UNIVERSITY OF ILLINOIS RESEARCH

Radio in the palm of your hand? Try on the head of a pi

By GREG KLINE
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Sure, that pack of cards-sized transistor radio you once thought was so small pales by comparison to your iPod Shuffle, which isn't much bigger than a square from a Hershey's chocolate bar.

But your diminutive Shuffle has got nothing over on the portable tune machine University of Illinois Professor John Rogers and colleagues have fabricated.

Their radio is built from transistors made of carbon nanotubes — and you could fit it easily on a grain of sand, Rogers said recently.

OK, they're not making a big deal out of the first broadcast they picked up — "The Safety Dance," the goofy 1980s hit by the late, unlamented pop group Men Without Hats. They've since received traffic broadcasts and more.

The point isn't what's playing on the radio you can't even see. It isn't even the radio itself.

What the demonstration, outlined last week in the Proceedings of the National Academy of Sciences, represents is a milestone in using carbon nanotubes, structures on the scale of a billionth of a meter, in devices designed for a practical purpose.

"The radio is just a demonstration vehicle to show people we can start to do realistic things now," said Rogers, a UI materials science and engineering professor. "It's really an electronics material technology that can compete with established state-of-the-art technologies."

That demonstration was made possible with a technique developed by Rogers and his UI students to produce carbon nanotubes in ordered collections rather than the jumbled rat's nest the structures usually arrive in when synthesized.

The growth technique results in horizontally aligned arrays of nanotubes — tiny tubelike structures of interlinked carbon atoms — that function as a thin film of material with electronic properties similar to, and even better than, materials like the silicon used in microelectronics now.

The nanotube sheets, in fact, can be turned into electronic devices and circuits using conventional chip-processing technology.

"A silicon transistor is also a very small thing," Rogers said.

The UI researchers and colleagues at Lehigh and Purdue outlined their method for making nanotubes last year in the journal Nature Nanotechnology, among other places.

"It's just a workhorse for us and many other groups around the world have adopted this," said Rogers, who also is a professor at the UI's Beckman Institute and Frederick Seitz Materials Research Laboratory.

He said the technique was a bit of serendipity from other work in his lab. The UI researchers were growing nanotubes on quartz, for use in conjunction with a laser to burn out certain tubes and leave others undamaged, when one of Rogers' graduate students noticed the structures forming in an ordered fashion on part of the test bed.

That prompted an effort to optimize the quartz substrate and chemistry for the effect and led to scientific papers, which scientists at Northrop Grumman Electronics Systems in Maryland saw, leading them to contact Rogers.

The researchers decided analog radio frequency was a promising area for employing nanotubes — Northrop Grumman is interested in the technology from the standpoint of military communications, for example — and collaborated on an amplifier component first, then a whole radio.

The latter is built from six transistors fashioned from thousands of nanotubes and connected to a small, standard circuit board from Radio Shack, which provides the full-sized connectors for an antenna and headphones.

The antenna is manipulated to tune the radio, which means you wouldn't have to buy an electron microscope just to turn the dial.

The project was funded by the National Science Foundation and the U.S. Department of Energy.

Rogers said nanotubes have "spectacular" electronic properties that can make devices fashioned from them faster and, in the case of radio devices, better at receiving and sending signals.

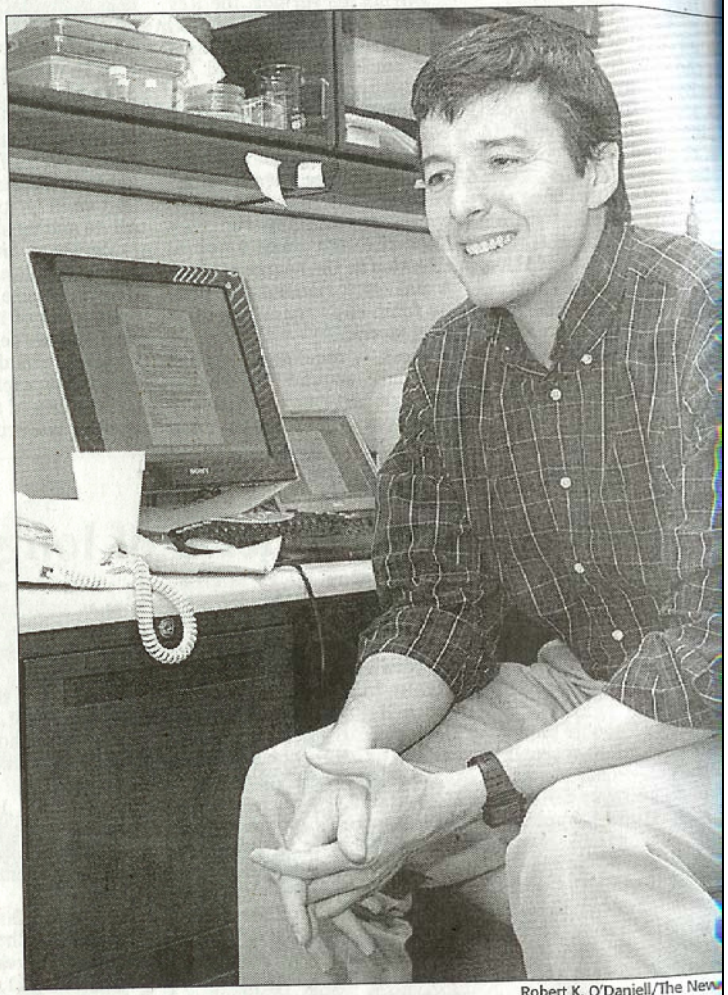
Nanotube devices also can be integrated with flexible materials, like plastic (think radio you could fold up and put in your pocket).

Practical applications, besides military communications, could range from cell phones, to the kind of radio frequency tags retailers like Wal-Mart use to track inventory, to networks of powerful, yet minuscule, sensors.

Rogers said the researchers, in addition to improving their nanotube manufacturing method, are working on devices incorporating many more than six transistors to show the technology can scale up.

They're also working on tools to help make it easier to fabricate things from nanotubes.

"The whole design tool set has got to be there if you want to take it to the next level," Rogers said.



Robert K. O'Daniell/The News

UI Professor John Rogers and his team of researchers have created very s transistor radios made with carbon nanotubes.