Shirts that Stop Bullets

What if you could wear lightweight armor that kept you warm – and let you phone home? Nanotechnologists have come up with a super strong, flexible fiber that can conduct heat and electricity. It could be made into a modern version of chain mail, the heavy metal mesh worn by medieval knights. If woven from the new fiber, modern chain mail could be light as a cotton shirt, but bulletproof.

Molecular Chain Mail

Over hundreds of millions of years of evolution, many animals, plants, and natural materials have developed extraordinary properties. Spider silk, for example, is five times tougher than steel. (Toughness is defined as the measure of the energy needed to break a fiber.) Some nanotechnologists would like to make synthetic (man-made) yarn with the same toughness as spider silk.

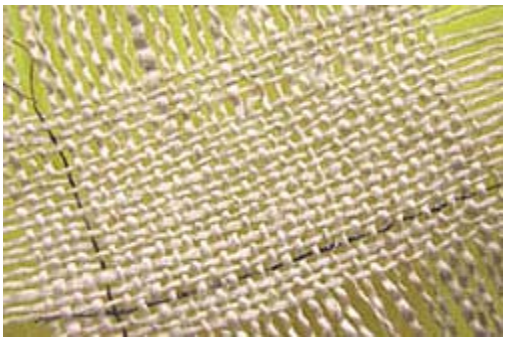
At the NanoTech Institute at the University of Texas at Dallas, a research team headed by Institute director Ray H. Baughman has spun a new lightweight fiber that the scientists say is the toughest known. Their new fiber is four times tougher than spider silk, and 17 times tougher than Kevlar, now used to make bulletproof vests. The team's key ingredient is tiny carbon nanotubes, miniscule rolled-up sheets of carbon atoms that can be found naturally in soot.

Since carbon nanotubes were discovered in 1991, their enormous promise has intrigued nanotechnologists. Carbon nanotubes are light and flexible, but enormously strong. They also can conduct heat and electricity. Many researchers want to make them into much larger materials with the same useful properties.

Strings of the nanotube fiber.

The new fiber, says chemist John Ferraris, a member of the research team, is "probably one of the first realizations of taking something that has phenomenal properties at the nanoscale, and actually converting it into something that has size that you can do something with." To make carbon-nanotube fibers, some researchers have tried pulling out threads from bundles of the nanotubes, like drawing silk thread from a cocoon. But the Texas scientists turned to spinning, a method of working with carbon nanotubes originally developed in France.

Ferraris explains that this approach allows the researchers to tailor the fibers by adjusting the ratio of carbon nanotubes to plastic, or changing the plastic slightly. The result is fibers with "a wide range of properties that we can actually maximize. We can maximize strength, or toughness, or electrical conductivity or charge-storage capacity" without sacrificing the fiber's other properties. Ferraris foresees the fiber, which is easy to weave and sew, being woven into "a multifunctional fabric" that could protect wearers as well as provide warmth and telecommunications.



The fiber woven into a fabric.
image: Univ. of Texas at Dallas

He predicts that antennae and batteries, sensors and electronic connections could be wired into a lightweight military uniform. As so often happens with military wear, the fiber also could be made into fashionable street wear.

At present, however, the major obstacle is the steep price of carbon nanotubes—as high as $15,000 an ounce. The new fiber won't be widely available until prices drop considerably—and that isn't likely for another five to ten years.

Dalton, Ferraris, Baughman, and other UTD team members' work has appeared in *Nature*, June 12, 2003. Their research is funded by the Defense Advanced Research Projects Agency (DARPA).

by Ann Marie Cunningham