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By John Matson | October 17, 2010 | 8

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An international team of researchers has devised a way to embed tiny light emitters and light sensors into stretchable, bendable, twistable sheets. The flexible systems might someday find use as implanted sensors to keep tabs on biological processes.



A LIGHT READ: A flexible array of LEDs on a folded sheet of paper.
Image: COURTESY OF JOHN A. ROGERS

Many approaches to developing flexible electronics have targeted a class of light emitters known as organic LEDs, which can be assembled using electrically conductive polymers and deposited on bendable plastic substrates. Conventional, inorganic LEDs are a more mature technology, with their own distinct advantages, but they are generally tethered to semiconductor wafers that limit their elasticity.

Now researchers have bridged the gap between organic and inorganic LEDs by harnessing the light of conventional electronics in an elastic system with biomedical potential. "The applications we're interested in mostly include interfaces with the human body," says [John Rogers](#), a materials scientist at the University of Illinois at Urbana-Champaign and a co-author of [a paper published online October 17 in Nature Materials](#) describing the advance. For some biological applications, he adds, a conventional LED's brightness, reliable operation and suitability for waterproof implementation make it a more attractive option than an organic LED. (*Scientific American* is part of Nature Publishing Group.)

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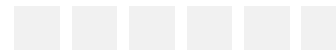
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Rogers and his colleagues printed an interlaced array of tiny light-emitting diodes, or LEDs, on a rigid wafer, then dissolved the top layer of the substrate to release a thin network of LEDs that can be transferred to a flexible, waterproof polymer sheet. "We can lift off from the wafer just the active layers," Rogers says, describing the process as a rubber stamp that picks up the LED array as if it were solid ink. Each LED is just 100 microns across (about the width of a human hair) and 2.5 microns thick—a micron is one millionth of a meter—and is connected to its neighbors by serpentine strands that can accommodate the deformation of stretching and twisting.

As a demonstration of the technology the researchers put LED arrays through any number of experimental implementations. They deposited LEDs on aluminum foil, the leaf of a tree, and a sheet of paper; they wrapped arrays around nylon thread and tied it in a knot; and they distended LED arrays by inflating the polymer substrate or stretching it over the tip of a pencil or the head of a cotton swab. "Eventually the students just got tired" of devising new tests for the light-emitting sheets, Rogers says. "There was nothing that we tried that we couldn't do."

The researchers also integrated light sensors alongside the LEDs and embedded the assembly in the fingertip of a vinyl glove. As the glove drew closer to a surface, the light sensors registered progressively more reflected light from the LEDs, producing a sort of proximity sensor that could be used to guide a surgeon's hand during a procedure or to form an artificial sensory system for robots.

But ultimately the use of LED arrays may be most attractive for implantable biomedical devices. "You can build systems that very naturally integrate with the tissues of the human body, because these systems are flexible and soft," Rogers says. Optical, spectroscopic measurements of tissue could alert physicians to the presence and location of infections after a surgical procedure. "Photoactivated drug delivery is another area that we think LEDs could be useful," he adds. As a demonstration, the researchers built light-emitting sutures and an implantable sheet of LEDs that they tested in vivo with an anesthetized laboratory mouse. (The mouse was later euthanized.)

A researcher in biomedical engineering whose company has collaborated with the researchers sees promise if not immediately clear-cut uses for the deformable electronic arrays. "We like flexible electronics," says Georgios Bertos, a senior R&D principal engineer at [Baxter Healthcare Corporation](#). But this is new technology, he adds, "and I don't think the applications have emerged yet." Bertos says that systems based on the new research are probably five to 10 years from implementation.

"I think we're going to collaborate more" with Rogers's group to make the technology more market-specific, Bertos says. He notes that the practicality of the devices will rest on tailoring them to uses in which implantability conveys enough of an advantage over traditional external devices to justify the added cost and complication. "You have to find the application where you can't live without having it integrated in the body," he says. "Otherwise it's just another sexy technology, which is cool but maybe is not needed for that particular application."



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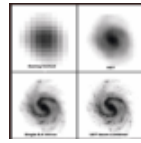
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Very cool. This type of technology and OLED will have a huge impact.

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you could make gloves that light up when you put them on.

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you could make mice that light up when they die.

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I'm thinking more you could have a display on your forehead illustrating what you're really thinking...

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What is amazing is that squids and octopi already have the ability to phosphorescence at the pigment level. If we could come up with a system that mimics this ability we could construct touch screen applications on our skin with a simple transfer patch. Actually we should be able to use this technology as low energy display for both electronics and digital paper.

I still haven't seen this type of technology married to the battery potential of phlange tipped bacteria. We need to fund this type of research as the next revolution in business. If I am correct the energy requirement is low enough that we could use solar energy somewhat like calculators do currently.

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clothing. Holiday decore. hair accessories. put them in the ruff of your arctic hood, and you can talk across the yard without screaming.

and following the medical theme, the clothing itself could monitor things like heartrate and body ph, alerting phsician to developing problems.

Possibly integrate them into posters, then have the leds react to the ambient room sound. Might be interesting to try them as wall paper...
depending on strength, they could be a topiary-type curtain outside, isolating the public and private parts of the yard.
I really need to read the article, see what THEY are suggesting using them for.

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not to mention the battery potential of the human skin. Might even help out those of us who can't wear watches or use electronics because our electrical systems are out of whack.

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clever. I really am excited about this technology.

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