The next generation of electronics is a press-on tattoo

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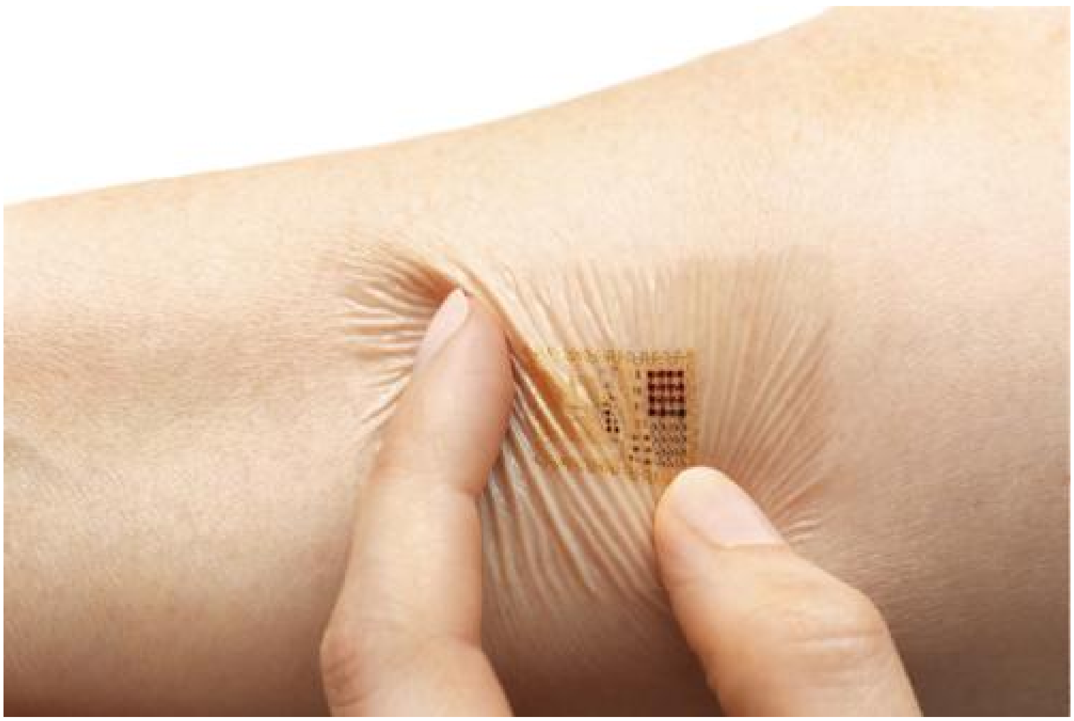

Rogers' stretchy, flexible circuits have much in common with temporary tattoos. Credit: MC10.

For John Rogers, the inspiration to develop ground-breaking stretchable circuits that are compatible with human tissue came from an unlikely source.

"A kid's temporary tattoo was a great model," said Rogers, a materials scientist and former MacArthur Foundation "genius" grant recipient. Temporary tattoos conform to human skin without any negative implications. Once applied, people forget they're even there and they eventually wash off without a trace. If he could make an electronic device that worked the same way, he realized, it could open up a world of opportunities.

Rogers noted that over the past several decades, the devices produced by the electronics industry continue to get smaller, faster, and cheaper. However, they've also remained rigid, rectangular, and everlasting—features that aren't compatible with the natural processes of the human body.

"Unless you change the form factor, you're limited because devices are mismatched to the characteristics of human skin," Rogers said.

Rogers, a professor at the University of Illinois, Urbana-Champaign, described his pioneering research Thursday afternoon to a packed audience at Raytheon Amphitheater. His talk marked the eighth installment in Northeastern University's Profiles in Innovation Presidential Speakers Series. Northeastern University President Joseph E. Aoun hosts the series, which is designed to bring the world's most creative minds to campus for conversations on innovation and entrepreneurship. Previous speakers include cell biologist Jeanne Lawrence, Aereo CEO Chet Kanojia, and IBM Watson creator David Ferrucci.

Rogers said that he's impressed with Northeastern's co-op program, adding that he's seen the value firsthand since he's employed Northeastern co-op students at his companies, which include Cambridge-based MC10 and the former Natick-based Active Impulse Systems. "Both of those companies have benefitted tremendously from co-ops from Northeastern," he said. "Our experience is that the students are really talented (and) high energy."

Aoun noted that Rogers' approach is motivated by both traditional measures of academic success as well as a use-inspired drive to solve the world's grand challenges—which happen to align with the university's mission. "We quantify success not only by the publications and the citations but also by the impact," Aoun said.

For his part, Rogers' devices are certainly making an impact.

Silicon is the predominant material in today's standard electronic devices , and it's typically considered about as rigid and immoveable as any solid available. However, that's only because the silicon wafers the industry is using are so thick, Rogers explained. Make them thinner—roughly one-tenth the width of a human hair—and silicon's properties begin to change rather radically, he said.

First off, it becomes extremely flexible. Indeed, a one-micron-thick wafer of silicon collapses under its own weight, Rogers said. While it still isn't itself inherently stretchy, it can be applied onto a stretched-out rubber substrate, which when relaxed gives the silicon something of an accordion effect.

Second, thin silicon wafers can be dissolved in water and broken down into a biocompatible material. "If the silicon is thin enough, then reactions that you would ordinarily ignore become important," he said. While a thick chunk of silicon may take 1,000 years to decompose, Rogers' 35-nanometer-thick devices do so in less than a couple of weeks–a feature that has obvious implications for both the environment and biocompatible devices.

Using this platform, Rogers and his team are developing a range of devices with applications in the healthcare, sports, gaming, and even energy industries. His team has used them to fly a miniature helicopter, play video games, and collect mechanical and cardio-electric data from the body.

So, how exactly do you power these wearable devices? That was one question asked during a Q-and-A following Rogers' talk. In response, he admitted this is perhaps one of the most pressing challenges currently facing his lab. Three options have so far emerged: micro-distributed batteries, in which pieces of the battery are spread around a surface; harvesting the body's natural mechanical energy; and wireless power coming from our smartphones and other mobile devices.

Several questions came in from those following the event via social media, one being whether Rogers' circuits will help advance evidence-based research on wearable healthcare devices.

"We think we have a device platform that will allow you to collect clinical-quality data that's multimodal in terms of the measuring capabilities—continuously," Rogers answered. "It opens up a whole set of new opportunities. You're going to have a tremendous amount of data." Over time, he added, the utility of all that data will only increase in terms of how healthcare workers will be able to integrate it into clinical solutions.

Provided by Northeastern University