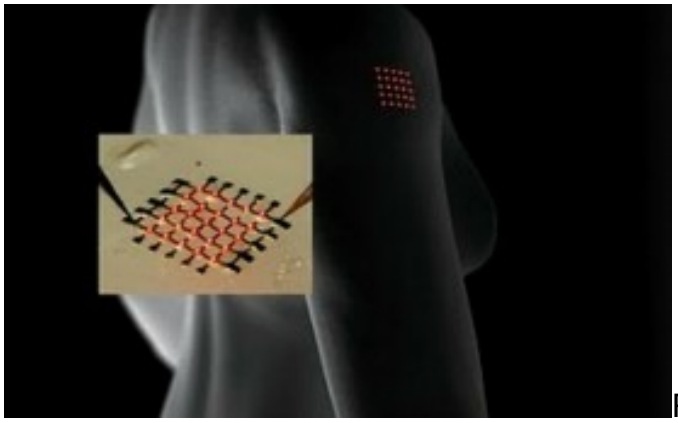
Electronic Implant Dissolves in the Body



Researchers at the University of Illinois at Urbana-Champaign, Tufts University, and others have created fully biodegradable electronics that could allow doctors to implant medical sensors or drug delivery devices that dissolve when they're no longer needed. The transient circuits, described in today's issue of *Science,* can be programmed to disappear after a set amount of time based on the durability of their silk-protein coating.

“You want the device to serve a useful function, but after that function is completed, you want it to simply disappear by dissolution and resorption into the body,” says John Rogers [1], a physical chemist at the University of Illinois at Urbana-Champaign and senior author on the study.

The authors demonstrate this possibility with a resorbable device that can heat the area of a surgical cut to prevent bacterial growth. They implanted the heat-generating circuit into rats. After three weeks, the authors examined the site of the implant and found that the device had nearly completely disappeared, leaving only remnants of the silk coating, which is eliminated more slowly than the silicon and magnesium of the circuit itself.

The work builds upon previous efforts from Tufts University's Fiorenzo Omenetto [2] (whose work won a 10 Emerging Technologies award in 2010 [3]) on using silk as a body-friendly mechanical support for electronics as well as a tunable coating that can be made to last days or months depending on chemical processing.

By combining that technology with their own thin and flexible circuitry, Omenetto, Rogers and the rest of their team were able to develop silicon-based electronics that completely biodegrade. Other groups are also working to develop biodegradable electronics, some with different materials that may not perform as reliably as the silicon device but might dissolve faster.

“The basic idea is to fabricate implants that are not only electronically active but that can degrade over time,” says Chris Bettinger [4], a materials scientist at Carnegie Mellon University who also is developing such electronics. “Integration, I

think, is the achievement here," he says of the study. "It's really impressive, with regards to how they were able to integrate all the materials."

The circuits themselves are made from magnesium electrodes and thin sheets of silicon. They are built on a support substrate of protein purified from silkworm silk. The thin silicon sheets, or nanomembranes, are an important part of the integrated technology, says Bettinger, because they are more flexible and easily broken down and eliminated by the body than other forms of the semiconductor.

The technology could be useful in a variety of biomedical implants, from treating surgical infections, as demonstrated, to drug delivery or disease diagnostics. But the potential extends beyond the body, says Rogers. "Environmental monitors or even consumer electronics might be interesting to build in this fashion, because it would help to eliminate a lot of waste streams with discarded electronics," he says.

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