Using imprint processing to mass-produce tiny antennas could improve wireless electronics

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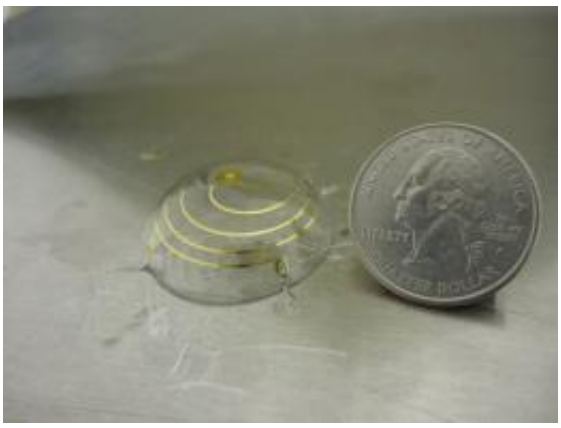

A hemisphere-shaped antenna developed at the University of Michigan has the capacity to be mass produced and could lead to improvements in wireless consumer electronics. Credit: Carl Pfeiffer

(PhysOrg.com) -- Engineering researchers at the University of Michigan have found a way to mass-produce antennas so small that they approach the fundamental minimum size limit for their bandwidth, or data rate, of operation.

This could lead to new generations of wireless consumer electronics and mobile devices that are either smaller or can perform more functions. The antenna is typically the largest wireless component in mobile devices . Shrinking it could leave more room for other gadgets and features, said

Anthony Grbic, an associate professor in the Department of Electrical Engineering and Computer Science.

Grbic and Stephen Forrest, a professor in the departments of Materials Science and Engineering and Physics, led the development of the hemisphere-shaped antennas, which can be manufactured with innovative imprint processing techniques that are rapid and low cost. The finished product is 1.8 times the fundamental antenna size limit established in 1948 by L.J. Chu. The dimensions of this limit vary based on an antenna's bandwidth.

"Ever since the Chu limit was established, people have been trying to reach it. Standard printed circuit board antennas don't come close. Some researchers have approached the limit with manually-built antennas, but those are complicated and there's no efficient way to manufacture them," Grbic said.

"We've found a way to reduce the antenna's size while maximizing its bandwidth, using a process that's amenable to mass production."

The researchers' prototype operates at 1.5 gigahertz, in the frequency range of WiFi devices as well as cordless and mobile phones. The antenna is 70 percent efficient and ten times smaller than conventional antennas, Grbic said. It has three times the conductivity of similar devices produced by 3-D ink-jet printing techniques, a process that serially writes the antenna geometry.

This new method is a very general process, said Carl Pfeiffer, a doctoral student in the Department of Electrical Engineering and Computer Science and first author of a paper on the work being presented at the 2011 IEEE International Symposium on Antennas and Propagation.

"It can be used to fabricate antennas that are of a wide variety of sizes,

shapes, frequencies, and designs," Pfeiffer said. "Basically if you tell me the data rate that is required for a particular application, I can make an antenna that does this while at the same time being as small as possible."

Beyond consumer electronics, this work could be useful in wireless sensing and military communications. Wireless sensor networks could be used for environmental monitoring or surveillance.

The prototype was made in the College of Engineering's Lurie Nanofabrication Facility. The work was funded by the Department of Education's Graduate Assistance in Areas of National Need program, the National Science Foundation and the U.S. Air Force Office of Scientific Research.

More information: The paper is titled, "Novel Methods to Analyze and Fabricate Electrically Small Antennas."

Provided by University of Michigan