Record Performance for Printed Electronics

Katherine Bourzac

Using carbon nanotubes and a new insulating material, researchers have made flexible electronics with the best performance yet for printed devices. Integrated circuits printed from these materials could be used to drive simple displays and drug-delivery patches, and the flexible nanotube arrays might also be used as light emitters in telecommunications.

Printed electronics promise scalability, low cost, and flexibility. "Printing allows you to achieve scalability and low cost, but the field has been dominated by organic semiconductors whose performance is low," says Mark Hersam, professor of materials science and engineering at Northwestern University. Carbon nanotubes, on the other hand, offer a high-performance alternative in flexible electronics. But the printed nanotube circuits made so far require a lot of power to switch at high speeds - in a display driver, for example, this would mean a trade-off between the refresh rate of the picture and device battery life.

Working with researchers led by University of Minnesota chemical engineering professor Daniel Frisbie, Hersam has overcome the two main challenges to printing high-performance nanotube circuits. First, researchers don't know how to make batches of purely semiconducting nanotubes; metallic nanotubes in a printed circuit act like tiny copper wires, shorting out the circuit. The new devices get a performance boost because they're printed from pure solutions of semiconducting tubes separated using a technique Hersam developed in 2006. The pure nanotubes offer a boost in switching speed.

The second challenge is power requirements. In printed circuits made in the past, nanotubes have been paired with insulating materials that don't work very well. That's because it's difficult to control how thickly these materials are printed, which affects the quality of the device. Frisbie paired the nanotubes with a new printable insulating material, a gel that offers good electrical performance even when printed thickly.

Frisbie and Hersam have used the pure nanotubes and the gel insulator to print integrated circuits with record performances. Online in the journal ACS Nano, they report flexible circuits that switch at frequencies of two kilohertz (about 2,000 times per second) at a voltage of 2.5 volts. "They've achieved devices and circuits with record properties for a room temperature, printing-based fabrication process," says John Rogers, professor of materials science and engineering at the University of Illinois at Urbana-Champaign. "These results are exciting, and suggest an important and realistic application of carbon nanotubes in electronics."

The group reported making simple circuits incorporating as many as 14 transistors. "Now the idea is to push this a little, and make more complex circuits and

functionalities," says Frisbie. For the next level of scaling, the Minnesota group is looking at applications where about 100 of the transistors would be sufficient, such as simple sensors and displays. The devices can't operate at high enough voltages to switch the pixels in electronic paper, but they could work with organic light-emitting diodes. And Hersam's group is looking into alternative applications for printed nanotube electronics. The types of devices they're able to fabricate can also be made to emit and absorb light, particularly in the near-infrared wavelengths used for telecommunications and some biomedical imaging.

Article Source: Technology Review, www.technologyreview.com

Source URL (retrieved on *03/12/2014 - 1:34pm*):
http://www.wirelessdesignmag.com/news/2010/07/record-performance-printed-electronics?qt-blogs=0