New technique scales up nanofiber production

August 10 2011, By Tracey Peake

(PhysOrg.com) -- A new spin on an old technology will give scientists and manufacturers the ability to significantly increase their production of nanofibers, according to researchers at North Carolina State University.

Collections of nanofibers, because they are porous and lightweight, are useful in applications ranging from water filtration to tissue regeneration to energy storage. But although nanofibers are relatively inexpensive to produce, the current method of production – needle electrospinning – is time-intensive.

In electrospinning, a liquid-polymer solution is passed through a hypodermic needle held at high voltage. The needle transfers electric charge, which transforms the solution into a jet of charged liquid that "spins" into a nanofiber as it exits the needle. Unfortunately, this method of production does not lend itself to large-scale manufacturing processes.

NC State physicists Laura Clarke and Jason Bochinski, textile engineer Russell Gorga and graduate student Nagarajan Thoppey found a particularly simple technique that scales up nanofiber production and provides a close connection to the needle electrospinning method. In a study recently published in the journal *Nanotechnology*, they demonstrated "bowl electrospinning." In place of a hypodermic needle, the researchers filled a bowl with the polymer fluid and applied a short burst of very high voltage to the liquid's surface, which caused multiple jets to form and "spin" nanofibers onto a collector placed around the

outside of the bowl.

According to Bochinski, the experiment gave them a 40-fold increase in nanofiber production, and demonstrated the potential for further increases. It also led to one question that they hope to answer in the near future:

“One of our next steps will be studying the limitations of the bowl apparatus we used – for instance, why was the increase only 40-fold and not 40,000-fold – and how that relates to the geometry of the arrangement and the fluid’s properties,” Bochinski says.

More information: “Edge electrospinning for high throughput production of quality nanofibers,” Authors: N M Thoppey, et al., North Carolina State University, Published: July 29, 2011, in *Nanotechnology*.

Abstract
A novel, simple geometry for high throughput electrospinning from a bowl edge is presented that utilizes a vessel filled with a polymer solution and a concentric cylindrical collector. Successful fiber formation is presented for two different polymer systems with differing solution viscosity and solvent volatility. The process of jet initiation, resultant fiber morphology and fiber production rate are discussed for this unconfined feed approach. Under high voltage initiation, the jets spontaneously form directly on the fluid surface and rearrange along the circumference of the bowl to provide approximately equal spacing between spinning sites. Nanofibers currently produced from bowl electrospinning are identical in quality to those fabricated by traditional needle electrospinning (TNE) with a demonstrated ~40 times increase in the production rate for a single batch of solution due primarily to the presence of many simultaneous jets. In the bowl electrospinning geometry, the electric field pattern and subsequent effective feed rate are very similar to those parameters found under optimized TNE

experiments. Consequently, the electrospinning process per jet is directly analogous to that in TNE and thereby results in the same quality of nanofibers.

Provided by North Carolina State University