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Electronic 'tattoos' to monitor vital signs

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Once a patient has left hospital, how can doctors track his or her physical condition? Conventional technology is too bulky or obtrusive, but rub-on electronics that stick to the skin like a temporary tattoo could revolutionise medical monitoring.

When doctors need to keep watch on someone's bodily systems, from the heart's beat to the brain's activity, they have to use bulky electronic devices and attach electrodes to the skin with sticky gel.

"These are useful in some clinical settings, but in the real world they restrain movement and cause irritation to the skin," says [John Rogers](#) at the University of Illinois at Urbana-Champaign.

To avoid restricting movement, Rogers's team have given their new "epidermal electronics" the flexibility, elasticity and density of skin. They took the silicon and gallium arsenide typically used to build transistors, diodes and resistors, and fashioned it into wires just a few nanometres thick, each bent into the shape of a tiny meandering river. The meanders can stretch and contract to give electronics constructed from them a degree of flexibility which matches that of skin.

The researchers then took circuits made from the wires and put them on a thin patch of rubber. Finally, they embedded the rubber in a water-soluble protective sheet of plastic, creating a patch around 40 micrometres thick. This patch can then be applied to the skin like a temporary tattoo: it is placed on the skin, rubbed with a wet finger to dissolve the protective sheet and left to dry.

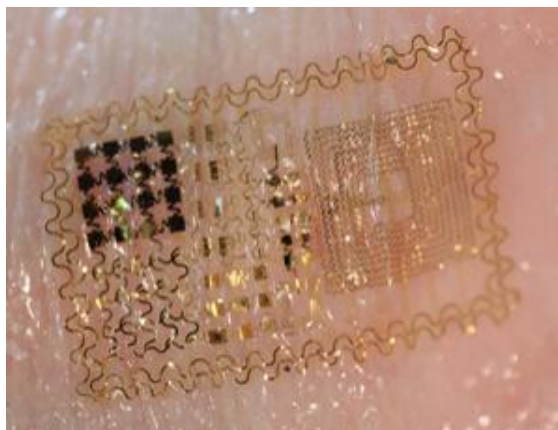
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The nifty "tattoo" is kept in place by the weak intermolecular forces that are at play whenever two surfaces come together. Because the circuit is soft and stretchy enough to conform to the skin's texture, the contact between the two surfaces is good enough to keep the device in place for several days. For the style-conscious patient, it can even be combined with a conventional temporary tattoo (see video above) – although until a wireless transmitter can be incorporated into the design, the temporary tattoo must still be wired to a computer.

In a preliminary study, the group put patches on the throats of volunteers. The thin electronics could detect the electrical changes beneath the skin associated with muscle movements as the volunteers spoke. The signals were then sent through a computer algorithm, which could differentiate the signals associated with different words and allow the volunteers to control a video game with spoken commands.

The first generation of medical patches can monitor electrophysiological signals associated with the heart, other muscles and brain activity. But in future people may benefit from patches that go beyond this passive role, says Rogers.

"We can also use the device to stimulate muscle contractions," he says – although this work, achieved in rats, has yet to be published.



A tattoo you won't regret (Image: John A. Rogers/Science)

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The patches are "a beautiful example of the novel applications than can be enabled by building electronic systems on non-conventional substrates", says [Ali Javey](#), an electronic engineer at the University of California, Berkeley. "This is truly exciting work," he adds.

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