A Thousand Pinpoints of Light

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Bright points. A new process allows tiny LEDs to be printed onto a glass cylinder or a thin sheet of plastic (*inset*).

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Imagine cardboard-thin TV screens that stretch across entire walls or portable video screens that can be rolled up when not in use. Those are some of the possible applications for tiny, inorganic light-emitting diodes (LEDs) that researchers have developed. The new LEDs are just as thin as conventional organic LEDs and liquid-crystal displays, but they're much brighter and more versatile.

In the world of LEDs, there's bright or there's cheap, but not both. Organic LEDs, such as those in cell phones and portable computer game systems, use carbon-based, thin-film materials as their main ingredient and thus can be manufactured cheaply in much the same way as computer chips. Inorganic LEDs, such as those used in outdoor video billboards, are based on gallium arsenide and gallium nitride; they're more rugged and much brighter, but they're also much thicker, so they must be cut and assembled individually by robots. The question has been how to combine the advantages of both display types into a single source of lighting.

That's what a team from institutions in China, Singapore, and the United States set out to do. "We wanted to see if we could use inorganic LEDs in ways that exploit some of the processing advantages of organic LEDs," says materials scientist and co-author John Rogers of the University of Illinois, Urbana-Champaign. The challenge, Rogers explains, was to find a way to grow, shape, and manipulate the inorganic LED devices en masse, because doing so would eliminate the need to cut and connect them individually--a cumbersome task when hundreds or thousands of the devices are involved.

As Rogers and colleagues report tomorrow in Science, they first created what they call a "sacrificial layer" in the manufacturing process. It's a weak adhesive that holds the LEDs in place while they form, but then it's partially dissolved away by an etching liquid. Next, a rubber stamping device presses down on and grabs hold of a bunch of the crystals. The stamping device picks up the LEDs and deposits them onto flexible sheets of glass, plastic, or rubber, where they are integrated with the conductors and insulators that will allow the lighting array to function. The result is a thin, flexible array that's much brighter than conventional organic LED arrays.

Rogers says the material for the inorganic LED arrays, square centimeter by square centimeter, is still more expensive than its organic LED counterparts. But because the inorganic diodes are so much brighter, far fewer are needed to create a display of equivalent brightness--and therefore the cost of the inorganic LED arrays is comparable.

The ability to manufacture and assemble inorganic LED elements as described in the paper will yield "amazingly flexible and robust membranes," says materials scientist Boris Yakobson of

Rice University in Houston, Texas. Although based on relatively simple mechanics, he says, the concept raises "tantalizing possibilities," such as weaving optical electronics into textiles--something Yakobson says could "offer a new variety of applications in this industry, which is striving for a high-tech revolution."

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