Chemists create, grow nanotube seeds

November 17 2006

Rice University chemists today revealed the first method for cutting carbon nanotubes into "seeds" and using those seeds to sprout new nanotubes. The findings offer hope that seeded growth may one day produce the large quantities of pure nanotubes needed for dozens of materials applications.

The research is available online and slated to appear in an upcoming issue of the *Journal of the American Chemical Society*.

Like vintners who hope to grow new vineyards from a handful of grape vine cuttings, Rice's chemists hope their new method of seeded growth for carbon nanotubes will allow them to reproduce their very best samples en masse.

"Carbon nanotubes come in lots of diameters and types, and our goal is to take a pure sample of just one type and duplicate it in large quantities," said corresponding author James Tour, director of Rice's Carbon Nanotechnology Laboratory (CNL). "We've shown that the concept can work."

The study's lead author, CNL founder and nanotube pioneer Richard Smalley, died in October 2005 after a long battle with leukemia. Tour said Smalley devoted an enormous amount of time and energy to the seeded-growth nanotube amplification research in the final two years of his life.

"Rick was intent on using nanotechnology to solve the world's energy problems, and he knew we needed to find a way to make large quantities of pure nanotubes of a particular type in order to re-wire power grids and make electrical energy widely available for future needs," Tour said. "Rick had a way of making things happen, and for six months during 2004, there were no fewer than 50 researchers in four Rice laboratories devoting their effort to this problem. It was unprecedented, and it paid off."

First discovered just 15 years ago, single-walled carbon nanotubes (SWNTs) are molecules of pure carbon with many unique properties. Smaller in diameter than a virus, nanotubes are about 100 times stronger than steel, weigh about one-sixth as much and are among the world's best electrical conductors and semi-conductors. Smalley, who devoted the last 10 years of his career to studying SWNTs, pioneered the first method for mass-producing them and many of the techniques scientists use to study them.

There are dozens of types of SWNTs, each with a characteristic atomic arrangement. These variations, though slight, can lead to drastically different properties: Some nanotubes are like metals, and others are semiconductors. While materials scientists are anxious to use SWNTs in everything from bacteria-sized computer chips to geostationary space elevators, most applications require pure compounds. Since all nanotube production methods, including the industrial-scale system Smalley invented in the 1990s, create a variety of 80-odd types, the challenge of making mass quantities of pure tubes – which Smalley referred to as "SWNT amplification" – is one of the major, unachieved goals of nanoscience.

"Rick envisioned a revolutionary system like PCR (polymerase chain reaction), where very small samples could be exponentially amplified," Tour said. "We're not there yet. Our demonstration involves single nanotubes, and our yields are still very low, but the amplified growth route is demonstrated."

The nanotube seeds are about 200 nanometers long and one nanometer wide – length-to-diameter dimensions roughly equal to a 16-foot garden house. After cutting, the seeds underwent a series of chemical modifications. Bits of iron were attached at each end, and a polymer wrapper was added that allowed the seeds to stick to a smooth piece of silicon oxide. After burning away the polymer and impurities, the seeds were placed inside a pressure-controlled furnace filled with ethylene gas. With the iron acting as a catalyst, the seeds grew spontaneously from both ends, growing to more than 30 times their initial length – imagine that 16-foot water hose growing by more than 500 feet – in just a few minutes.

Tour, Chao Professor of Chemistry, professor of mechanical engineering and materials science and professor of computer science, said CNL's team has yet to prove that the added growth has the same atomic architecture – known as chirality – of the seeds. However, he said the added growth had the same diameter as the original seed, which suggests that the methodology is successful.

Source: Rice University

Citation: Chemists create, grow nanotube seeds (2006, November 17) retrieved 26 April 2024 from https://phys.org/news/2006-11-chemists-nanotube-seeds.html