

---

## ...But how do you build it?

It's a common occurrence in the world of advanced materials—an engineer develops a brilliant design, but it is too expensive or complex to mass produce because of limitations in the manufacturing methods available to integrate ceramics, metals, glasses, and polymers.

The brilliant design may require features such as radiating surfaces, circuits, chambers, piezoelectric elements, passives, sensors, and even moving parts. Manufacturing technologies are very limited in this multi-material realm, especially with devices in the size range of millimeters and microns; many materials must be bonded or sintered together to achieve the desired properties. As a result, some devices remain too costly or impossible to produce in volume.

The problem is that a manufacturing gap exists at the miniature scale when working with multiple materials. Some designs are too large or contain too many materials to be manufactured with MEMS or related processes, yet they are too small for assembly to be cost-effective.

Recognizing this need, EoPlex Technologies drove development of a new technology platform called “high-volume print forming” (HVPF) to build parts such as fuel-cell components, energy harvesters, miniature ceramic antennas, and electronic packaging.

Energy harvesters are a good example of the challenges created by this manufacturing gap. These devices, which harvest vibration to create electric power, are being developed as battery substitutes for applications including tire pressure systems required in all new cars sold in the USA. They offer the potential of lifetime service and the elimination of batteries, and they are better for the consumer and the environment.

Energy harvesters have been around for a while in relatively crude forms. For example, in the electric match, squeezing the trigger bends and releases a spring to strike a piezoelectric material, creating an electric spark. This is OK for lighting a barbecue—but devices that can replace batteries are far more complex, and unfortunately, higher-cost.

A look inside a device shows why. The energy harvester includes a multilayer beam of piezo-material bonded to metal conductors to form a tiny bimorph sandwich, fixed at one end and free to vibrate like a tuning fork. Electricity is generated, captured by electrodes, and stored in a capacitor. Manufacturing these devices requires precise integration and bonding of up to seven different materials, which cannot be done with present methods at low cost, and that is why these devices have seen slow market adoption.

Our HVPF process offers the potential to make rugged low-cost energy harvesters available. The HVPF platform allows tiny elements of metals, ceramics, polymers, and void spaces to be integrated into devices and manufactured simultaneously. Thousands of parts are made together in a panel process similar to that used for semiconductors, and cost-per-part is low. Proprietary “inks” are print-formed in sheets at high accuracy and then decomposed by special heat treatments to form the required dielectrics, conductors, and spaces in a form that will work together. Parts may require hundreds of layers with thicknesses from microns to millimeters.

Miniature fuel cells represent another area where this manufacturing gap has delayed market entry. Unlike energy harvesters which work in limited applications that require small amounts of power, fuel cells produce high power in lightweight packages and offer unlimited service-life for portable applications such as emergency radios, laptop computers, cell phones, etc. Unfortunately, commercial fuel cells have been “just around the corner” for years, due in part to limitations in the production of components like miniature pumps, hydrogen reformers, catalyst beds, and other small complex parts. The HVPF manufacturing process represents a new solution to low-cost production of these parts, and is currently being used in the development of small fuel cells—offering encouragement that we may finally see these products on the market in the near future.

The gap in manufacturing complex multi-materials devices is a barrier to commercialization. EoPlex is working to help bridge this gap by providing a low-cost technology platform to design and manufacture such parts in high volume.



**Arthur L. Chait** is president and CEO of EoPlex Technologies Inc., Redwood City, CA.



*Small Times* December, 2008

**Author(s)** : Arthur L. Chait

---

To access this article, go to:

**[http://www.smalltimes.com/articles/article\\_display.cfm?ARTICLE\\_ID=347761&p=109](http://www.smalltimes.com/articles/article_display.cfm?ARTICLE_ID=347761&p=109)**

---

Copyright © 2009: PennWell Corporation, Tulsa, OK; All Rights Reserved.