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A Bendable Heart Sensor

New flexible electronics can better chart the heart's electrical activity.

By Duncan Graham-Rowe

A new flexible and biocompatible electronic device can produce a more detailed picture of the electrical activity of a beating heart. This high-resolution electrical map could help improve the diagnosis and treatment of heart abnormalities by pinpointing areas of damage or misfiring circuitry.

Today, the best way to map the electrical activity of a person's heart is to insert a probe tipped with a few electrical sensors through a vein and into the heart. The probe is used to measure activity at different locations in the tissue to slowly build up a picture of electrical activity. An electrocardiogram, which picks up signals from outside the body, offers a less precise picture.

"It can take hours to map where these heart rhythms are coming from," says Brian Litt (http://www.seas.upenn.edu/~littlab/Site/Home.html) , a neurologist and biomedical engineer at the University of Pennsylvania, and one of the senior researchers on the project. "If you map at a very high resolution, it may be possible that you can pick up, in local areas, precursors to arrhythmias before they occur."

The flexible device can be used to attach multiple sensors to the wall of a beating heart, measuring electrical activity at multiple sites despite the heart's movement. The electronics needed to record this activity are also built into the device, meaning more data can be collected. The new device is 25 microns thick and covers 1.5 square centimeters. It contains over 2,000 transistors sealed within a flexible coating and is covered with 288 sensor electrodes. So far the device has been tested successfully in pigs.

It is the first time that flexible electronics have been used in such high density in a medical device, says John Rogers (http://rogers.mse.uiuc.edu/) , an engineer at the University of Illinois, Urbana-Champaign, who collaborated on the work. "These devices contain more transistors than any previously reported flexible device," he says.

The flexible device could be used in other kinds of biological sensors, says Litt, including devices for monitoring neurological conditions such a Parkinson's and epilepsy. The work, which also involved researchers from Northwestern University (http://www.northwestern.edu/) , is published in the journal *Science Translational Medicine*.

The key to making the device is what Rogers calls "nanomembrane transistors." These components are made out thin ribbons of silicon, about 100 nanometers thick; on this scale the material loses its characteristic rigidity and becomes flexible. "It's much like a piece of two-by-four," Rogers says. "Wood is not very bendable, but a sheet of paper is."

Making these transistors required a completely new fabrication technique. Rogers etched out the ribbon circuits from larger blocks of silicon and then used chemical etching to remove silicon from underneath. The circuits could then be peeled away when brought into contact with a stamp-like device.

Once the circuit has been deposited on a substrate, it is encased in a photocurable water -tight epoxy material. This material was difficult to develop, since it had to have the same mechanical properties as the circuit in order to bend with it, but also needed to be resilient enough to prevent any seepage, even at points where the electrodes protrude. "It probably took us half a year to develop a recipe for that," says Rogers.

The next step, says Litt, is to build a power supply into the device so that it can be used for chronic implantation, and to find a way to transmit data from it wirelessly. The researchers are also developing a version that can also be used to ablate damaged heart tissue through localized heating.

"It is a very impressive advance for electrical mapping of the heart," says Eric Topol (http://www.scripps.edu/research/faculty.php?rec_id=23654) , a cardiologist and director of the Scripps Translational Science Institution (http://www.stsiweb.org/) , in La Jolla, CA. Today the average ablation procedure for arterial fibrillation takes about three hours at best. "This jump in mapping capability could markedly reduce and simplify these procedures and many other interventions," he says.

Upcoming Events

BetterWorld at MIT Conference (http://www.betterworldatmit.org)
MIT Media Lab, Cambridge, MA
Friday, April 30, 2010
http://www.betterworldatmit.org (http://www.betterworldatmit.org)

FEI 2010 – The Annual Front End of Innovation Conference A New Front End: The Era of Collaboration (http://www.iirusa.com/feiusa/fei-home.xml?registration=FEI2010TECHREV)
Boston, MA
Monday, May 03, 2010 - Wednesday, May 05, 2010
http://www.iirusa.com/feiusa/fei-home.xml?registration=FEI2010TECHREV (http://www.iirusa.com/feiusa/fei-home.xml?registration=FEI2010TECHREV)

BIO International Convention (http://convention.bio.org)
Chicago, IL
Monday, May 03, 2010 - Sunday, May 10, 2009
http://convention.bio.org (http://convention.bio.org)

MIT Sloan CIO Symposium (http://www.mitcio.com)
MIT Campus, Cambridge, MA
Wednesday, May 19, 2010
http://www.mitcio.com (http://www.mitcio.com)

Tech Connect World (http://www.techconnectworld.com)
Anaheim, CA
Monday, June 21, 2010 - Friday, June 25, 2010
http://www.techconnectworld.com (http://www.techconnectworld.com)

2010 IEEE Conference on Innovative Technologies for an Efficient and Reliable Electricity Supply (http://www.ieee-energy.org/)
Waltham, Massachusetts
Sunday, September 27, 2009 - Tuesday, September 28, 2010
http://www.ieee-energy.org/ (http://www.ieee-energy.org/)