High efficiency flat light source invented

April 12 2006

Tired of fluorescent tubes? Imagine your ceiling -- or any surface -- as a giant light panel, thanks to OLED research from the University of Southern California and Princeton University.

Scientists studying organic light-emitting devices (OLEDs) have made a critical leap from single-color displays to a highly efficient and long-lived natural light source.

The invention, described in the April 13 issue of *Nature*, is the latest fruit of a 13-year OLED research program led by Mark Thompson, professor of chemistry in the USC College of Letters, Arts and Sciences, and Stephen Forrest, formerly of Princeton University and now vice president for research at the University of Michigan.

"This process will enable us to get 100 percent efficiency out of a single, broad spectrum light source," Thompson said.

If the device can be mass-manufactured cheaply - a realistic expectation, according to Thompson - interior lighting could look vastly different in the future. Almost any surface in a home, whether flat or curved, could become a light source: walls, curtains, ceilings, cabinets or tables.

Since OLEDs are transparent when turned off, the devices could even be installed as windows or skylights to mimic the feel of natural light after dark - or to serve as the ultimate inconspicuous flat-panel television.

Thompson and Forrest previously invented efficient single- color displays now ready to enter the market in next-generation cell phones. But subsequent attempts by several groups to create white-light OLEDs fell short. The biggest issue was the fast burnout time of the blue component, since blue is one of the primary colors needed to make white.

The *Nature* paper presents a quantum mechanical trick that solves this problem. First, the researchers followed their standard recipe for making an OLED: placing four ultra-thin organic layers on glass or transparent plastic. Three of the layers serve as highways for charges to reach a central "emissive" layer.

When the oppositely charged molecules meet in the emissive layer, electrons jump from the negatively charged molecules to the positive ones, and ultimately relax to their starting energy. In the process, light is emitted, which can be tuned to cover a broad range of wavelengths.

Previous OLEDs used phosphorescent blue, green and red dyes to generate light with greater energy efficiency than all-fluorescence based devices (phosphorescence and fluorescence, both expressions of energy that is released as excited electrons fall back into their regular orbit, differ mainly in the speed of their response).

Thompson and Forrest found that they could substitute a fluorescent dye for blue without sacrificing the superior properties of OLEDs.

In fact, the researchers reported, the fluorescent dye should prolong the lifetime of the blue component and also uses 20 percent less energy.

"We're hoping this will lead to significantly longer device lifetimes in addition to higher efficiency," Thompson said.

According to Forrest, the device eventually could achieve three times the efficiency of standard incandescent light bulbs.

"With a future emphasis on manufacturing technology, this structure may provide an important, low-cost and efficient means that will replace incandescent lighting in many different applications," Forrest wrote.

The tallest remaining hurdle to production of these devices may have nothing to do with the OLED itself, Thompson said, but with the plastic layer to be used as a backing in economical large-area devices. All mass-produced plastics allow some humidity to pass through to the OLED, eventually degrading it.

"There's no plastic that's hermetic enough to make devices that will last a long period," Thompson said, while predicting that this problem can be solved. Already, Universal Display Corp. has developed the group's research into a commercially feasible process for making cell phone screens.

Source: University of Southern California