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# Cheaper LEDs

Flexible arrays of bright inorganic LEDs could mean cheaper displays and lighting.

By Katherine Bourzac

Thursday, August 20, 2009


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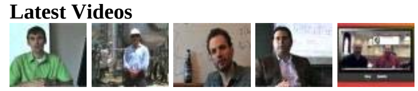


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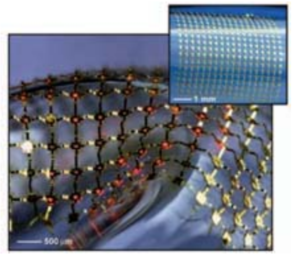
A new technique makes it possible to print flexible arrays of thin inorganic light-emitting diodes for displays and lighting. The new printing process is a hybrid between the methods currently used to make inorganic and organic LEDs, and it brings some of the advantages of each, combining the flexibility, thinness and ease of manufacturing organic polymers with the brightness and long-term stability of inorganic compounds. It could be used to make high-quality flexible displays and less expensive LED lighting systems.



**Stretchy screens:** Arrays of tiny red inorganic LEDs can be printed on stretchable rubber substrate to conform to curves. The gold-colored wires are electrical connections and are also flexible.
Credit: *Science*/AAAS

Inorganic LEDs are bright and long lasting, but the expense of manufacturing them has led to them being used mainly in niche applications such as billboard-size displays for sports arenas. What's more, the manufacturing process for making inorganic LED displays is complex, because each LED must be individually cut and placed, says John Rogers, a materials science professor in the Beckman Institute at the University of Illinois at Urbana-Champaign. So display manufacturers have turned to organic materials, which can be printed and are cheaper. While LED-based lighting systems are attractive because of their low energy consumption, they remain expensive. The new printing process, developed by Rogers and described today in the journal *Science*, could bring down the cost of inorganic LEDs because it would require less material and simpler manufacturing techniques.

Displays based on inorganic LEDs, says Nicholas Colaneri, director of the Flexible Display Center at Arizona State University in Tempe, "are not generally economical to make." The manufacturing process involves sawing wafers of semiconducting materials such as gallium arsenide, picking and placing each piece individually using robotics, and adding electrical connections one at a time.



To make the hybrid LEDs, the Illinois researchers start by growing an inorganic semiconducting material on top of what Rogers calls a "sacrificial" layer. The group uses a chemical bath to etch out LEDs that are just 10 to 100 micrometers on each side. Each LED is then secured with polymer anchors on two of its four corners. The anchors hold the LED in place during a second chemical bath that undercuts the LED, removing the sacrificial layer. The LEDs, which are about 2.5 micrometers thick, can then be picked up on a soft stamp and printed onto a glass, plastic or rubber substrate covered in a polymer adhesive. "You can deliver thousands of LEDs in a single step," says Rogers. "And because they're so thin, they can be interconnected using the conventional processes" used for organic LEDs and liquid-crystal displays.

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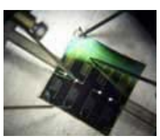

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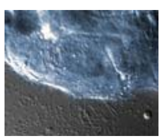

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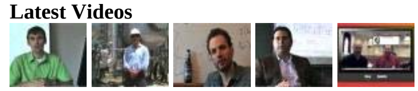

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Rogers says the method should be cheaper than conventional methods for printing inorganic LEDs because it requires less of the expensive semiconducting materials. Using the chemical etching and stamping techniques, it's possible to make each individual LED smaller. "The materials cost is a significant component of the final cost, so you have to use the minimum amount," says Rogers. LEDs made using conventional sawing techniques range are about a half a millimeter per side. But because they're bright, these LEDs can be much smaller and still provide the same display resolution. "To light a 100-micrometer pixel, you only need a 5-micrometer LED because to your eye, it looks the same," says Rogers.

The researchers have so far demonstrated the printing process for red LEDs made from gallium arsenide. Rogers says that the same approach can be used to make other colors of LEDs using different materials. "Conceptually it's the same process," he says. Rogers says he has also used the method to make blue LEDs using nitrides, though this work has not yet been published.

"These are conventional LEDs made by an unconventional process," says Colaneri. If Rogers and his coworkers can "demonstrate that this dramatically reduces the cost," he says, then "this is a potential competitor with OLEDs, though it's far from proven."

Rogers says the university is in talks with recently formed Canadian start-up Cool Edge to license the printing method and expects the first applications to be in lighting. Existing LED lightbulbs cost $30 to $100 for a single fixture, says Steven DenBaars, professor of materials science and co-director of the Solid-State Lighting Center at the University of California, Santa Barbara. "We've got to reduce the costs," he says.

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