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Tuning in to the possibilities of nanotube transistors

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John Rogers is a founder professor of materials science and engineering at the University of Illinois. Recently, he managed to do what nobody else has done - build the world's first all-carbon nanotube transistor radio. Its circuits are made from arrays of carbon nanotubes and, in one experiment, even picked up a local traffic report.

He's not making very tiny radios, as the word "nano" might suggest. But why bother to do the work anyway? Transistors have been around since 1947, finding their way - and becoming smaller - into everything electronic.

A carbon nanotube is an arrangement of carbon atoms that forms a hollow tube, more than 50,000 times smaller than a human hair. "Carbon nanotubes have many electronic properties that are better than silicon, and certain capabilities that are impossible with silicon-based approaches," says Rogers.

As a materials scientist, Rogers believes his radio is a major milestone. It was put together with help from colleagues and engineers from Northrop Grumman. Single-walled carbon nanotubes were first deposited onto a quartz substrate in densely packed, horizontally aligned arrays (around five nanotubes per micron).

The nanotube arrays (individual nanotubes are a few nanometres in diameter and several-hundred nanometres long) are then incorporated into devices like transistors or circuits using conventional microchip-processing techniques. With many thousands of nanotubes, electrodes, and other layers, the finished semiconducting components are the same physical size as their silicon counterparts.

Rogers' radio experiments have prompted many inaccurate headlines such as "Researchers make tiny radio from nanotubes" - it's actually several centimetres across. Carbon nanotubes aren't for tiny radios, though: the technology offers improved amplification properties, very high device operating speeds, and may be deposited from solution onto plastic substrates.

"We think that RF [radio frequency] analog electronics and flexible electronics are the most promising," says Rogers. "In the area of RF, we are working on Wi-Fi and Bluetooth transmitters/receivers. In flexible electronics, we are working on RFID tags and display driver circuits."

Wireless applications would gain from lower power consumption, improved communication fidelity and range. Displays might also benefit from lower costs and higher refresh rates, while emissive displays would become more readily possible. But commercial uses for nanotube arrays are years away yet.

Rogers says: "There is now a very clear pathway for building circuits and systems with nanotubes. We use the arrays as a material alternative to silicon. We are not attempting to replace silicon for the things that silicon already does well."