Skinlike Electronic Patch Takes Pulse, Promises New Human-Machine Integration

A web of minuscule wires woven into an adhesiveless silicon patch could provide a future where heart monitors are nearly invisible, prosthetics can feel pressure and video games can take verbal commands

By Katherine Harmon | August 11, 2011 | 6

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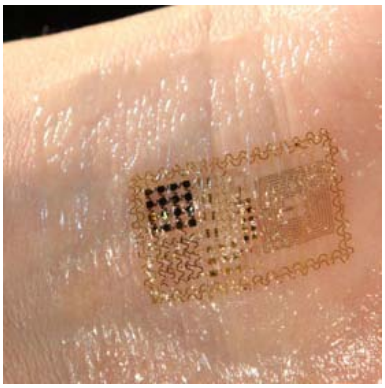
You might think that temporary tattoos *look* cool, but what if they could also collect and transmit information about your heart rate, temperature, muscle contractions or brain waves?

A new flexible electronic circuit promises to do just that, by moving with the skin and staying in place without any adhesive. The research used existing semiconductor technology to imprint integrated circuits



TECHNO TEMPORARY TATTOO: A new form of ultra-flexible circuit is pushing forward the possibilities of bio-monitoring--and human-machine interface.
Image: John Rogers

onto a thin, flexible silicon film that can be applied directly on the skin. The device is described in a new paper published online August 11 in *Science*.

"The goal is really to blur the distinction between electronics and biological tissues," John Rogers, a professor of materials science and engineering at the University of Illinois at Urbana-Champaign (U.I.C.U.) and co-author of the new study, said in a podcast interview.

The new technology might soon allow monitoring to become "simpler, more reliable and uninterrupted," Zhenqiang Ma, a professor at the University of Wisconsin–Madison's Department of Electrical and Computer Engineering, wrote in an essay in the same issue of *Science*.

Rogers, who is working with Cambridge, Mass.–based start-up company mc10, Inc., to commercialize the device, and his team have already demonstrated the patch can be used to measure vitals—and they suggest that it could one day be used to help stimulate muscles, speed wound healing, improve prosthetics and even communicate with video games.

Slim fit

The most powerful force of this new patch is its thinness. "At an intuitive level, it's really pretty simple," Rogers said in the podcast. "If you make anything thin enough it becomes flexible." So, instead of a more typical one-half-millimeter-thick silicon wafer, they used a 50-nanometer-thick silicon membrane.

Rogers calls the membrane itself "kind of disgusting," noting in a Wednesday press briefing that "it looks a little bit like it's been ripped off—or excreted from—the body." But that is, in some sense, the point: to arrive at a material in which "the distinction between the mechanics and the tissue is blurred," he said Wednesday. And to get around the problem of application, the group took a cue from the temporary tattoo industry and used a plastic backing that is peeled off after application. (Rogers and his colleagues are fond of demonstrating the sensor's application on a temporary pirate tattoo.)

The ultra-flexible patches were made via transfer printing (or "inking and printing"), in which the chips are assembled on two silicon layers and then transferred onto the elastomer polymer base material, which is designed to conform to the skin.

Although the materials and components are not particularly new, they are "configured in geometries that are unusual," Rogers said. The circuits are formed into an open mesh shape, "almost like a spider web of electronics that we embedded in a very thin elastomer skin," he explained. That means, "we have not had to go back and reinvent semiconductor materials or reinvent transistor design," he said. And just by slimming everything down and assembling it in the right configurations, his team hopes they are leading the way to new "opportunities in biointegration."

Xiaolin Zheng, an assistant professor of mechanical engineering at Stanford University, has been working on a similar device and is excited about the new report. Her team's device, described in a recent *Nano Letters* paper, relies on a different manufacturing process that involves a layer between the circuitry and silicon that helps to prevent stress on larger circuits in the application process. As Ma pointed out in his essay, however, the fact that the polyester layer and the sensor layer are the same thickness in the new device means that they "develop opposite strains that cancel, so the middle circuit layer experiences little stress no matter which direction the device is bent."

Although Zheng's group used straight metal rather than the more deformable shapes in the new patch, the Stanford team's version is substantially slimmer, measuring in at about 0.8 micron. "Our device is even more flexible and can easily achieve conformal coating onto curved surfaces," she says.

Easy on

Much of today's monitoring equipment requires bulky hardware, such as heart monitors that cardiac patients often have to drag or tote around. But this new device would be "almost mechanically invisible to the wearer," Rogers noted in the podcast. Being slim and sleek would allow it to go where other devices can be awkward or invasive. One possible application could be for premature babies, who, because of their small size "just aren't compatible" with bulkier, hardwired sensors, Rogers said. It could also be a more appealing monitoring method for sleep studies, nixing the need for cumbersome, disruptive equipment and wires.

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1. Mythusmage
07:43 PM 8/11/11

One use I'm thinking of is temporary tattoos that could take your vitals while you're in the waiting room.

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2. robert schmidt
07:59 PM 8/11/11

"Like a temporary tattoo, these patches do not cling forever." could they be made to be more like real tattoos? I can imagine a network of RF tattoos that communicate with the user and the world around them. Imagine a sensor that can tell you what you need to eat or avoid, that could provide early warning for disease, that can integrate with machines to provide additional interface points. If they are deep enough in the dermis they should be somewhat permanent.

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3. svande8952
08:31 PM 8/11/11

"The goal is really to blur the distinction between electronics and biological tissues,"
It looks like Kurzweil is right. The singularity is here.

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4. Drogers1082
in reply to robert schmidt
03:12 PM 8/12/11

A permanent tattoo is not logical decision due to the fact that technology evolves so quickly that you would be getting a new tattoo every year just you could update/accommodate any new medical technology. With a temporary tattoo like design you could simply wipe off the old/out dated and apply updated version.

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5. veronaa
03:53 PM 8/12/11

...and of course, it will be fully paid for by Medicare and Medicaid for their covered patients!

The need for "two small wires" to collect data (connected to a small data collector/transceiver- and more profits) would make this less useful for real-life usage. How are these "two small wires" protected from snags and pulls during normal daily actions?

It looks like there is a lot of work to be done yet, and a wireless interface to the data collector is probably going to entail a longer development path and a larger patch in the final product.

Not that these technological innovations being developed are going to be cheerily supported by the current negative political environment. The future is what we make of it, if we can afford it.

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6. SoundAndFury
in reply to svande8952
04:56 PM 8/12/11

Not really. It seems like this is just a more convenient version of what we had before. There's still a lot of progress to be made before Kurzweil's world becomes a probability. Remember, there are a lot of singularitans (SP?) who believe that Kurzweil's predictions are a little out there.

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