

Science News

Share Blog Cite

Print Email Bookmark

Nanotube Formation: Researchers Learn To Control The Dimensions Of Metal Oxide Nanotubes

ScienceDaily (Aug. 29, 2007) — Moving beyond carbon nanotubes, researchers are developing insights into a remarkable class of tubular nanomaterials that can be produced in water with a high degree of control over their diameter and length. Based on metal oxides in combination with silicon and germanium, such single-walled inorganic nanotubes could be useful in a range of nanotechnology applications that require precise control over nanotube dimensions.

See also:

Matter & Energy

- Nanotechnology
- Materials Science
- Chemistry
- Inorganic Chemistry
- Nature of Water
- Organic Chemistry

Reference

- Nanowire
- Carbon nanotube
- Fullerene
- Carbon

At the Georgia Institute of Technology, researchers are studying the formation of these metal oxide nanotubes to understand the key factors that drive the emergence of nanotubes with specific diameters and lengths from a "soup" of precursor chemicals dissolved in water. Their goal is to develop general guidelines for controlling nanotube diameter with sub-nanometer precision and nanotube length with precision of a few nanometers.

So far, the researchers have obtained encouraging results with a model system that produces aluminosilicogermanate (AlSiGeO) nanotubes. The research, which will be presented August 23rd at the 234th National Meeting of the American Chemical Society, could open the door for developing a more general set of chemical "rules" for dimensional control of nanotubes that could lead to a range of new applications for inorganic nanotubes and other nanometer-scale materials.

"We have shown that there is a clearly quantifiable molecular-level structural and thermodynamic basis for tuning the diameter of nanotubes," said Sankar Nair, an assistant professor in Georgia Tech's School of Chemical and Biomolecular Engineering. "We're interested in developing the science of these materials to the point that we can manipulate their curvature, length and internal structure in a sophisticated way through inexpensive water-based chemistry under mild conditions."

Using chemical reactions carried out in water at less than 100 degrees Celsius, Nair's research team -- which included graduate students Suchitra Konduri and Sanjoy Mukherjee -- varied the germanium and silicon content during the nanotube synthesis and then quantitatively characterized the resulting nanotubes with a variety of analytical techniques to show a clear link between the nanotube composition and diameter.

Simultaneously, the group's molecular dynamics calculations showed a strong correlation between the composition, diameter and internal energy of the material.

"There appear to be energy minima that favor or stabilize certain nanotube diameters because they have the lowest energy, and those stable diameters change with the composition of the material," said Nair. "This shows that the nanotube dimensions are not just a fortuitous coincidence of the many synthesis parameters, but that there is an underlying thermodynamic basis arising from the subtle balance of interatomic forces within the material."

Specifically, the molecular dynamics simulations -- which are corroborated by the experiments -- show that the variation of germanium and silicon content causes sheets of aluminum hydroxide to form nanotubes with diameters ranging from 1.5 to 4.8 nanometers and lengths of less than 100 nanometers. If that turns out to be a general principle applicable to other metal oxides, it could be used to dramatically expand the catalog of nanotube structures available.

Once the researchers fully understand the factors affecting the formation of nanotubes from aluminosilicogermanate materials, they hope to apply similar principles to other metal oxides. The ultimate goal will be an ability to predictably vary the



Researcher Sankar Nair is studying nanotubes made from metal oxides -- work that could lead to a technique for precisely controlling the dimensions of the structures. (Credit: Image courtesy of Georgia Institute of Technology)

Ads by Google

Advertise here

Carbon Nanotubes

High quality, low cost single-wall (SWCNT) & multi-walled (MWCNTs)
www.helixmaterial.com

Highest Quality Zeolite

Safe & Powerful detox. Made from the purest sources. Great results!
www.ambayagold.com/zeolite.html

Precision Particles

Controlled release & flexibility in a scalable single step process.
orbisbio.com

SWeNT Carbon Nanotubes

High quality and affordable Commercial and R&D applications
swentnano.com

national polymer labs

Polymer and nano technology in Ohio coatings - adhesives - composites
www.nationalpolymerlabs.com

Related Stories



Breakthrough In Production Of Double-walled Carbon Nanotubes (Dec. 29, 2008)

— In recent years, the possible applications for double-walled carbon nanotubes have excited scientists and engineers, particularly those working on developing renewable energy technologies. These tiny ... > [read more](#)

Method Sorts Out Double-walled Carbon Nanotube Problem (Dec. 16, 2008)

— It's hard to study something with any rigor if the subject can't be produced uniformly and efficiently. Researchers who study double-walled carbon nanotubes find themselves in just this predicament. ... > [read more](#)

Tweezers Trap Nanotubes By Color (Sep. 29, 2008)

— Singled-walled carbon nanotubes are graphene sheets wrapped into tubes, and are typically made up of various sizes and with different amounts of twist (also known as chiralities). Each type of ... > [read more](#)

Scientists Stretch Carbon Nanotubes: Research May Influence Future Development Of Semiconductors, Nanocomposites (Jan. 26, 2006)

— Physicists at Boston College have for the first time shown that carbon nanotubes can be stretched at high temperature to nearly four times their original length, a finding that could have ... > [read more](#)

Nanotube Production Leaps From

Just In:

New Memories: Easy To Encode, Hard To Retain

Science Video News



Mathematics Of Beer Bubbles

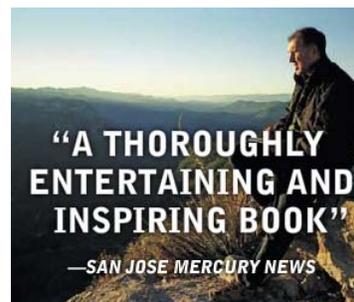
Mathematicians built a formula to explain the behavior of beer bubbles in three dimensions and found that it can be applied to other materials like. ... > [full story](#)

Chemists Create Self-assembling Conductive Rubber

Biomedical Engineers Improve Dental Imaging And Care

Electrical And Computer Engineers Design Wheelchair Controlled By A Magnet On The User's Tongue

[more science videos](#)



Breaking News

... from NewsDaily.com

Experts unearth history of pandemic flu viruses

Astronauts board shuttle for fifth launch attempt

U.S. to spend another \$1 billion on flu vaccine

U.S. space shuttle ready to deliver Japanese porch

Potato famine disease striking home gardens in U.S.

[more science news](#)

In Other News ...

Madoff on way to federal prison: U.S. official

Republicans contest Obama's Supreme Court choice

New flu "unstoppable", WHO says, calls for vaccine

U.S. worried about American scholar detained in Iran

Costa Rica eyes fresh Honduras mediation talks

U.S. military boss urges Iraq to settle differences



National Black Society of Engineers: #1 employer of preference

Microsoft Entertainment & Devices

- Project managers
- Database administrators
- Enterprise architects
- Mechanical engineers

Redmond, WA
 Relocation Available



microsoft-entertainment-jobs.com
 Ads by Google

materials," Nair noted. "Almost all metals form oxides and many of them form layered sheet-like oxides, so if one can coax them into nanotube form with dimensions comparable to single-walled carbon nanotubes, the range of useful properties would be great."

Controlling the dimensions of nanostructures is critical because properties such as electronic band-gap depend strongly upon the dimensions. Dimension control has proven to be difficult in carbon nanotube fabrication processes, leading to an entire area of research focused on purifying nanotubes of specific dimensions from an initial mixture of different sizes.

"If we are able to produce single-walled nanotubes of specific and controllable diameter with inexpensive water-based chemistry, devices based on them would perform in a consistent and predictable manner," Nair explained. "If we could synthesize the same nanotube structure with predictably different diameters and lengths, we can tune the properties like the band-gap across a wide range. We could even get a limited toolbox of materials to do many different things."

Though the chemical reactions that produce the metal oxide nanotubes are complicated, they occur over a period of days at low temperatures and can be carried out with simple laboratory apparatus. That facilitates control over processing conditions and allows the researchers to track many different aspects of the reaction with a variety of characterization tools.

"There is a lot of complex chemistry that can be done in the aqueous phase, which motivated us to understand the processes by which metal ions dissolved in water organize themselves together with oxygen into specific nanotubular arrangements, perhaps aided by water and other species present in the solution," Nair added.

The metal oxide nanotubes have properties very different from those of carbon nanotubes, which have been studied heavily since they were discovered in the 1990s. "For example, the materials that we are working with are much more hydrophilic than carbon and can load nearly 50 percent of their weight with water," Nair explained. "There is a whole range of behavior in oxide nanotubes that we cannot explore with carbon-based materials."

The research has been sponsored by the American Chemical Society Petroleum Research Fund.

Other recent results of the group's research were published May 5 in the Journal of the American Chemical Society, and have also been reported in the journals Physical Review B and Chemistry of Materials.

Adapted from materials provided by [Georgia Institute of Technology](#), via [EurekAlert!](#), a service of AAAS.

Email or share this story: [|](#) [More](#)

Need to cite this story in your essay, paper, or report? Use one of the following formats:

- APA Georgia Institute of Technology (2007, August 29). Nanotube Formation: Researchers Learn To Control The Dimensions Of Metal Oxide Nanotubes. *ScienceDaily*. Retrieved July 14, 2009, from <http://www.sciencedaily.com/releases/2007/08/070823155521.htm>
- MLA

potential as a super material is blighted by the fact that when first made they often take the form of an unprepossessing pile of sooty black mess in the bottom of a test tube. Now ... > [read more](#)



Hybrid Structures Combine Strengths Of Carbon Nanotubes And Nanowires (Jan. 11, 2007) — A team of researchers at Rensselaer Polytechnic Institute has created hybrid structures that combine the best properties of carbon nanotubes and metal nanowires. The new structures, which are ... > [read more](#)

Cautionary Note In Use Of Carbon Nanotubes As Interconnects (Sep. 16, 2008) — Researchers have used scanning tunneling microscopy to confirm remarkable changes in the fundamental electronic behavior when double-walled carbon nanotubes are subject to radial deformations and ... > [read more](#)



Penn Researchers Take A Big Step Forward In Making Smaller Circuits (Aug. 2, 2005) — In the race to take advantage of the amazing electric properties of nanotubes, researchers at the University of Pennsylvania developed a new method to create functional nanotube circuits. The ... > [read more](#)

Copyright Reuters 2008. See [Restrictions](#).

Free Subscriptions ... from *ScienceDaily*

Get the latest science news with our free email newsletters, updated daily and weekly. Or view hourly updated newsfeeds in your RSS reader:

- [Email Newsletters](#)
- [RSS Newsfeeds](#)

Feedback ... we want to hear from you!

Tell us what you think of the new ScienceDaily -- we welcome both positive and negative comments. Have any problems using the site? Questions?

Your Name:

Your Email:

Comments:

Click button to submit feedback:

Search ScienceDaily *Number of stories in archives: 44,032*

Find with keyword(s):

Enter a keyword or phrase to search ScienceDaily's archives for related news topics, the latest news stories, reference articles, science videos, images, and books.

Ads by Google [Advertise here](#)

Nanotechnology Law
Nanotechnology Legal Issues Porter
Wright Morris & Arthur LLP
www.nanolawreport.com

Nano-C, Inc.
Fullerenes, Carbon Nanotubes,
PCBM and Other Derivatives
www.nano-c.com

SMART Grids for TEM
The Gold Standard in electron
microscopy
www.dunesciences.com