Chemists create nanotube structures that can expand and contract without breaking down

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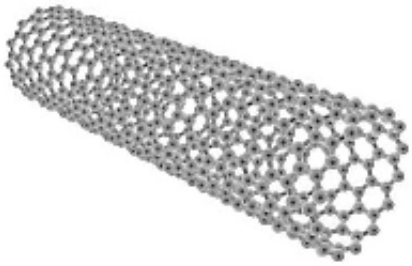

(Phys.org)—A group of chemists from China, Japan and Korea have succeeded in creating nanotubes that can be made to expand and contract in response to warm or cold water. Led by Myongsoo Lee of Seoul University, the team, as they describe in their paper published in the journal *Science*, manipulated a series of molecules into forming hexagons, which when stacked resulted in the formation of a nanotube. Upon subjecting the nanotube to warm or cold water, the nanotube was made to expand or contract on demand.

To create the nanotubes, researchers bent six molecules which caused them to automatically assemble themselves into a hexagon. Several of the hexagons were then stacked, creating a nanotube which displayed properties of expanding and contracting in the presence of warm or cold

water. The expanding and contracting occurs due to the central molecule being a hydrocarbon called pyridine, which has a nitrogen atom attached to it. That atom attracts water molecules, causing some degree of expansion until the water is heated to 60 °C. At that point, the water molecule attraction is disrupted causing contraction.

The expansion and contraction was so well defined that the team was able to cause their nanotube to expel a buckyball that was placed inside leading to speculation that the nanotube might somehow be fashioned into a nano sized pump, or circulatory system, with one application being a very tiny drug delivery system.

The results by this team represent a milestone, as it's the first time anyone has been able to get a nanotube to expand or contract without having its structure modified in the process, which means the same tube can be used over and over. It also shows that nano structures in general can be created that can be made to do things without them being broken down in the process, which is significant, because most attempts to do so thus far have resulted in failure. The problem is of course, is that it's extremely difficult to manipulate things at such a tiny scale. The contraction of the nanotube in this study, for example, was just 11 nanometers down to 7; a nanometer is one billionth of a meter.

In a related perspective piece also published in *Science*, Wei Zhang and Takuzo Aida tie the development of the expanding/contracting nanotube to the seemingly never ending search for the artificial creation of cardiac muscle cells that could pulsate autonomously, resulting perhaps, in a cure for heart disease.

More information: Pulsating Tubules from Noncovalent Macrocycles, *Science*, 21 September 2012: Vol. 337 no. 6101 pp. 1521-1526. DOI: 10.1126/science.1224741

ABSTRACT

Despite recent advances in synthetic nanometer-scale tubular assembly, conferral of dynamic response characteristics to the tubules remains a challenge. Here, we report on supramolecular nanotubules that undergo a reversible contraction-expansion motion accompanied by an inversion of helical chirality. Bent-shaped aromatic amphiphiles self-assemble into hexameric macrocycles in aqueous solution, forming chiral tubules by spontaneous one-dimensional stacking with a mutual rotation in the same direction. The adjacent aromatic segments within the hexameric macrocycles reversibly slide along one another in response to external triggers, resulting in pulsating motions of the tubules accompanied by a chiral inversion. The aromatic interior of the self-assembled tubules encapsulates hydrophobic guests such as carbon-60 (C60). Using a thermal trigger, we could regulate the C60-C60 interactions through the pulsating motion of the tubules.