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How do you make a fuel cell? Print it

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The technology that helped make black-light posters and concert T-shirts a cultural mainstay is now being used to make fuel cells, chip packages and PC components.

South San Francisco, Calif.-based EoPlex Technologies has come up with a technique for producing mechanical components with industrial printers. Instead of embossing a logo through thin layers of ink piled on top of each other, the company builds components by piling thin, patterned layers of ceramics, metals and other materials on top of each other and curing the individual layers as the structure takes shape.

These printed components, which consist of hundreds of layers, can also contain fully integrated moving parts, hinges or sealed air chambers.

Although these parts can be cranked out now with conventional manufacturing techniques, EoPlex claims that its technology will greatly reduce the cost. Many parts can be produced simultaneously and with less need of micromachining or assembly.

Cost is a key consideration if the futurists--who predict that sensors and computers will become ubiquitous--are right. The technique is too beefy to produce microprocessors inside sensors, but it can be used to make the packages, power supplies and other necessary, albeit less "intelligent," components for pervasive computing.

"A fuel cell reformer can take two weeks on conventional manufacturing processes. It will take us three minutes on a full-scale production line. We can now do a prototype in a day," said Arthur Chait, CEO of EoPlex. "We can manufacture fully functional parts."

Several companies have examined over the years the possibility of using printers to make parts. Traditional manufacturing remains an expensive process involving dedicated machinery and production lines. Printers are appealing because they can be reprogrammed to print a variety of devices, thus drastically cutting capital costs, real estate and even staff sizes.

Most have concentrated on inkjet printing. Hewlett-Packard, for instance, has come up with a way to produce 3D design prototypes, which can give engineers a better idea of what a finished product might ultimately look like.

British inkjet manufacturer Xaar, meanwhile, has teamed up with researchers at the University of Manchester to develop spray-on human bone cells. Xaar is also working with Sweden's Thin Film Electronics to create memory chips that can be sprayed (rather than produced out of the highly expensive lithography and chemical etching processes used by chipmakers today).

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Although EoPlex will likely one day incorporate inkjet technology into its offerings, for now it concentrates on techniques like screen printing where fluid is pressed directly onto a surface by a drum or a plate. Conventional printing may not draw as fine lines as inkjet printing, but it costs less.

"If you've ever seen posters printed, the process is similar," Chait said. "They print the yellow, then the red and then the blue."

Unlike posters, each stage gets individually cured through heating. A single layer, for instance, may contain ceramic material and a polymer. By heating this layer after printing, the polymer will evaporate, leaving a void. In the next printing layer, metals or a different type of ceramic will

--Arthur Chait, CEO, EoPlex

then fill all or part of the void created in the previous round of printing and burning.

Right now, the company's processes can produce features measuring less than 50 microns. In the future, EoPlex will be able to print features under 10 microns. (A micron is a millionth of meter.)

In semiconductors, 50 microns is gigantic--about the width of a human hair--but for medical probe manufacturers or producers of small solar cells, that's small. Partly as a result of these relatively small dimensions, features such as ball-and-socket joints or hinges can be produced as an integrated element of a single component (rather than represent the marriage of two separate miniature parts). The gap between two moving parts actually represents layers of voids created during the curing process.

The curing also makes the latest layers bond to the base of layers that went before it. After 300 rounds of stenciling and heating layers, the finished product might emerge.

The company's intellectual property largely revolves around coming up with various printing fluids for different applications. Some metals have relatively low evaporation points and therefore can't be mixed with other ones more tolerant of high temperatures. Some metals also conduct electricity better than others; depending on the product being made, that can be good or bad. Thus, Chait said, HP is less of a competitor than a materials specialist like Japan's Kyocera.

"Typically there are certain ceramics that go better with certain metals," Chait said. "This is more material science than printing. The trick is to get the materials to work together."

A complete set of printers for producing products with the company's technology costs about $1 million, Chait said, and can be squeezed into a space about the same size as a large conference room. The start-up right now has the ability to make about 1,000 components a year, but it hopes to be capable of building 30 million units a year by 2011.

EoPlex, which has received venture funding from Draper Fisher Jurvetson and Labrador Ventures, will gain its revenue from producing parts rather than licensing its intellectual property. Right now, a number of manufacturers are looking at the technology, Chait said. The first products made by EoPlex to hit the market will probably be fuel cells, he predicted.

"They are big, thick, complex and involve multiple materials," he said.