New Flexible, Transparent Transistors made of Nanotubes

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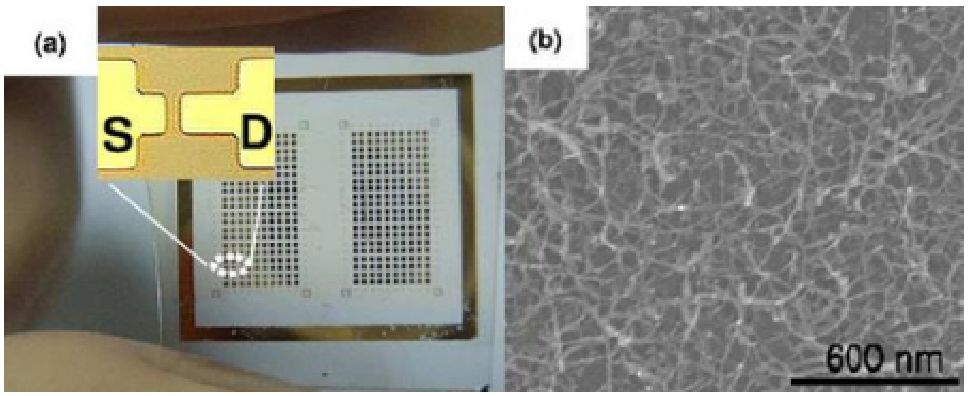

(A) The thin film transistor array on a glass substrate. Inset: A magnified transparent transistor. (B) Scanning electron microscope image of the network of SWNTs. Image credit: Eun Ju Bae, et al.

The ability to create flexible, transparent electronics could lead to a host of novel applications, such as e-paper and electronic car windshields. Now, scientists have constructed a transistor made of a network of nanotubes that may serve as an essential component in a trans-flex device.

Such devices require two main components: light displays and current-controlling transistors. While scientists have found that OLEDs and LCDs work well as light displays, finding a truly transparent and flexible transistor material is still an open area. Usually, these transistors consist of metallic nanowires.

Recently, researchers from Hanyang University in Seoul have constructed a thin film transistor made of networked single-walled carbon nanotubes (SWNTs) on a glass substrate. While it's not the first thin film transistor made of SWNTs, it has the advantage of allowing a high density of SWNTs to be grown under lower temperatures than normally required.

Most significantly, the method shows that nanotubes can offer a practical choice for fabricating transparent, thin film electronics such as flat-panel displays and future opto-electronics devices.

"This works shows that we are able to build a transistor with thin films of SWNTs, rather than with single SWNTs," coauthor Wanjun Park told *PhysOrg.com*. "It means that we have an easier fabrication method for building electronic devices made of nanotubes, without the need to individually control each single tube."

In a recent issue of *Nanotechnology*, the researchers explained how the SWNT network can be arranged through a technique called chemical vapor deposition. In this method, the substrate is pre-patterned with catalysts to avoid the need for etching, and the nanotubes can be directly deposited on the substrate. By enhancing this technique with the use of a water plasma, the scientists were able to grow the nanotubes at significantly lower temperatures than in previous methods.

Due to the high SWNT density on the substrate, the nanotubes intersected with each other to form a continuous conductive path. However, for nanotubes above a critical percolation threshold (a measure of connectivity), there was no conductance. In this way, the SWNTs act like semiconductors, providing the basis for the on-off switching in the transistor.

In the future, the scientists plan to make improvements to the nanotube transistors by increasing their mobility and further understanding the complex configuration of the nanotube networks.

"These results are just the beginning," Park said. "The technology needs lower temperatures for semiconducting SWNT growth, as well as higher transistor performance for real applications. But SWNT is a very robust material with outstanding electrical properties. It can be expected to be one of the candidates for a future electronic material."

More information: Bae, Eun Ju, Min, Yo-Sep, Kim, Un Jeong, and Park, Wanjun. "Thin film transistors of single-walled carbon nanotubes grown directly on glass substrates." *Nanotechnology* 18 (2007) 495203 (4pp).