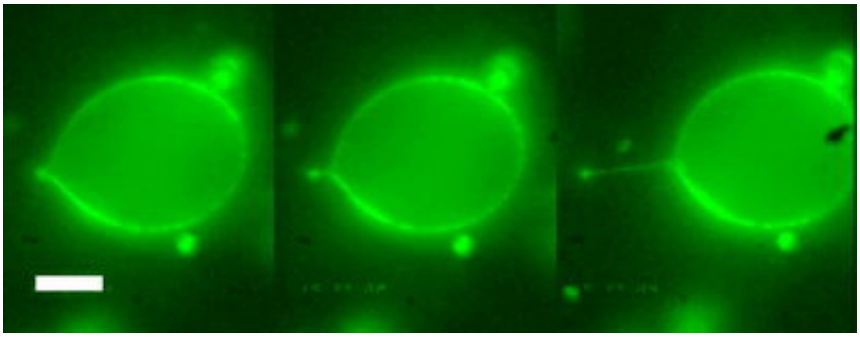
Stable polymer nanotubes may have a biotech future

February 2 2006



This sequence of images taken at NIST shows the creation of a nanotube as a highly focused infrared laser tugs on a polymer membrane that has been colored with a fluorescent dye. The white scale bar indicates 10 micrometers.

Scientists at the National Institute of Standards and Technology (NIST) have created polymer nanotubes that are unusually long (about 1 centimeter) as well as stable enough to maintain their shape indefinitely. Described in a new paper in *Proceedings of the National Academy of Sciences*, the NIST nanotubes may have biotechnology applications as channels for tiny volumes of chemicals in nanofluidic reactor devices, for example, or as the "world's smallest hypodermic needles" for injecting molecules one at a time.

Carbon nanotubes are of keen interest in nanotechnology research, especially for making ultrastrong fibers and other structures. Nanotubes made from other materials are used for transport in biochemical

applications, but are typically fragile and usually collapse within a few hours. The NIST team developed processes for extending the shelf life of polymer nanotubes--considered essential for commercial applications--and forming sturdy nanotube network structures.

First the researchers made tiny, fluid-filled spherical containers with bi-layer membranes consisting of polymers with one end that likes water and one end that does not. (These fluid-filled containers are a spin-off of liposomes, artificial cells with fatty membranes used in cosmetics and for drug delivery.) The researchers made the membranes stretchy by adding a soap-like fluid to change the polymer membranes' mechanical properties. Then they used "optical tweezers" (highly focused infrared lasers) or tiny droppers called micropipettes to pull on the elastic membranes to form long, double-walled tubes that are less than 100 nanometers in diameter. (View a movie of this process here)

A chemical was added to break bonds between atoms in one section of the polymers and induce new bonds to form between the two different sections, forming a rigid "cross-linked" membrane. The nanotubes are then snipped free from the parent cell with an "optical scalpel" (highly focused ultraviolet laser pulse). The nanotubes maintain their shape even after several weeks of storage, and can be removed from the liquid solution and placed on a dry surface or in a different container. The optical tweezers can be used to custom build nanotube network structures. The work was supported in part by the Office of Naval Research.

Reference: J.E. Reiner, J.M. Wells, R.B. Kishore, C. Pfefferkorn, and K. Helmerson. 2006. Stable and robust polymer nanotubes stretched from polymersomes. *Proceedings of the National Academy of Sciences*. Published online Jan. 23, 2006.

Source: NIST