Technology PUBLISHED BY MIT Review

Monday, April 19, 2010

Brain Interfaces Made of Silk

Gentler, softer electrodes wrap around the folds of the brain to take higher-resolution measurements.

By Katherine Bourzac

Doctors can put arrays of electrodes on the surface of the brain to pinpoint the source of epileptic seizures; patients can use such electrodes to control a computer cursor. But it's still not safe to leave these devices in the brain over the long term, and that's a quality that needs to be developed before researchers can develop better brain-computer interfaces.

Now a group of researchers is building biocompatible electronics on thin, flexible substrates. The group hopes to create neural interfaces that take higher-resolution measurements than what's available today without irritating or scarring brain tissue.

"Biocompatibility is a major challenge for new generations of medical implants," says Brian Litt (http://www.seas.upenn.edu/~littlab/Site/Brian.html) , professor of neurology and bioengineering at the University of Pennsylvania Medical School. "We wanted to make devices that are ultrathin and can be inserted into the brain through small holes in the skull, and be made out of materials that are biocompatible," he says. Litt is working with researchers at the University of Illinois at Urbana-Champaign who are building high-performance flexible electronics from silicon and other conventional materials on substrates of biodegradable, mechanically strong silk films provided by researchers at Tufts University.

This week in the journal *Nature Materials (http://www.nature.com/nmat/index.html)* , the team reports using a silk electrode device to measure electrical activity from the surface of the brain (http://www.technologyreview.com/biomedicine/22739/?a=f) in cats. Silk is mechanically strong--that means the films can be rolled up and inserted through a small hole in the skull--yet can dissolve into harmless biomolecules over time. When it's placed on brain tissue and wetted with saline, a silk film will shrink-wrap around the surface of the brain, bringing electrodes with it into the wrinkles of the tissue. Conventional surface electrode arrays can't reach these crevices, which make up a large amount of the brain's surface area.

"A device like this would completely open up new avenues in all of neuroscience and clinical applications," says Gerwin Schalk (http://www.wadsworth.org/resnres/bios/schalk.htm) , a researcher at the Wadsworth Center in Albany, NY, who is not affiliated with the silk electrode group. "What I foresee is placing a silk-based device all around the brain and getting a continuous image of brain function for weeks, months, or years, at high spatial and temporal resolution."

The advantage of surface electrodes over implanted ones is that they don't cause scarring, says Andrew Schwartz (http://motorlab.neurobio.pitt.edu/people.php?name=andy) , professor of neurobiology at the University of Pittsburgh. In 2008, Schwartz demonstrated that a monkey with an electrode (http://www.technologyreview.com/biotech/20832/?a=f) in its brain can control a prosthetic arm to feed itself. "This design is even better because it has a relatively small feature size and is flexible--it could make these implants less traumatic," he says. "What would really be nice is if you could amplify the signal near where you pick it up to reduce noise, and multiplex the signal to cut down on the number of wires needed," says Schwartz.

The silk electronics researchers say this is their next step, and one of the major promises of the technology. They've already demonstrated thin, flexible silicon transistor arrays built on silk, and tested them in animals--just not in the brain yet. Schwartz says other groups have recognized the importance of multiplexing and signal amplification, but have been working with rigid circuit boards that are not as biocompatible. Adding these active components would reduce the number of wires needed in these implants, which today require one wire per sensor. And active devices could respond to brain activity to provide electrical stimuli, or release drugs. (One of the collaborators on the silk project, David Kaplan (http://ase.tufts.edu/faculty-guide/fac/dkaplan1.biomed.htm) at Tufts University, has demonstrated that silk devices implanted in the brain in small animals can deliver anti-epilepsy drugs.)

Adding transistors to the electronics is currently a design challenge, says John Rogers, professor of materials science and engineering at the University of Illinois at Urbana-Champaign. The electrode-array design his group found to be most compatible with brain tissue is a mesh--solid sheets won't wrap around brain tissue as effectively. And adding silicon transistors to the mesh is more difficult than doing so on a solid substrate. Still, says Rogers, all the major pieces are in place and just need to be integrated. With further development and testing to prove the devices are safe, says

Rogers, "we hope this will be the foundation for new higher quality brain-machine interfaces."

Upcoming Events

Green:Net 2010 (http://events.earth2tech.com/greennet/10/)
San Francisco, CA
Thursday, April 29, 2010
http://events.earth2tech.com/greennet/10/ (http://events.earth2tech.com/greennet/10/)

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/)

Santa Barbara Summit on Energy Efficiency (http://iee.ucsb.edu/sbsee2010)
Santa Barbara, CA
Wednesday, May 12, 2010 - Thursday, May 13, 2010
http://iee.ucsb.edu/sbsee2010 (http://iee.ucsb.edu/sbsee2010)