible than the brittle, millimetre-thick silicon chips that comprise most electronics. "At this scale, something that would otherwise be brittle is completely floppy," says Rogers. "You can trick the system into behaving like tissue even if it uses these tiny, rigid pieces of silicon."

The device is thin enough to stick to skin using only the short-range van der Waals forces that hold molecules together, as the forces that threaten to detach it are 10 million times weaker than they would be for a chip a millimetre thick. The circuits are fashioned as a net of narrow S-shaped filaments, so they can stretch and contract without breaking.

The team is now working on adding new components, including piezoelectric devices that are powered by body movements, batteries, and wireless communicators for uploading data or commands.

One major downside is that the continual shedding of skin cells means that the patch falls off after a few days. The researchers are looking for ways around this, so they can be worn for months at a time.

The electronic skin is also expensive to make, but Rogers hopes that the patches could eventually be mass-produced. "We're building on existing technology rather than reinventing it, so I think the technical hurdles to commercial manufacture are lower than you'd ordinarily see."

- ## References

1. Kim, D.-H. *et al.*, Science 333, 838-843 (2011).

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