technology review
Published by MIT

Pinch me: These microelectronics are able to wrinkle, bend, and twist along with skin, even as it is being pinched, without breaking or coming loose.
Credit: John A. Rogers, University of Illinois

COMPUTING

Stick-On Electronic Tattoos

A flexible electronic device stuck on the skin could provide irritation-free monitoring of heart, brain, and muscle activity.

THURSDAY, AUGUST 11, 2011 | BY KENRICK VEZINA

Audio »

Researchers have made stretchable, ultrathin electronics that cling to skin like a temporary tattoo and can measure electrical activity from the body. These electronic tattoos could allow doctors to diagnose and monitor conditions like heart arrhythmia or sleep disorders noninvasively.

John A. Rogers, a professor of materials science at the University of Illinois at Urbana-Champaign, has developed a prototype that can replicate the monitoring abilities of bulky electrocardiograms and other medical devices that are normally restricted to a clinical or laboratory setting. This work was presented today in *Science*.

To achieve flexible, stretchable electronics, Rogers employed a principle he had already used to achieve flexibility in substrates. He made the components—all composed of traditional, high-performance materials like silicon—not only incredibly thin, but also "structured into a serpentine shape" that allows them to deform without breaking. The result, says Rogers, is that "the whole system takes on this kind of spiderweb layout."

In the past, says Rogers, he was able to create devices that were either flexible but not stretchable, or stretchable but not flexible. In particular, his previous work was limited by the fact that the electronics portions of his designs couldn't flex and stretch as much as the substrate they were mounted on.

The electronic tattoo achieves the mechanical properties of skin, which can stand up to twisting, poking, and pulling without breaking. Rogers's tattoo can also conform to the topography of the skin as well as stretch and shift with it. It can be worn for extended periods without producing the irritation that often results from adhesive tapes and rigid electronics. Although Rogers's preliminary tests involved a custom-made substrate, he also demonstrated that the electronics could be mounted onto a commercially available temporary tattoo.

The prototype was equipped with electrodes to measure electric signals produced by muscle and brain activity. This could be useful for noninvasive diagnosis of sleep apnea or monitoring of premature babies' heart activity. It also might be possible, Rogers says, to use the tattoos to stimulate the muscles of physical rehabilitation patients, although this use wasn't demonstrated in the paper.

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To demonstrate the device's potential as a human-computer interface, Rogers mounted one of the tattoos on a person's throat and used measurements of the electrical activity in the throat muscles to control a computer game. The signal from the device contained enough information for software to distinguish among the spoken words "left," "right," "up," and "down" to control a cursor on the screen.

The device included sensors for temperature, strain, and electric signals from the body. It also housed LEDs to provide visual feedback; photodetectors to measure light exposure; and tiny radio transmitters and receivers. The device is small enough that it requires only minuscule amounts of power, which it can harvest via tiny solar cells and via a wireless coil that receives energy from a nearby transmitter. Rogers hopes to build in some sort of energy-storage ability, like a tiny battery, in the near future. The researchers are also working on making the device wireless.

Ultimately, Rogers says, "we want to have a much more intimate integration" with the body, beyond simply mounting something very closely to the skin. He hopes that his devices will eventually be able to use chemical information from the skin in addition to electrical information.

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non-invasive monitor

I would call something attached to the skin at least slightly invasive. Many patients,

building a custom solution versus buying an off-the-shelf system. This paper discusses the benefits and drawbacks of both a traditional custom design approach and off-the-shelf embedded tools.

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especially elderly, have thin skin, and those with infections on the skin would not want these.

Another type of passive totally non-invasive monitor for heart, breath and bed movement is a monitor wire embedded mattress pad, the LifeBed, used for several years in med-surg units, made by a hawaiian company.

Being external, in the mattress pad, it doesn't of course follow the patient around like this thing stuck to the skin.

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