One-volt operation of high-current vertical channel polymer semiconductor field-effect transistors

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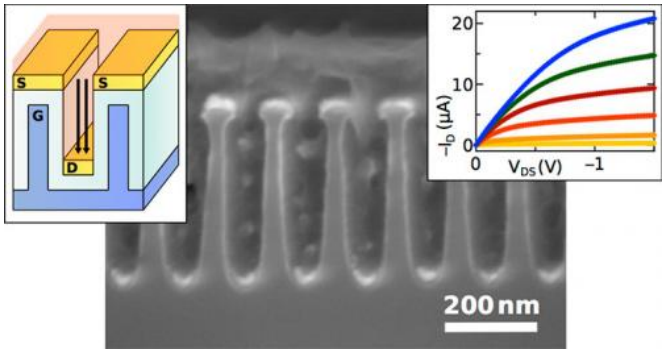

Schematic drawing and scanning electron microscope cross-sectional image of a vertical channel polymer semiconductor field-effect transistor. The device current output (ID) versus voltage (VDS) graph illustrates near-ideal transistor performance attributes at only one-volt operating voltage.

(Phys.org)—Scientists from the CFN, in collaboration with a scientist from the Condensed Matter Physics and Materials Science Department at BNL, have fabricated a vertical channel polymer semiconductor field effect transistor architecture by confining the organic material within the gratings of interdigitated trenches. These vertical channel transistors have a similar electronic mobility to that of planar devices that use the same polymer semiconductor, which is consistent with a molecular reorientation within the confining trenches that we now understand through synchrotron X-ray scattering measurements that were performed at the National Synchrotron Light Source (NSLS).

Field effect transistors made from organic semiconductors that possess both high current output and using low power supply voltages may find more widespread technological use. The geometric space savings achieved from the perpendicular channel orientation result in devices that source areal current densities that are in excess of 40 mA/cm^2, using only a one-volt supply voltage. This configuration maintains near-ideal device operating characteristics, which are among the best reported for organic semiconductor based devices.

Field effect transistors made from organic semiconductors, which have both high current output and using low power supply voltages, have the potential for more widespread technological use in various electronic devices. The geometric space savings of a perpendicular channel orientation results in devices that source areal current densities in excess of 40 mA/cm2, using only a one-volt supply voltage, and maintain near-ideal device operating characteristics - among the best reported for organic semiconductor based devices.

The Details:

- Vertical-channel polymer semiconductor field-effect transistors provide more than 40 mA/cm2 current output at one-volt operating voltage.
- Devices maintain near-ideal transistor performance attributes, despite a 90º change in direction of current flow compared to a planar transistor.
- Synchrotron x-ray scattering measurements at the NSLS show a 90º reorientation of polymer molecules in the vertical channel device.

More information: Johnston, D. et al., One-Volt Operation of High-Current Vertical Channel Polymer Semiconductor Field-Effect Transistors, *Nano Letters* 12, 4181 (2012).

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