Building Hybrid LEDs by Directly Writing Blended Polymers

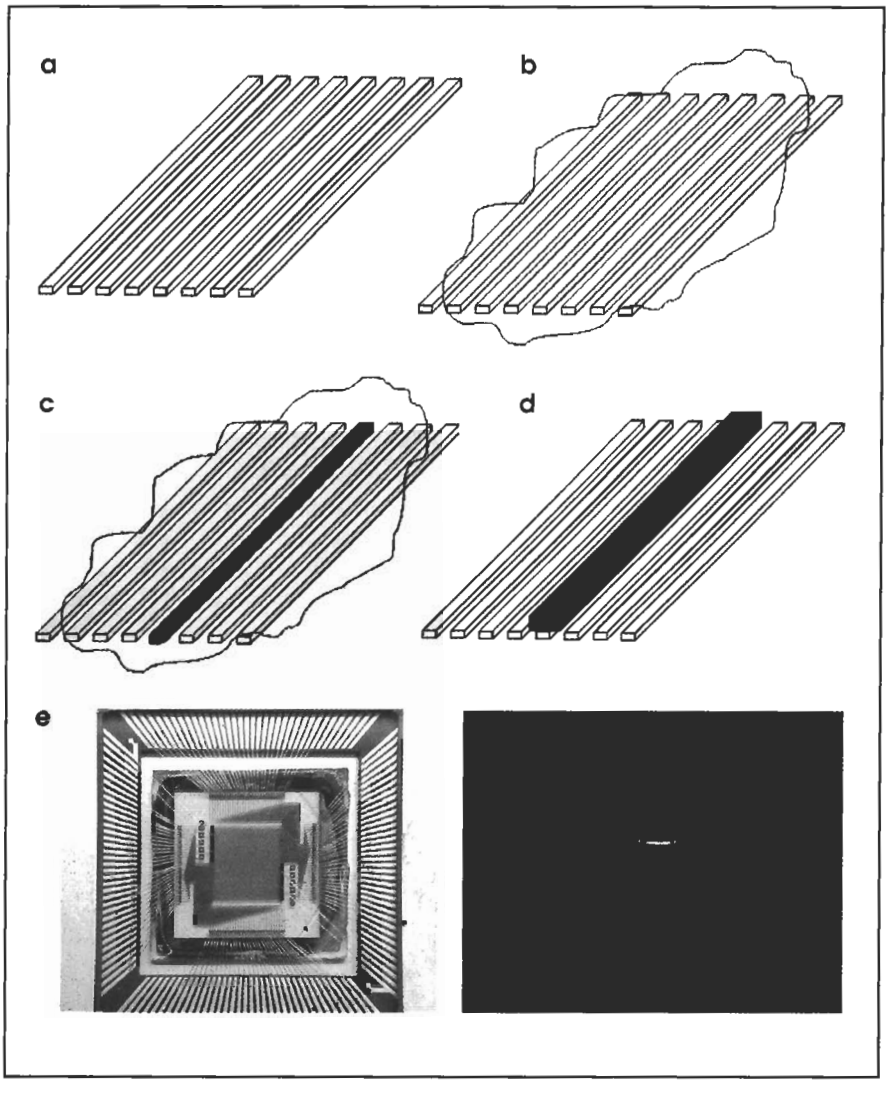
In animal breeding, hybrids can be superior to either parent. The same may be true for LEDs, given recent research from the University of Strathclyde in Glasgow, UK, and Imperial College London, where investigators fabricated hybrid inorganic/organic microstructured LEDs that could become a compact light source for full-color microdisplays or for white light.

The group, including university professor Martin D. Dawson, the principal investigator, and physics professor Donal D.C. Bradley of the college, had already demonstrated a hybrid inorganic/organic LED that could cover the visible spectrum and provide white light. However, the organic component was an unpatterned film, making it hard to miniaturize the devices and limiting functionality. Traditional photolithography could not overcome this problem because of chemical incompatibilities.

The researchers, therefore, took a different approach, blending light-emitting polymers with divinyl monomers and a photoacid generator. They knew that the latter could be photoactivated with ultraviolet radiation, meaning that the blend would be photocurable. They thought that it also might protect the polymers from the air.

For photocuring, the researchers turned to micro-LEDs, fabricating them out of AlInGaN semiconductors. They patterned these into 120 stripes that were ~20 µm wide, each individually addressable and capable of emitting at 370 nm. They spin-coated them with the light-emitting polymer/divinyl blend. When they turned a stripe on by forcing a current through it, the blend directly above it photocured, resulting in a self-aligned polymer microstripe as narrow as 50 µm.

The blend took less than 1 s to cure, which offers several advantages. "The process is fast and therefore scalable to large areas, and the fast polymerization process restricts photoacid diffusion and thus enables high-resolution structure fabrication," said Strathclyde-based team leader Erdan Gu.



Researchers have created a hybrid inorganic/organic LED by coating UV LED stripes with a photocurable polymer (a, b) and then turning on selected stripes to create a self-aligned polymer microstripe (c, d). The hybrid has a distinctly different color (e) than the starting UV LED microstripes. Courtesy of Erdan Gu, University of Strathclyde.

After removing the excess blend, the scientists were left with either bare microstripes, because they had not been turned on, or covered microstripes, because they had been activated. Those that were covered converted a portion of the UV radiation from the underlying activated LEDs, producing a bright color-shifted emission with both a UV peak and one in the visible with a maximum near 450 nm. They measured the optical output power with a power meter from Coherent Inc. and the emission spectra with a spectrometer from Horiba Jobin Yvon.

With the concept demonstrated,

the investigators are working to enhance the technology. They are trying to write even smaller polymer structures in different forms, with an eye toward fabricating micro-optoelectronic devices. They also are looking into white light emission from micro-LED pixels, either by stacking multiple polymer layers atop one another or by blending different light-emitting polymers into a matrix. "We are working on both," Gu said. □

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