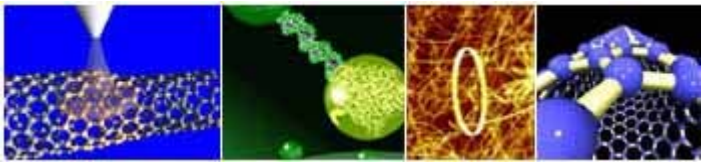
February 08, 2008

Nanotech Alert

TECHNICAL INSIGHTS
FROST & SULLIVAN
http://www.ti.frost.com



Emerging Technologies :: R&D Trends :: Technology Innovation :: Strategic Analysis

---

FABRICATING EXTREMELY LONG NANOFIBERS VIA DIRECT WRITING

Quite a number of direct-write fabrication processes have been developed over the past several years. These processes include dip-pen nanolithography, ink-jet printing, electrochemical fountain pen nanofabrication, and the like. Some the techniques create two-dimensional patterns while others can make three-dimensional (3D) constructions. But most of these techniques are somewhat limited by size and ink material. Since nanotech requirements will likely become more sophisticated, we'll need to find a direct-write method that will allow us to create complex shapes and extremely long fibers--attributes that can't easily be accommodated now. A team from the University of Illinois at Urbana-Champaign (UIUC) has developed a unique direct-write method that produces nanofibers of unlimited length. The method is applicable for use with a number of different materials.

The UIUC team is Min-Feng Yu, a professor of mechanical science and engineering, and graduate students Abhijit Suryavanshi and Jie Hu. The team developed the process which is akin to drawing with a fountain pen, but with a 3D difference.

The method uses a reservoir of water-based ink that's connected to a glass micropipette with an aperture as small as 100 nanometers (nm). When the micropipette is placed near a substrate, a liquid meniscus is formed between the two. As the micropipette is pulled away from the substrate, ink is drawn from the reservoir. Within the meniscus, the solute nucleates and precipitates as the solvent in the ink evaporates. The team has successfully made freestanding nanofibers about 25 nm in diameter and 20 micrometers long. Longer nanofibers can be

produced using a spinning process that draws and winds a nanofibers on a spool. Using this technique, the team produced a coil of nanofiber about 850 nm in diameter and 40 cm long.

The team happened on the technique one winter day. "It began with the observation we had when we were doing experiment during the winter time when the weather was quite cold and thus dry," Yu tells *Nanotech Alert*. "We were using a pipette containing an electrolyte solution to do electrochemical deposition on surface. But then because the air was so dry, the solution within the meniscus formed between the pipette and the surface simply evaporated and quickly formed clogs around the pipette. As we then pulled away the pipette, we observed nanowire formation. We started from there and adjusted various parameters to realize the continuous fabrication of nanofibers of unlimited length," he says.

In addition to the water-based inks, the team drew nanofibers out of sugar, potassium hydroxide, and densely packed quantum dots. The nanofibers made from quantum dots are particularly intriguing. According to Yu, the team "used a toluene solution of quantum dots, which are about 6 nm in diameter, and applied the same principle to draw the nanofiber. As quantum dots can not be readily dispersed in water, the quantum dot nanofiber is immune from dissolution by the ambient humid environment, different from the nanofibers made from water-based solutions. We are still exploring the specific applications of such quantum dot nanofibers. One possibility would be to use them as extreme bright sources for intracellular imaging," he says.

What's next for the team? The team hopes to "make even smaller and longer nanofibers," Yu says, as well as to "make extremely long nanotubes by a templating method" and create a "network of nanochannels based on templating method." Last, but not least, the team will work to "scale up the process for parallel and mass production of nanofibers made of a variety of materials," says Yu.

To learn more about the work, see the journal *Advanced Materials*, Web-published on January 29, 2008. The work is supported by The Grainger Foundation, the National Science Foundation, and the Office of Naval Research. A patent application has been filed US Patent Application No. 60/972571.

Details: Min-Feng Yu, Professor, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, 1206 W. Green St., Urbana, IL 61801. Phone: 217-333-9246. Fax: 217-333-1942. E-mail: mfyu@uiuc.edu.

GO BACK TO TABLE OF CONTENTS

To comment on these articles, write to us at tiresearch@frost.com

---

You can call us at: **North America** : +1-210-247-3877, **London** : +44-0-1865-398680, **Chennai:** +91-44-42005820, **Singapore** : +65-68900949.