CHEMICAL & Engineering News

Serving The Chemical, Life Sciences, and Laboratory Worlds
September 28, 2005
Volume 83, Number 40
VENTURE CAPITAL
At The Crossroads Of Biology, Electronics

Start-up Cambrios seeks to harness biology for electronics manufacturing

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http://pubs.acs.org/cen/news/83/i40/8340cambrios.html

SEEKER Cambrios researcher Adrian Winoto prepares bacteriophages for screening against different metals.

Modern integrated circuit manufacturing entails the high-temperature deposition of extremely thin insulating, capping, and dielectric films on top of silicon wafers. And with the help of the chemical industry, semiconductor companies have become pretty good at this delicate operation.

In the process, known as chemical vapor deposition, or CVD, organometallic precursor molecules are heated to more than 600 °C. The vaporized molecules are flowed into a reaction chamber where they hit the silicon wafer, release their organic ligands, and end up as a thin inorganic film. The chamber is then cleaned with a highly reactive scavenging gas such as nitrogen trifluoride.

The process works, but it's getting more expensive and more difficult with each successive scaling down of computer chip architecture. Now, a start-up firm called Cambrios is proposing a completely new, biological means of laying down thin films and carrying out other steps in electronics manufacturing.

The Cambrios approach has its roots in the laboratories of Angela Belcher, a materials chemist now at Massachusetts Institute of Technology who formed the company in 2002 with long-time collaborator Evelyn Hu of the University of California, Santa Barbara.

Belcher had observed how abalone and other sea creatures use proteins to create highly ordered inorganic films based on calcium and silicon. Using a screening process called bacteriophage display, she turned up proteins that would do the same with inorganic materials that have industrial applications.

The idea was good enough to attract $1.8 million in venture capital funding in late 2003. The following February, the firm hired a chief executive officer, Michael R. Knapp, a microbiologist who had earlier cofounded Caliper Life Sciences. Then in February 2005, Cambrios secured a second round of financing worth $12 million from investors that included nanotechnology specialist Harris & Harris and In-Q-Tel, a venture-capital group funded by the Central Intelligence Agency.

Today, Belcher and Hu are on Cambrios' scientific advisory board, and Knapp is leading a staff of 15 that includes chemical engineers, biologists, biochemists, and an electrical engineer. Hash Pakbaz, the firm's vice president for business development, is a Ph.D. physicist who earlier worked at Lawrence Livermore Lab and Siemens on organic semiconductors.

Knapp says Cambrios spent most of 2004 narrowing down the scope of a technology that has very wide applicability. "Our goal was to take a huge landscape and find something a small company could do," he says. Pakbaz arrived in October 2004 and helped the firm focus on the electronics industry, where constant miniaturization was challenging traditional chip-making techniques.

Building on Belcher's work, Cambrios uses the phage display technology to screen commercial libraries of billions of protein-containing phages, finding proteins that bind to inorganic compounds useful in manufacturing electronics. These proteins include unique ones that have affinity for two distinct materials.

At its Mountain View, Calif., laboratories, the company is developing water-based semiconductor fabrication techniques that are the antithesis of today's high-heat vacuum-based approach. Cambrios takes a silicon wafer covered with ultrafine electronic features and dips it in a solution of proteins that have affinity for the features. After the proteins bind to the features, the wafer can be dipped into a solution of a second material that then binds to the same proteins, creating a thin film on top of the existing features—and nowhere else on the wafer.

This kind of selective film deposition, Pakbaz notes, is highly coveted by the electronics industry. Today, companies must expend considerable time and materials to deposit films with the CVD process and then painstakingly etch away the unwanted portions. "Using chemistry alone is challenging," he says. "We believe biochemistry brings much-needed additional functionality."

According to Knapp, Cambrios has already attracted the attention of North American companies with semiconductor fabrication problems they haven't been able to solve via traditional means. "They see the potential, but we need to demonstrate some key feasibilities in the areas we're talking about with them," he says. "We have to prove that our technology has potential in that specific space."

Knapp and Pakbaz acknowledge that they don't play up the biotechnical fine points of Cambrios' technology when approaching potential customers. "The cruel reality is that nobody cares about technology," Knapp says. "People are interested in applications and products." Thus, Cambrios sees itself as a supplier of electronic materials that happen to have biological roots. Just like companies such as Rohm and Haas, Air Products & Chemicals, and JSR, Cambrios aspires to supply electronics materials and recipes for how to apply them.

Although still young, Cambrios is starting to be recognized. Joanne Itow, managing director for manufacturing at the semiconductor consulting firm Semico, met with the company recently and concluded in a report that its technology "could take a while to reach commercialization but is the kind of innovation that expands markets and keeps the electronics industry on a growth path."

Despite the two investment rounds, Knapp and Pakbaz know they have less than "a while" to establish themselves. Their $12 million will last about 30 months, and they can't count on too much more investment beyond that. "We need to have convincing commercial traction in the next three to five years," Pakbaz says.

Chemical & Engineering News
ISSN 0009-2347