Carbon nanotube enabled vertical organic light-emitting transistor paves way for next-gen consumer electronics

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(PhysOrg.com) -- The technology that makes your smart phone's display screen fast, bright and lightweight could be coming to your television or laptop, thanks to a new type of light emitting transistor created by University of Florida researchers.

The new transistor design resolves a key issue that has kept the organic light-emitting diode, or OLED, technology used in small screens from being viable for computer monitors or televisions.

“It’s a very practical sort of development that could have big implications for consumers,” said UF physics professor Andrew Rinzler, author of a paper about the development that appears in the April 29 issue of the journal *Science*. “Progress from LCD to OLED has been slow. This new design should remove some of the stumbling blocks that have prevented OLEDs from being implemented in larger displays.”

OLED display pixels use less power, create a brighter picture and don’t have the viewing-angle issues of LCD pixels, which consume power even when they are their dark state.

Despite these advantages, OLED displays have been largely limited to hand-held devices because of the difficulty of making transistors to drive the OLEDs. The new transistor design opens up possibilities to tackle that problem with a new transistor that uses organic semiconductors —man-made compounds that contain carbon. Though much researched and improved over the last several decades, these materials consume too much power when used in the conventional transistor design.

That’s where the new design comes in. Making use of carbon nanotubes, it allows organic semiconductors to efficiently drive the high currents needed by OLED pixels, but at lower voltages.

In addition to redesigning the transistor that powers the OLED within each pixel, the team also combined the transistor and the OLED into a single device called a light emitting transistor. The resulting carbon nanotube enabled vertical organic light-emitting transistor, or CN-VOLET, is more than eight times more energy efficient than the closest competing devices.

That leads to another advantage, Rinzler said: “The light emitter can occupy more of the pixel area, giving the same light output at a lower current density through the light emitter. Since high current density degrades the lifetime of the light emitter, the change should make these devices last longer.”

The integrated design should also reduce manufacturing complexity, which could lead to lower costs, Rinzler said.
In addition to its potential impact on consumer electronics, the development also could help pave the way for more affordable radio frequency identification tags, which are used in inventory tracking for retailers, Rinzler said.

More information: Low-Voltage, Low-Power, Organic Light-Emitting Transistors for Active Matrix Displays, *Science* 29 April 2011: Vol. 332 no. 6029 pp. 570-573 DOI: 10.1126/science.1203052

ABSTRACT

Intrinsic nonuniformity in the polycrystalline-silicon backplane transistors of active matrix organic light-emitting diode displays severely limits display size. Organic semiconductors might provide an alternative, but their mobility remains too low to be useful in the conventional thin-film transistor design. Here we demonstrate an organic channel light-emitting transistor operating at low voltage, with low power dissipation, and high aperture ratio, in the three primary colors. The high level of performance is enabled by a single-wall carbon nanotube network source electrode that permits integration of the drive transistor and the light emitter into an efficient single stacked device. The performance demonstrated is comparable to that of polycrystalline-silicon backplane transistor-driven display pixels.

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