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NDSU Dept. 4000 | PO Box 6050 | Fargo, ND 58108-6050 | p: 701.231.5174 | www.ndsu.edu

‘Smart Paper’ Antenna-Free RFID Tags in Works at NDSU

Professor Val Marinov holds a prototype “smart paper” document with an embedded microchip that uses radio waves to allow tracking

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Imagine pieces of paper that could broadcast their whereabouts. A team of researchers at North Dakota State University uses microchips to enable pieces of paper to be tracked. Val Marinov calls it “smart paper.” His team of researchers at NDSU’s Center for Nanoscale Science and Engineering has applied for a patent for a laser process they’ve developed to apply tiny silicon chips to paper.

The process is not unlike a sophisticated version of screen printing techniques used for making T-shirts. The chips use a technology called Radio Frequency Identification, or RFID, that allows tracking via radio signals.

NDSU researchers also are developing antenna-less “smart tags” that can be used to track all sorts of objects.

Now that the process to apply microchips to “smart paper” has been proven through prototypes, the engineering team is working on testing suitability for mass production. Their goal is to drive down the cost of the embedded microchips to five or six cents per sheet of paper; a goal Marinov’s team believes is attainable. One firm is selling “smart forms” costing 80 cents to $1.50 each. “No one is going to be interested in RFID paper if it costs $2 per sheet,” said Marinov, an associate professor in industrial and manufacturing engineering.

Besides lottery tickets and mass transit passes, potential uses of “smart paper” include election ballots, as well as financial documents. Although a major benefit of “smart paper” would be to prevent counterfeiting, Marinov said governments are conservative about changing their currency, so “smart paper” money isn’t likely soon. Because paper is bent and even crumpled, the circuitry also must be flexible, one of the challenges Marinov and his team had to overcome.

Marinov is working with Aaron Reinholz, associate director for electronics technology at the nanoscale center, on bringing the technology to market. The pair has been in contact with multiple companies interested in “smart paper” applications. A Canadian manufacturer of office

furniture, one of the more novel examples, is interested in using the devices for quality control, allowing any defects to be traced back to a processing batch. Another company is interested in using the technology in wristbands for hospital patients. We're in different stages of conversation," with various companies, Reinholz said. "There is significant interest in the industry about this product."

"Smart paper" could reach the market in one or two years, Reinholz said. Researchers are looking for funding to build the apparatus to take production closer to commercial scale. "It really is about finding the right business partners," he said.

Another NDSU team is working on "smart tag" technology that would allow the tiny devices to work without an antenna. That's an important capability, since the electromagnetic fields created by radio signals go haywire when placed in contact with metal surfaces. Cherish Bauer-Reich, a research engineer, had the idea of using a thin buffer material to allow the tags to work on metal surfaces and containers of liquids. To test the concept, researchers crafted crude, handmade prototypes. "And it worked," said Mike Reich, a senior research engineer at NDSU's nanoscale center. "Much to our surprise, actually," Bauer-Reich added.

The tags now are about two millimeters thick, and the researchers are striving to make it thinner. NDSU obtained a provisional patent, and a patent is pending for the invention. "We've had a lot of interest," Bauer-Reich said. The problem, she added, is they want a product that's ready for market. Researchers are looking for business partners to help launch a commercial product. "There's this funding gap," she said. "We've had a few inquiries of the nature of 'When can you send us these?' "

The aerospace and oil industries have expressed interest. "Imagine all the things they have to track in the oilfields," Reich said.

Both the "smart paper" and antenna-less "smart tags" were developed with help from grants by the Department of Defense.

Both Marinov and Bauer-Reich have been invited to speak at an upcoming scientific conference. The expertise involved in developing NDSU's "smart paper" technology is rare, Marinov said. "I don't think anyone else has demonstrated a functioning product using this technology," he said. "We can do things here that no one else can in the country – not only the country, the world. We should be proud of that, I believe."

Additional information about these RFID related technologies and other NDSU innovations available for licensing are available at:
http://www.ndsuresearchfoundation.org/rft370 and
http://www.ndsuresearchfoundation.org/rft370

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