Researchers create 'nanofiber gusher'

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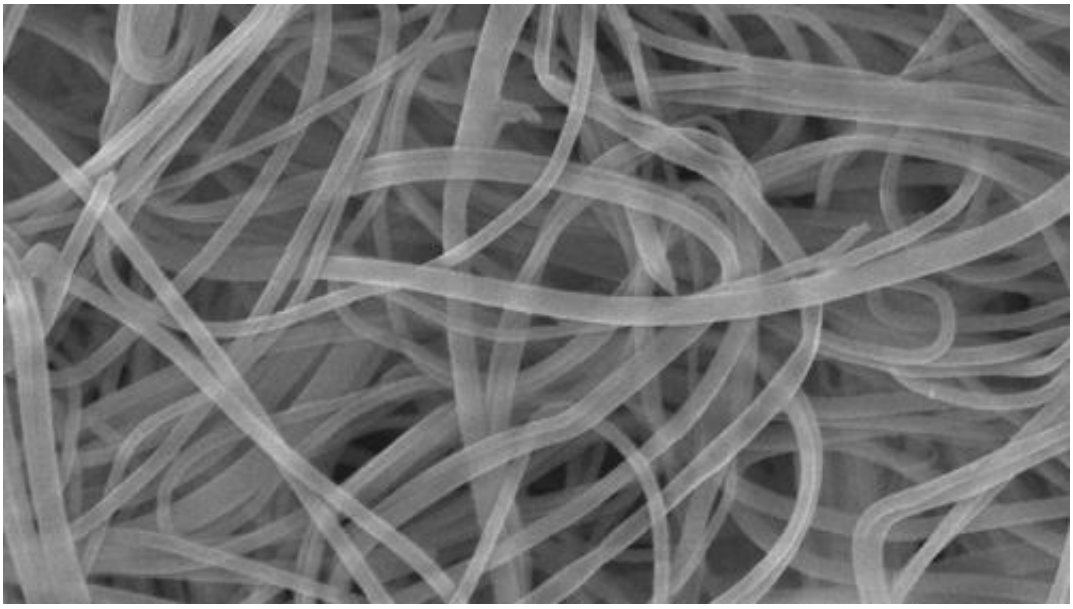

NC State researchers use shearing method to create polymer nanofibers in liquid. Credit: Orlin Velev, NC State University.

Creating large amounts of polymer nanofibers dispersed in liquid is a challenge that has vexed researchers for years. But engineers and researchers at North Carolina State University and one of its start-up companies have now reported a method that can produce unprecedented amounts of polymer nanofibers, which have potential applications in filtration, batteries and cell scaffolding.

In a paper published online in *Advanced Materials*, the NC State researchers and colleagues from industry, including NC State start-up

company Xanofi, describe the method that allows them to fabricate polymer nanofibers on a massive scale.

The method - fine-tuned after nearly a decade of increasing success in producing micro- and nanoparticles of different shapes - works as simply as dropping liquid solution of a polymer in a beaker containing a spinning cylinder. Glycerin - a common and safe liquid that has many uses - is used to shear the polymer solution inside the beaker along with an antisolvent like water. When you take out the rotating cylinder, says Dr. Orlin Velev, Invista Professor of Chemical and Biomolecular Engineering at NC State and the corresponding author of the paper describing the research, you find a mat of nanofibers wrapped around it.

When they first started investigating the liquid shearing process, the researchers created polymer microrods, which could have various useful applications in foams and consumer products. "However, while investigating the shear process we came up with something strange. We discovered that these rods were really just pieces of 'broken' fibers," Velev said. "We didn't quite have the conditions set perfectly at that time. If you get the conditions right, the fibers don't break."

NC State patented the liquid shear process in 2006 and in a series of subsequent patents while Velev and his colleagues continued to work to perfect the process and its outcome. First, they created microfibers and nanoribbons as they investigated the process. "Microfibers, nanorods and nanoribbons are interesting and potentially useful, but you really want nanofibers," Velev said. "We achieved this during the scaling up and commercialization of the technology."

Velev engaged with NC State's Office of Technology Transfer and the university's TEC (The Entrepreneurship Collaborative) program to commercialize the discoveries. They worked with the experienced entrepreneur Miles Wright to start a company called Xanofi to advance

the quest for nanofibers and the most efficient way to make mass quantities of them.

"We can now create kilograms of nanofibers per hour using this simple continuous flow process, which when scaled up becomes a 'nanofiber gusher,'" Velev said. "Depending on the concentrations of liquids, polymers and antisolvents, you can create multiple types of nanomaterials of different shapes and sizes."

"Large quantities are paramount in nanomanufacturing, so anything scalable is important," said Wright, the CEO of Xanofi and a co-author on the paper. "When we produce the nanofibers via continuous flow, we get exactly the same nanofibers you would get if you were producing small quantities of them. The fabrication of these materials in liquid is advantageous because you can create truly three-dimensional nanofiber substrates with very, very high overall surface area. This leads to many enhanced products ranging from filters to cell scaffolds, printable bioinks, battery separators, plus many more."

More information: Scalable Liquid Shear-Driven Fabrication of Polymer Nanofibers, Published: March 18, 2015, online in *Advanced Materials*, DOI: 10.1002/adma.201404616

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