Nano-based RFID tags could replace bar codes

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RFID tags printed through a new roll-to-roll process could replace bar codes and make checking out of a store a snap. Credit: Gyou-Jin Cho/Sunchon National University

Long lines at store checkouts could be history if a new technology created in part at Rice University comes to pass.

Rice researchers, in collaboration with a team led by Gyou-jin Cho at Sunchon National University in Korea, have come up with an inexpensive, printable transmitter that can be invisibly embedded in packaging. It would allow a customer to walk a cart full of groceries or other goods past a scanner on the way to the car; the scanner would read all items in the cart at once, total them up and charge the customer's account while adjusting the store's inventory.

More advanced versions could collect all the information about the contents of a store in an instant, letting a retailer know where every package is at any time.

The technology reported in the March issue of the journal *IEEE Transactions on Electron Devices* is based on a carbon-nanotube-infused ink for ink-jet printers first developed in the Rice lab of James Tour, the T.T. and W.F. Chao Chair in Chemistry as well as a professor of mechanical engineering and materials science and of computer science. The ink is used to make thin-film transistors, a key element in radio-frequency identification (RFID) tags that can be printed on paper or plastic.

"We are going to a society where RFID is a key player," said Cho, a professor of printed electronics engineering at Sunchon, who expects the technology to mature in five years. Cho and his team are developing the electronics as well as the roll-to-roll printing process that, he said, will bring the cost of printing the tags down to a penny apiece and make them ubiquitous.

RFID tags are almost everywhere already. The tiny electronic transmitters are used to identify and track products and farm animals. They're in passports, library books and devices that let drivers pass through tollbooths without digging for change.

The technology behind RFID goes back to the 1940s, when Léon Theremin, inventor of the self-named electronic music instrument heard in so many '50s science fiction and horror movies, came up with a spy tool for the Soviet Union that drew power from and retransmitted radio waves.

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RFID itself came into being in the 1970s and has been widely adopted by the Department of Defense and industry to track shipping containers as they make their way around the world, among many other uses.

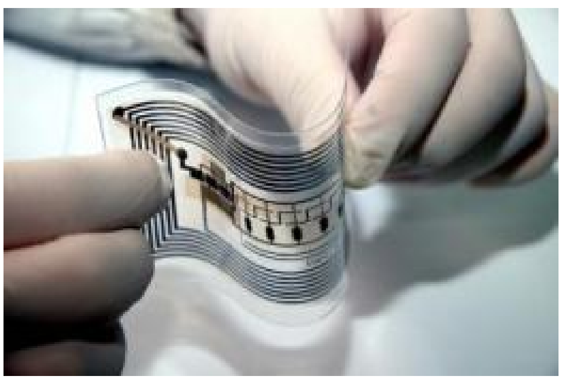
But RFID tags to date are largely silicon-based. Paper or plastic tags printed as part of a package would cut costs dramatically. Cho expects his roll-to-roll technique, which uses a gravure process rather than ink-jet printers, to replace the bar codes now festooned on just about everything you can buy.

Cho, Tour and their teams reported in the journal a three-step process to print one-bit tags, including the antenna, electrodes and dielectric layers, on plastic foil. Cho's lab is working on 16-bit tags that would hold a more practical amount of information and be printable on paper as well.

Cho came across Tour's inks while spending a sabbatical at Rice in 2005. "Professor Tour first recommended we use single-walled carbon nanotubes for printing thin-film transistors," Cho said.

Tour's lab continues to support the project in an advisory role and occasionally hosts Cho's students. Tour said Rice owns half of the patent, still pending, upon which all of the technology is based. "Gyou-jin has carried the brunt of this, and it's his sole project," Tour said. "We are advisers and we still send him the raw materials" -- the single-walled carbon nanotubes produced at Rice.

Printable RFIDs are practical because they're passive. The tags power up when hit by radio waves at the right frequency and return the information they contain. "If there's no power source, there's no lifetime limit. When they receive the RF signal, they emit," Tour said.



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There are several hurdles to commercialization. First, the device must be reduced to the size of a bar code, about a third the size of the one reported in the paper, Tour said. Second, its range must increase.

"Right now, the emitter has to be pretty close to the tags, but it's getting farther all the time," he said. "The practical distance to have it ring up all the items in your shopping cart is a meter. But the ultimate would be to signal and get immediate response back from every item in your store - what's on the shelves, their dates, everything.

"At 300 meters, you're set - you have real-time information on every item in a warehouse. If something falls behind a shelf, you know about it. If a product is about to expire, you know to move it to the front - or to the bargain bin."

Tour allayed concerns about the fate of nanotubes in packaging. "The amount of nanotubes in an RFID tag is probably less than a picogram. That means you can produce one trillion of them from a gram of nanotubes - a miniscule amount. Our HiPco reactor produces a gram of nanotubes an hour, and that would be enough to handle every item in every Walmart.

"In fact, more nanotubes occur naturally in the environment, so it's not even fair to say the risk is minimal. It's infinitesimal."

More information: Read the paper at: ieeexplore.ieee.org/xpl/freeab … jsp?arnumber=5406115

Provided by Rice University