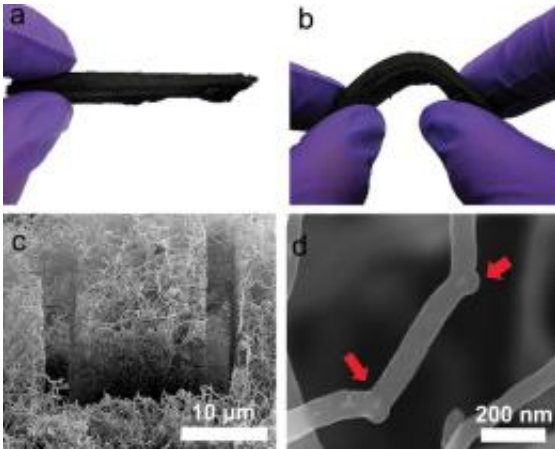# Nanotube 'sponge' has potential in oil spill cleanup

May 10 2012

A carbon nanotube sponge developed with help from ORNL researchers holds potential as an aid for oil spill cleanup.

(Phys.org) -- A carbon nanotube sponge that can soak up oil in water with unparalleled efficiency has been developed with help from computational simulations performed at the Department of Energy's (DOE's) Oak Ridge National Laboratory.

Carbon nanotubes, which consist of atom-thick sheets of carbon rolled into cylinders, have captured scientific attention in recent decades because of their high strength, potential high conductivity and light weight. But producing nanotubes in bulk for specialized applications was often limited by difficulties in controlling the growth process as well as

dispersing and sorting the produced nanotubes.

ORNL's Bobby Sumpter was part of a multi-institutional research team that set out to grow large [clumps](#) of nanotubes by selectively substituting boron atoms into the otherwise pure carbon lattice. Sumpter and Vincent Meunier, now of Rensselaer Polytechnic Institute, conducted simulations on supercomputers, including Jaguar at ORNL's Leadership Computing Facility, to understand how the addition of boron would affect the carbon nanotube structure.

"Any time you put a different atom inside the hexagonal carbon [lattice](#), which is a chicken wire-like network, you disrupt that network because those atoms don't necessarily want to be part of the chicken wire structure," Sumpter said. "Boron has a different number of valence electrons, which results in curvature changes that trigger a different type of growth."

Simulations and lab experiments showed that the addition of [boron atoms](#) encouraged the formation of so-called "elbow" [junctions](#) that help the nanotubes grow into a 3-D network. The team's results are published in Nature *Scientific Reports*.

"Instead of a forest of straight tubes, you create an interconnected, woven sponge-like material," Sumpter said. "Because it is interconnected, it becomes three-dimensionally strong, instead of only one-dimensionally strong along the tube axis."

Further experiments showed the team's material, which is visible to the human eye, is extremely efficient at absorbing [oil](#) in contaminated seawater because it attracts oil and repels water.

"It loves carbon because it is primarily [carbon](#)," Sumpter said. "Depending on the density of oil to water content and the density of the

sponge network, it will absorb up to 100 times its weight in oil."

The material's mechanical flexibility, magnetic properties, and strength lend it additional appeal as a potential technology to aid in oil spill cleanup, Sumpter says.

"You can reuse the material over and over again because it's so robust," he said. "Burning it does not substantially decrease its ability to absorb oil, and squeezing it like a sponge doesn't damage it either."

The material's magnetic properties, caused by the team's use of an iron catalyst during the nanotube growth process, means it can be easily controlled or removed with a magnet in an oil cleanup scenario. This ability is an improvement over existing substances used in oil removal, which are often left behind after cleanup and can degrade the environment.

The experimental team has submitted a patent application on the technology through Rice University. The research is published as "Covalently bonded three-dimensional carbon nanotube solids via boron induced nanojunctions," and is available online.

Provided by Oak Ridge National Laboratory