Flexible Polymer Transistors 'Printed' Using Ultraviolet Light

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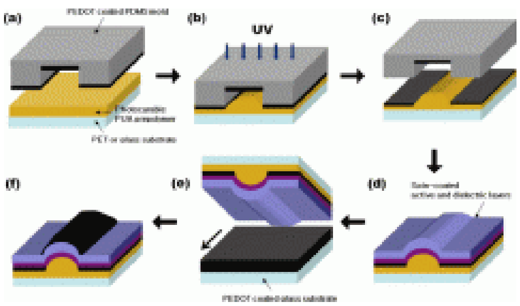

The procedure for creating UV-printed polymer transistors. (a) A PEDOT-coated mold is placed in contact with the pre-polymer-coated flexible substrate (b) They are illuminated with UV light (c) Upon removing the mold, PEDOT source-drain layers are transferred onto the substrate (d) Active and dielectric layers are "spin coated" on top of the source-drain layers (e) and (f) Using a PEDOT-coated glass substrate, the self-aligning gate layer is contact-printed on the dielectric layer. Image by Hong Lee, © American Institute of Physics

(PhysOrg.com) -- Computer and television displays made using flexible, bendable polymer materials are technologies of the future, promising roll-up computer monitors and other innovations. Scientists are making progress toward bringing these technologies into our homes and offices.

A research group at Seoul National University in Korea recently created a flexible polymer transistor that is printed using a simple process involving ultraviolet (UV) light, described in the November 20 online edition of *Applied Physics Letters*. Creating transistors in this way is an important avenue toward flexible electronics, as transistors form the basis of most modern electronic devices. Computer processing chips, for example, consist of more than 200 million transistors.

"Our printing method is low-cost and could be scaled to the manufacturing level -- a requirement for most technologies," said Hong Lee, the paper's corresponding author, to *PhysOrg.com*. "It performs as well as non-flexible polymer transistors and better than similar transistors produced by other research groups."

The researchers started with a commercially available polymer mold etched with a "source-drain" pattern, forming locations for two of the three electric terminals that make up a transistor: the source, drain, and gate. They then coated the mold with a very thin layer (just 100 nanometers) of a conducting polymer material, known in abbreviated form as PEDOT.

Next they coated a flexible substrate -- a surface on which to build the transistor -- with a "pre-polymer" liquid layer. The pre-polymer is key to the process because it hardens and binds to the PEDOT layer when illuminated with UV light.

Applying no pressure, the researchers brought the mold and the substrate into contact and exposed them to UV light for 20 minutes. When the mold was removed, the researchers saw that the PEDOT on the mold's raised areas had been transferred to the substrate, forming the transistor's source and drain.

But unlike ink deposited onto paper by a stamp, in which the paper's surface remains flat, the substrate underwent topological changes caused by the physical bonding between the pre-polymer and the PEDOT under the UV light during the hardening process. Where the raised parts of the mold met the substrate, the substrate's surface developed "low" areas.

And across from the mold's low areas, the substrate developed a raised mound between the source and drain, which acts as a channel between them.

The substrate was coated with two additional polymers, an "active" current-carrying layer and a dielectric, a material used in transistors to control the flow of current.

Finally, the substrate was flipped over and put in contact with PEDOT-coated glass. PEDOT "ink" was transferred to the substrate's raised area, completing the four-layer printed transistor structure.

This method departs from the inkjet-style approaches commonly used to print polymer transistors, in which a printer head moves back and forth across the substrate, depositing the polymer layers in tiny droplets. Inkjet printing has been successful, but ensuring the overall transistor pattern is properly aligned before the ink is dispensed can be difficult. The UV method does not require this step because the formation of the raised mound after the mold and substrate are combined and illuminated acts as a self-alignment mechanism.

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