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Researchers Advance CNT-Based Networks

In what appears to be a major advance in carbon nanotube-based circuits, researchers from Purdue University and the University of Illinois at Urbana-Champaign said they have succeeded in building networks of carbon nanotubes (CNTs). The team solved the problem of metallic CNTs causing short circuits by cutting the network into precise strips. The effort could advance the field of flexible circuits and displays, they said.

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After four years of collaborative research, researchers from **Purdue University** (West Lafayette, Ind.) and the **University of Illinois** (Urbana-Champaign, Ill.) said they have succeeded in building networks of carbon nanotubes (CNTs) that could advance the field of flexible circuits and displays.

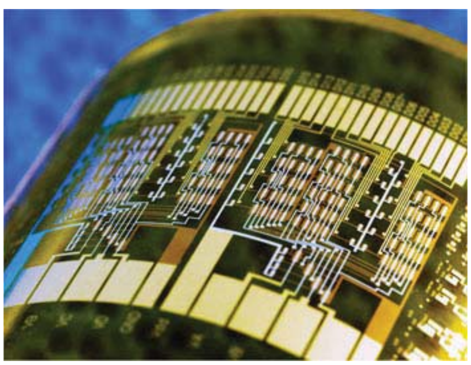
Networks of semiconducting CNTs become contaminated with metallic nanotubes that cause short circuits. The Illinois-Purdue team said it figured out how to cut the CNT network into strips, preventing short circuits by breaking the path of the metallic nanotubes.

Potential applications include "electronic paper" that displays text and images, solar cells that could be printed on plastic sheets, and television screens capable of being rolled up for transport and storage.

Professor Ashraf Alam led a team of professors and graduate students at Purdue in creating the simulations and models, while **Illinois Professor John Rogers** led a group effort to build the experimental circuits.

"Other researchers have proposed eliminating the metallic nanotubes," Rogers said. "Instead, we found a very nice way of essentially removing the effect of these metallic nanotubes without actually eliminating them."

The "nanonets" are made of semiconducting cylinders of single-walled CNTs that overlap each other like needles. During the process of making the CNTs, metallic nanotubes form and link together in meandering threads that eventually stretch across the width of the transistor. If the nanonet area is large enough, the overlapping metallic nanotubes cause a short circuit. However, if the device is segmented into strips, this meandering path of metallic rods is cut at the point where the lines separate one strip from another, preventing short circuits.



Researchers have created CNT-based 'nanonets' that could advance the field of flexible circuits and displays.

The metallic nanotubes make up about one-third of the nanotubes in the transistor. Because the carbon nanotubes are twice as numerous as the metallic tubes, enough of them exist to form a complete circuit. The models and simulations are needed to tell researchers precisely how wide to make the strips so that the pathway of metallic tubes is cut but the carbon nanotubes complete their circuit.

"The simulations showed there is always a way to break the metallic path and still keep the semiconducting CNT path intact," Alam said.

The researchers created a flexible circuit of >100 transistors, the largest nanonet ever produced and the first demonstration of a working nanonet circuit. Alam said that there is no fundamental reason why the approach cannot be scaled up from flexible circuits of 100 transistors to circuits with 10,000 or more transistors. "Now there is no fundamental reason why we couldn't develop nanonet technologies," he said, opening the way to CNT-based transistors used to create high-performance, shock-resistant, lightweight and flexible ICs at low cost.

The **Network for Computational Nanotechnology** was employed during the simulation phase. "This work requires tremendous computing resources because these are not trivial calculations," Alam said.

Findings are detailed in a research paper, "**Medium-Scale Carbon Nanotube Thin-Film Integrated Circuits on Flexible Plastic Substrates**," appearing today in the journal *Nature*.

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