Printing Technology Makes Miniature Energy Harvesters, Antennas, and Fuel-Cell Parts

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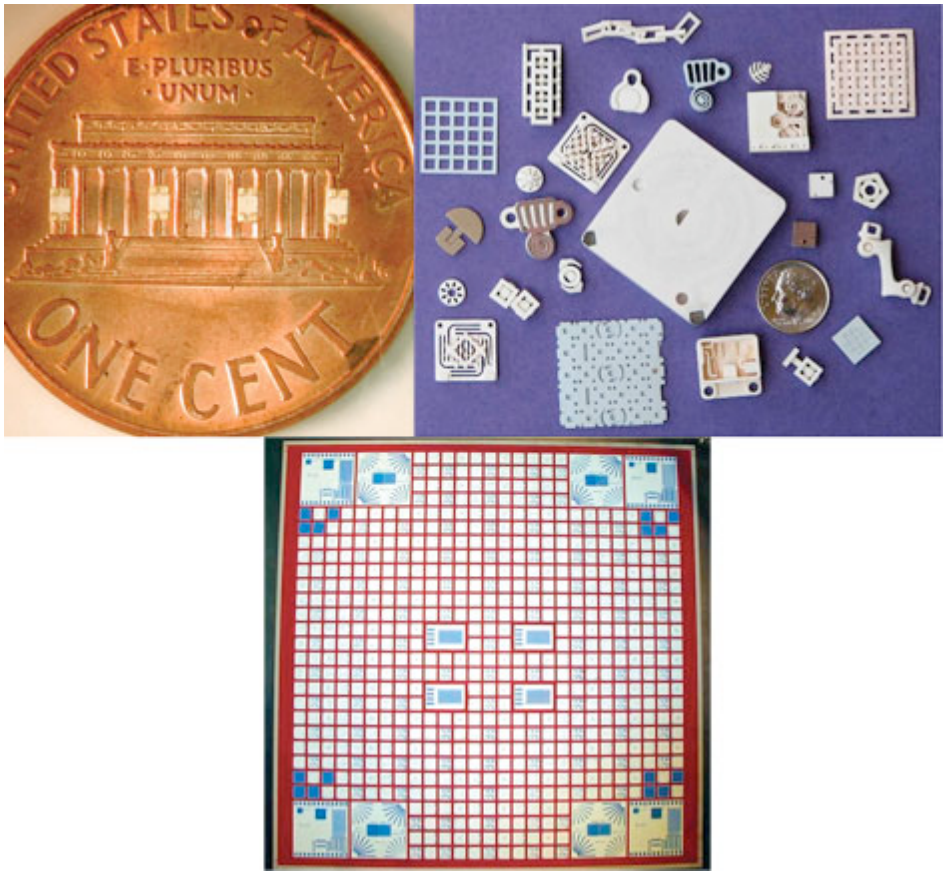
EoPlex Technologies miniaturizes for multiple markets



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31 January 2008—In an effort to prevent rollover accidents, new cars sold in the United States must be outfitted with electronic tire-pressure sensors that warn the driver when tires are going flat. But the battery-powered initial version of the technology is less than ideal. The batteries may work fine at first but are subject to extreme heat, cold, and shock that will likely lead to several battery changes over the lifetime of the car. Replacing them could prove costly, because the sensors are sealed and must be replaced with the batteries. A consortium of tire and auto suppliers hopes to cut that cost. It's testing sensors that can be mounted on the wheel or even embedded in the tires themselves that needs no battery and can radio pressure data from the tire to electronics inside the car. The secret is a cheap coin-size device called a "PZT bimorph" that harvests energy from the tire's vibration via a miniature piezoelectric springboard.

The tire makers are depending on a small start-up company, EoPlex

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Technologies, in Redwood City, Calif., which has tuned its three-dimensional printing technology to construct the complex devices on the cheap. If the new power source passes its multiyear tests, carmakers may start to install other wireless components that will cut back on the kilometers of wiring in today's cars.

The device looks like a miniature diving board with a block at the end of it. The board is made of layers of piezoelectric material and metal conductors. So when the device bounces around, the diving board vibrates and converts the vibration into electricity. In a typical rolling tire, it provides about 20 microwatts, which when accumulated in a capacitor is enough to periodically power the pressure sensor and a radio transmission that's strong enough to reach antennas inside the car.

PZT bimorphs are a decades-old technology, but they couldn't be made cheaply enough or small enough for such a problem until EoPlex applied its manufacturing process to the problem, says the company's CEO Arthur Chait. That process prints a three-dimensional pattern of metals and ceramics embedded in a proprietary paste one layer at a time. Even parts of the device that will be empty space, such as the areas surrounding the PZT diving board, are printed in a type of paste called a "negative." When the structure is heated properly, the paste evaporates and the metals and ceramics become dense, leaving a miniature structure. Amazingly, the negative paste disappears even if it's completely enclosed in a ceramic paste structure as is the case with the PZT bimorph.

Chait says one of the technology's main strengths is that it allows you to add complexity to a design without adding cost.

Because the auto industry moves so cautiously, it will likely be at least two years before PZT-powered tire-pressure sensors show up in cars. But Chait says EoPlex has some nearer-term prospects, too. By the end of 2008, the company expects to be shipping a miniature methanol reformer, a device that converts methanol to hydrogen for use in compact fuel cells. Emergency and military radio makers are interested in the reformer, because such radios need about 20 W of power, which can mean lugging around more than 10 kilograms of batteries. One liter of methanol powering a fuel cell could take the place of 10 kg of batteries, says Chait.

From the outside the reformer looks like a matchbox, but inside, "this is the most sophisticated thing we've ever built," says Chait. It's made up of more than 300 layers and has chambers, channels, mixers, vents, and pipes as well as a bed of platinum catalyst that breaks the methanol into hydrogen and carbon dioxide. EoPlex was asked to build the reformer by a customer that Chait would not name. "We built their original design," says Chait. "But taking advantage of our technology, we could make it one-third the size."

EoPlex will begin producing chip dielectric antennas for cellphones this year. There is typically one of these for each type of radio—Bluetooth, Wi-Fi, GPS—the phone uses. With its ability to construct complex 3-D shapes, EoPlex can build two or three antennas on one substrate, Chait says, saving some real estate on the circuit board.