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Latecomer to nanomedicine has advantage

## Hitachi throws its financial weight behind nanoimprint technology

By Marie Powers

Hitachi, Ltd. (NYSE:HIT), of Tokyo, is throwing its considerable financial clout behind a nanotechnology that was invented nearly a decade ago by a U.S. researcher now at Princeton University. Hitachi's Advanced Research Laboratory (ARL) has already begun preparing sample shipments of a low-cost "nanostamp" technology that has taken on new significance for its potential use in medical applications.

Nanoimprint lithography, developed by Stephen Y. Chou, PhD, in 1994 and patented in 1998,<sup>1</sup> is a lithographic method for creating ultra-fine patterns -- less than 25 nm -- over a large area with high throughput and at low cost. Chou, now Joseph C. Elgin professor of engineering and director of the NanoStructures Laboratory in the Department of Electrical Engineering at Princeton University, has continued to refine the technology, earning additional patents<sup>2</sup> while engineering the nanopillar technology to as small as 6 nm.

Nanoimprint lithography patterns a resist by deforming the resist shape through embossing, with a mold, rather than by altering resist chemical structures through radiation with particle beams, Chou explains. After imprinting the resist, an anisotropic etching is used to remove the residue resist in the compressed area to expose the substrate.

Akihiro Miyauchi, PhD, a senior researcher in Hitachi's ARL, tells *NanoBiotech News* that the company's integrated nanopillar structure has extremely high aspect ratios -- a feature the company says will prove attractive for immunoassays, DNA/protein separation chips, and related applications such as biochips and detectors.

"The size of the nanopillar is less than 80 nm -- comparable to the size of a virus," Miyauchi says.

The Hitachi nanoimprint technology uses a silicon "nanomold" that presses a pattern onto a polymer film substrate, producing nanopillars that are just 3 microns in height. ARL is producing two

versions of the nanopillars: one that is 250 nm in diameter and a second that's 80 nm.

### **A tool for researchers**

"Both versions are on sale as samples," Miyauchi says, who is initially targeting the product to biotech researchers.

Because Hitachi's nanopillars don't require lithography equipment or dry etching machines -- just simple press molds -- "our press-and-release nanostamp process is about one-tenth the cost of conventional lithography production," according to Miyauchi.

Chou has commercialized his own nanoimprint lithography (NIL) technology -- considered to produce the smallest nanopillars in the world -- through Nanonex, Inc., a privately held Princeton spinoff located in Monmouth Junction, NJ, that was launched in 2000. Nanonex products already are used both in research and manufacturing, Chou says.

"Our technology gives not only excellent uniformity over the entire wafer in nanoscale, but also the precise alignment and extremely fast processing times," he points out.

A newer, laser-assisted direct imprint (LADI) technique invented by Chou uses a pulse of less than 250 ns from an excimer laser -- commonly used in laser surgeries -- to melt a quartz template against a silicon mold. Quartz is used because the material is transparent to the laser beam and does not stick to the silicon. Princeton has already applied for a patent on the technology, described last year in *Nature*.<sup>3</sup> The LADI technology could be commercially available in several years, Chou says.

### **The competition heats up**

A number of other researchers, both in the U.S. and Europe, also are commercializing nanoimprint technologies. These include Molecular Imprints

Inc., an Austin, TX-based startup, and the Nanometer Consortium at Lund University in Sweden, which is partnering with Obducat AB in Sweden to sell NIL machines.

Initially, Hitachi plans to market its NIL machine in Japan, "but I am planning to sell worldwide using the sales channel of Hitachi group companies," Miyauchi says. "The customer needs process support by Hitachi to fabricate nanopillars because special nano-molds and polymers must be used."

Miyauchi declines to disclose whether the company's ARL is handling the initial manufacturing in-house or with a partner, but Chou says the ARL is a relatively new division that has been established specifically to commercialize Hitachi's nanopillar technology.

To date, Hitachi has not published any patents for its design, but the company's enormous global operation -- \$36.4 billion in sales for the first half of fiscal 2003 -- has a considerable competitive advantage in a niche nanotechnology such as nanoimprint lithography, Chou admits.

"Intellectual property publishing depends on early entrance in a technology," he says. "We already have four or five patents issued, and Molecular Imprints has one issued. Hitachi is a late comer to the game, but a huge company. This is a small market today, but that could change quickly.

"The trend toward nanomedicine is clear," Chou adds, "and artificially produced nano patterns have many applications in nanomedicine, both on the lab side and, eventually, in human use."

*Editor's Note: Contact Stephen Y. Chou at (609) 258-3500.*

## References

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