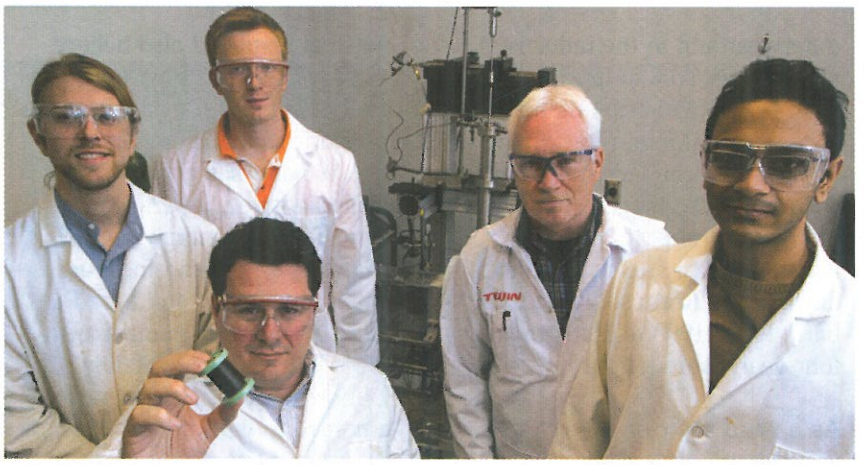
Rice University Develops Pliable CNT Fiber with Wearable Application. By Kathlyn Swantko

Advancing Carbon Nanotubes Scale-Ability

Since 2001, Rice University researchers have been focusing on the development of a pliable CNT fiber that can be used as lightweight, efficient wires for either electrical grid applications, or as basic applications for lightweight conductive textiles. While previous research has created CNT fibers by spinning the solid hair-like CNTs like wool as they come from a chemical reactor, Rice University has focused on developing a wet-spinning process for the CNTs.

Matteo Pasquali, professor of chemical and biomolecular engineering/chemistry at Rice and the lead researcher for the project, says, "The problem with spinning CNTs directly into fibers without using a solvent is that these methods are difficult to scale up and do not yield well-aligned and ordered fibers."



Teamwork: Rice engineering professor Matteo Pasquali (seated) led a team that created a performance enhanced pure carbon nanotube fiber.

The Rice research is based on the discovery that CNT fibers can be created through a wet-spinning process, in which the CNTs are dissolved in strong acids. While a number of other institutions have been involved in research on CNT fibers, the race to create useable CNT fibers took a leap forward in 2009, when Natnael Bahabtu, a graduate student in Pasquali's lab at Rice, discovered that CNT fibers could be spun from chlorosulfonic acid solutions. Up to this point, it was not possible to dissolve the CNTs in conventional solvents, and the use of weaker acids in the groups of Pasquali and Smalley at Rice had not yielded satisfactory results. The 2009 breakthrough resulted in the evolution of the first true solvent for nanotubes, which has furthered the team's understanding of how the solution process works, and how to predict and advance their research findings.

Over the past few years, Pasquali's CNT fibers research team has grown to include academic, government, and industrial scientists from Rice University; Teijin Aramid, Arnheim, the Netherlands; the Technion-Israel Institute of Technology, Haifa, Israel; and the Air Force Research Laboratory in Dayton, Ohio.

The Rice University expanded research group has laid the foundation for the liquid processing of the nanotubes. According to Pasquali, "Nanotubes spontaneously dissolve in this acid at concentrations much greater than they do in any other liquid." His team discovered that the acid charges the CNT surfaces, making them repel each other and dissolve; the CNT solution is the basis for a scale-able process for making CNT fibers that outperform commercially available products.

"We are making the CNT fibers, utilizing the same fiber production methods that already exist in the industry," explains Pasquali. "Therefore, CNT fibers are easy to scale up, because the wet-spinning process is similar to that used in producing rayon, Kevlar, and Twaron."

By processing CNTs in a chlorosulfonic acid solution, Rice researchers have been able to make continuous CNT fibers. Notes Pasquali, "There is really no practical limitation to the fiber length, and these CNT fibers can be handled like a cotton fiber."

Going forward, the Rice team is looking at a variety of potential applications for its CNT wet-spun fiber. Pasquali says, "We're working together with Teijin Aramid on how we can make the CNT fiber better on an industrial scale. We have created a lightweight, wearable fiber that is also an electrical conductor that can be made into a soft textile. We're considering applications in the medical, military and outdoor markets."

For more information on the research by Rice University and Teijin Aramid, contact Matteo Pasquali, professor of chemical and biomolecular engineering and chemistry, mp@rice.edu, and Marcin Otto, Business Development Manager, marcin.otto@teijinaramid.com. ●

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