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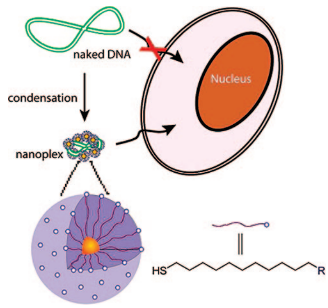
Golden Touch for Gene Delivery

Delivering genes efficiently into cells holds promise for basic biological research as well as therapies for a multitude of health problems. However, gene delivery requires an appropriate vehicle, as DNA does not readily enter cells through cell membranes. Researchers commonly use recombinant viruses as transfection vectors, but these vehicles bring with them the risk of immunogenicity, carcinogenicity, and inflammation, which raise concerns for clinical applications. As an alternative, some investigators have developed nonviral vectors based on polymers, dendrimers, and liposomes, though these synthetic systems are significantly less efficient than viral systems.

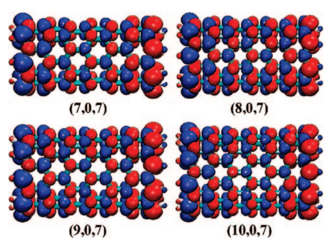


Seeking a new, more efficient nonviral method for gene delivery, Ghosh *et al.* (p 2213) developed colloids embedded with gold nanoparticles, a material known to be bioinert, nontoxic, and readily synthesized and functionalized. Taking a cue from how DNA winds around histone octamers in nature, the team functionalized histone-sized gold nanoparticles with amino acids to provide functional scaffolds for DNA binding.

Experiments showed that particles functionalized with lysines formed particularly compact complexes. Using β-galactosidase plasmids as reporter genes, the researchers tested the vehicle transfection ability on mammalian cells. They found that the gold nanoparticles provided highly efficient gene delivery that was ~28-fold superior to polylysine, a common synthetic vector, with no observed cytotoxicity. Further tests showed that transfection ability can be regulated by manipulating intracellular glutathione, a molecule known to displace cationic ligands on gold nanoparticles. Thus, the authors note, this new vector may eventually provide a valuable tool for controlled release and expression of DNA.

Spin Doctors: Electronic Properties of Half-Metallic Zigzag Carbon Nanotubes

Magnetism in carbon-based materials has recently attracted considerable interest from both experimental and theoretical investigators, though its mechanism is not fully understood. Researchers have previously suggested that spin ordering in graphene-based systems is related to edge states, with distinct electronic states with spin polarization localized to exposed edges when graphene sheets are cut along the zigzag axis. The bipartite hexagonal structure of graphene appears to impart thinly cut nanoribbons with long-range antiferromagnetic spin ordering, with the two edges of the ribbon displaying opposite spin states. Some reports have suggested that spin ordering may also occur on the zigzag edges of finite-sized carbon nanotubes, though results for magnetic ordering and spin states of unpassivated zigzag nanotubes have been contradictory in the literature.

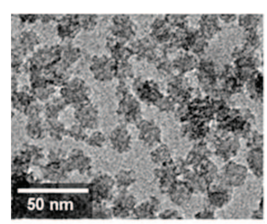


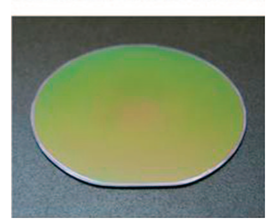
To gain a better understanding of electronic properties in these materials, Hod and Scuseria (p 2243) performed a comprehensive theoretical investigation of spin polarization in hydrogen-passivated finite zigzag carbon nanotubes. The researchers studied 16 nanotube segments in four different lengths. In contrast to previous reports, the researchers found that these nanotubes possess a spin-polarized ground state with a long-range antiferromagnetic-type spin ordering. This state is characterized by high spin density of opposite spins located at the two zigzag edges of the nanotube. These nanotubes display a half-metallic nature under an external in-plane electric field, similar to that of zigzag nanoribbons. The findings are a step toward application of these materials in future nanoelectronic and nanospintronic devices.

No Holes Barred: Porous Thin Films From Silica Nanoparticles

Porous materials in the nanometer size regime are promising candidates for a variety of applications, including gas sensing, host−guest chemistry, drug delivery, and coatings in the semiconductor industry. Investigators have recently developed monodisperse and stable colloidal suspensions of mesoporous silica particles below 40 nm, a size with the useful property of optical transparency. These particles can also be made into thin films using an evaporation/self-assembly method. However, this method has several drawbacks, notably cracking during removal of the surfactant and sensitivity to humidity.

To overcome these problems, Kobler and Bein (p 2324) developed a new method of preparing thin films of mesoporous silica nanoparticles. The researchers first synthesized colloidal suspensions of the nanoparticles using a co-condensation process, functionalizing the particles with phenyl groups. They were able to adjust the sizes of the particles using various temperatures and amounts of catalyst during synthesis, creating transparent suspensions of nanoparticles below 40 nm. The existence of very small, individual, porous particles was confirmed using transmission electron microscopy and sorption measurements. The team created thin films by spin-coating the particles onto silicon wafers from an ethanolic dispersion. Because of the small particle size and low surface roughness, the researchers were able to characterize the films using ellipsometric porosimetry, a method that can determine the sorption isotherms. These results showed that the films have good diffusion properties and a highly accessible pore system. The authors suggest that better control over pore size and molecular modification of the internal surface could enable the use of such porous nanoparticles in a wide range of applications.





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