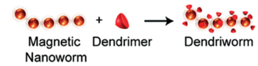
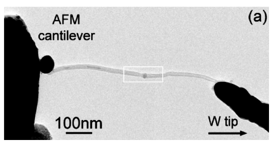
## The Worms Crawl In, siRNA Crawls Out

Biological researchers in a variety of fields have become increasingly interested in small interfering RNAs (siRNAs). These short, double-stranded nucleic acid molecules assemble into complexes inside mammalian cells to mediate cleavage of complementary mRNA sequences, thus regulating gene expression. siRNAs have been used as a tool for target validation, genetic studies, and as potential therapies for diseases including cancer. However, one barrier to exploiting this tool *in vivo* is the difficulty in efficiently transporting intact siRNAs across the cell membrane and into the cytoplasm of target cells.

In an effort to improve upon current delivery methods, Agrawal *et al.* (p 2495) developed nanocomposite constructs called "dendriworms", composed of magnetic iron oxide cores coated with fluorochromes and dendrimers, which are charged polymers that have been extensively evaluated as candidates for gene delivery. When incubated in solutions containing siRNA, the cationic dendrimer coating bound the negatively charged nucleic acids. The researchers show that this platform can effectively deliver siRNA into cells and silence selected genes, efficiently knocking down targeted protein production in a cellular model of brain cancer. The dendriworms showed no significant cytotoxicity and can be easily tracked within cells using a variety of imaging techniques because of the attached fluorophores and the magnetic cores. The authors suggest that these combined features may eventually make dendriworms a method of choice for delivering siRNA into cells.




## Nanowelding with Cobalt

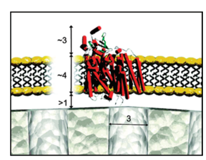



The rich mechanical and electrical properties of carbon nanotubes (CNTs) are closely related to their geometrical properties, and thus researchers have sought to fabricate predefined structures through controlled growth conditions. Currently, the most common way to determine the final morphology of CNTs is through manipulation of the interaction between the metal catalyst particles and the carbon atoms during the chemical vapor deposition process used to grow the CNTs. Researchers have also exploited the interactions between nanoparticles and graphitic structures to create novel CNT-based nanostructures *via* post-growth processes.

Seeking new ways to modify existing CNT geometry, Wang *et al.* (p 2632) used encapsulated Co nanoparticles to help cut, repair, and interconnect different CNTs. Each of these processes involved a structural change at the metal/CNT interface driven by running an electric current generated by a scanning tunneling microscope through the CNTs and focused electron-beam irradiation of the Co-containing region. Using this method, researchers developed two different CNT soldering processes. So-called "Co-joining" involves using the nanoparticle as the central node to which two CNTs are covalently attached on opposite sides. The other process, named "Co-catalytic", brings nanotubes together by taking advantage of the segregation of new graphitic shells from cobalt at the connecting site. Tensile tests show that the Co-catalytic method creates structures with superior strength. The researchers suggest that both methods could eventually find applications in designing future nanoelectronic circuits and devices and demonstrate a novel method for the manipulation and fabrication of CNT structures.

## Wrapping It Up: Nanoparticles in Proteolipid Membranes

Mesoporous silica particles can be designed to have a large accessible surface area in addition to a large pore volume, making them attractive vehicles for controlled delivery of drugs and genes. The internal and external surfaces of these particles can be chemically modified to immobilize and to control the release of their cargo. One approach for controlled release is to surround the mesoporous particles with lipid membrane embedded with functional channels or transporters, which can be triggered to release the cargo molecules based on a proton or electrochemical gradient.

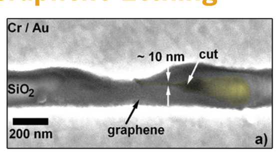


As a step toward realizing this prospect, Nordlund *et al.* (p 2639) created small unilamellar vesicles carrying cytochrome *c* oxidase (Cyt*c*O), a bacterially derived enzyme that acts as a proton pump. They coated mesoporous silica particles with these vesicles, which ruptured upon interacting with the particles' surfaces and surrounded the particles with a uniform lipid membrane incorporating Cyt*c*O. Tests showed that the enzyme remained functional, reliably catalyzing $O_2$ to water and maintaining charge separation across the membrane. The Cyt*c*O maintained a proton electrochemical gradient, effectively separating the interior particle compartment from the surrounding aqueous media, demonstrating the potential for drug delivery. The authors propose that this system could have applications not only in pharmaceuticals and therapeutics but also for functional studies of membrane-bound transport proteins.

## Helium Beam Rises to Challenge for Graphene Etching

To enable the use of graphene, single two-dimensional sheets of carbon atoms, for potential nanoelectronics applications, it is often necessary to fabricate structures on the order of 5−50 nm for experiments. Typical methods include electron-beam lithography followed by reactive ion etching, by chemical means such as thermally activated nanoparticles, or unfolding of a carbon nanotube; however, these methods have significant shortcomings, often producing structures with disordered edges or irregular shapes ill-suited for device applications.

Seeking a new method for etching graphene for devices, Lemme *et al.* (p 2674) used a helium ion microscope beam as a novel lithographic tool. Due to its short wavelength, the beam resolution is on the order of 0.5 nm or better, enabling precise etching control. The researchers tested various doses of the beam on suspended graphene and graphene deposited on a $SiO_2$ substrate, effectively creating features on both surfaces. However, devices fabricated on the $SiO_2$ substrate showed residual conductivity, a finding the authors attribute to surface contamination with hydrocarbons. The authors propose helium ion etching as an alternative method for nanofabrication for suspended graphene devices, and if contamination issues can be resolved, graphene on $SiO_2$ substrates as well.

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