
Microscopic RFID chips

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Microscopic RFID chips to embed in human cells

- in case you missed it the first time

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TAGS

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Researchers at Stanford University are now several phases into a development project to create a passive, 60 GHz RFID transponder that is small enough to be inserted into a human body's cell. Thus far, the group has been able to scale the chip and antenna down to about 22 microns (0.0009 inch) wide—one fifth the diameter of an average human hair—which is small enough that it could be inserted inside a cell, and thus be read throughout a person's body. The chip, in fact, has been inserted into a mouse melanoma cell. RFID could also be placed within a mass of cells, such as a tumor.

The group has designed a specialized RFID reader to transmit to—and receive responses from—a tag that small. Researchers call this miniaturized tag and associated specialized reader a promising step toward continuous, real-time monitoring of activities at cellular levels.

Both Hitachi and Murata have developed very small RFID tags. Hitachi's chip measures 300 microns (0.01 inch)—see [Hitachi Unveils Smallest RFID Chip](#). The Murata tag, however, measures approximately 700 microns (0.03 inch)—see [Murata Mass-Produces 'World's Smallest HF Tag'](#).

The Stanford team's chip is too small to be seen with the human eye. The researchers—members of the university's electrical engineering department—call the system a micrometer-scale magnetic resonance-coupled RFID transceiver for wireless sensors in cells. Their goal is to create the chip with an associated RF antenna at a microscopic size, so that it could be used for health-care diagnostic and research purposes. For instance, a chip embedded in a person's living cell could remain inert in a specific part of the body, and respond to interrogation from a reader outside the body, in order to indicate where it is located, as well as any sensor-based data if linked to such technology.

The octagonal-shaped tag consists of several layers. One layer is a piece of titanium measuring 5 nanometers (0.0000002 inch) in thickness, with gold film measuring 200 nanometers (0.000008 inch) laid on it, while the second layer is a sheet of aluminum 1,000 nanometers (0.00004 inch) in thickness. Finally, a 16 nanometer (0.0000006-inch)-thick electrical insulated layer of hafnium dioxide is included. The layers are encapsulated in silicon dioxide to protect the tag and the cells that come in contact with it. The tag is encoded with a unique identifier that makes it possible for health-care providers and other users to identify it within a mass of tissue or cells.

Researchers Develop Microscopic RFID Chip to Embed in Human Cells

BY CLAIRE SWEDBERG

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However, a tag that small traditionally would not be able to receive and respond to interrogation from a typical RFID reader. For that reason, the researchers designed a specialized reader. While most handhelds used on RFID tags have a single antenna, in this case they designed a reader with two antennas measuring about twice the transceiver's diameter. The extra antenna enables them to boost the signal to and from the tag approximately tenfold.

The project was designed with three phases, says Mimi X. Yang, a Stanford researcher. The first phase consisted of reducing the tag to the microscopic level, which they have accomplished, though they still need to reduce it further to embed it in a single cell. The second phase involved embedding the chip within a biological mass of cells. So far, the researchers have embedded the tags in the melanoma of a mouse. The chip's management poses a challenge due to its microscopic size, Yang says. Part of this process involved ensuring that tags would not be so close to each other that they would create confusion when a reader was used on a cell or a mass of cells.

The third phase will be to read the chips. "We have reduced the tag to a microscopic level," Yang states. "What we are missing is measuring electrical data [the RF transmission] while the tag is inside the cell." Therefore, the project's next phase will consist of implanting tags in an aqueous solution that will move through a microscopic silicone rubber tube. The team will then attempt to read the tags at close range as they move through the tube.

"What we're trying to develop is a very general electronic system" for the body, Yang says, while the long-term goal is to link the RFID chip with sensors to accomplish additional diagnostics, such as detecting antibodies or chemicals within the body. In this case, for instance, pressure or PH sensors could be of value, she says.

The system could also potentially be used to destroy a cell, such as cancer, if a chip could be prompted, based on a transmission from the reader, to emit sufficient voltage to kill that cell. In the meantime, the Stanford group will continue to determine whether the chips can be read by an interrogator in an environment similar to being embedded in living cells within a human body.

Once the tags are found to be effective, and are possibly miniaturized further to fit within a single cell, the functionality would enable individuals to identify specific cells without damaging them. This, Yang says, would enable disease study and detection, as well as a variety of other diagnostics and ev