Microfabrica Produces Tiny Actuated Medical Tools

Microfabrica's EFAB additive fabrication technology takes on minimally invasive surgical tools

Joseph Ogando, Senior Editor -- Design News, March 16, 2008

The growing popularity of minimally invasive surgical procedures has already started to create a need for tiny medical tools. And that need has now led **Microfabrica** to apply its proprietary micro-scale **additive fabrication** system to medical applications.

Here at the **MD&M West** show, the company showed off a new collection of "building blocks" it has created for minimally invasive medical devices. Among these mm- and micron-scale components and mechanisms were linkage-based tissue "expanders," micro-chain-mail structures, micro needles, a chainsaw-like tissue nibbler, forceps, miniature ratchets and multi-lumen tubes. The company has also built one of the world's smallest turbines, a fluid-powered unit that measures just 1mm across and spins at speeds up to 120,000 rpm. "The micro-turbine might be used as a high-speed distal **actuator** in catheter-based devices, eliminating the need for drive cables," says Adam Cohen, Microfabrica's chief technology officer.

Microfabrica produced all of these building blocks using a proprietary **additive fabrication** process called EFAB. An alternative to various micro-machining, molding and even **MEMS** processes, EFAB builds up the parts on ceramic wafer by depositing layer after layer of two distinct metals. One of these metals, usually an alloy of nickel and cobalt, forms the finished part itself. The other metal, usually copper, serves as sacrificial support material that is later etched away to reveal the net-shape part. EFAB employs an electroplating process to deposit the metals and a photomask to define the outline of each layer. "It's essentially a photolithography technique," says Cohen.

Working in batches of hundreds or thousands of parts, the process produces devices with feature sizes down to 4µm. Cohen puts the accuracy and repeatability of the process at 2µm. The system also offers plenty of design flexibility. It can produce a range of 3D geometries such as undercuts, internal passages, curved holes and more. The process is inherently free of burrs and other manufacturing artifacts that micro-machining can leave behind.

Even more important for those trying to avoid the big assembly costs associated with the smallest devices, Microfabrica has also demonstrated EFAB's ability to produce assembly-free mechanisms composed of many moving parts. To make these parts in a single step, the EFAB process applies the sacrificial material wherever there would be clearances between moving parts. The etching step frees the moving parts, leaving a working **mechanism** behind.

At the MD&M show, Richard Chen, the company's vice president of product development, showed off mm-scale mechanisms that had more than 70 moving parts held together by minuscule pin joints. "We can make just about any assembly that can be designed in CAD," he says.

Since its inception about eight years ago, Microfabrica has mostly been working outside the medical world. Cohen says the biggest applications for EFAB components so far have involved microprobes for semiconductor wafer testing, high-frequency communications devices and inertial **sensors** on a chip.

The company has just started to attract interest from medical researchers and device makers over the past year or so. Cohen says some of this interest involves making existing surgical tools more cost effective — by eliminating assembly steps. He cites a recent job revamping a set of tiny forceps as one example.

The biggest driver for this tiny technology, however, may come from entirely new classes of medical devices. Researchers at Boston University, for example, are working with Microfabrica to develop new tools for minimally invasive heart surgery. The project, which recently won a $5 million grant from the National Institutes of Health, involves creating robotic systems that could extend into the heart through needle-sized incisions and make repairs. Microfabrica's devices would act as the end-of-arm tooling for removing and suturing heart tissue — all while the heart continues to beat.