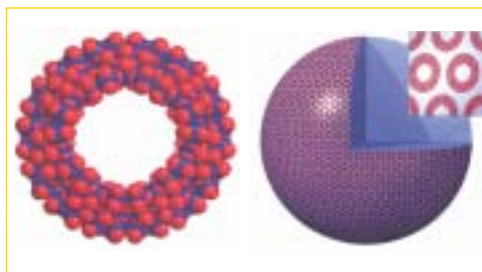


Rounding up nanoclusters

NANOTECHNOLOGY

Scientists at Brookhaven National Laboratory and the University of Bielefeld, Germany have found that a molybdenum oxide nanocluster assembles in solution into structurally well-defined hollow spheres [Liu *et al.*, *Nature* (2003) **426**, 59]. The researchers believe that the complex building blocks and the geometry of the assemblies will allow further modification and the development of a variety of structures, properties, and applications.

Oxometallates – simple slats of metal-oxygen anions such as molybdates – can be built up into complex species or polyoxometallates with defined structures. Achim Müller and colleagues have successfully synthesized discrete, wheel-shaped polyoxomolybdate clusters containing 154 Mo atoms. These hydrophilic $\{Mo_{154}\}$ anions or ‘nanowheels’ have a diameter of ~ 3.6 nm. The nanowheels form large assemblies in aqueous solutions. Static and dynamic light scattering measurements show the presence of hollow spheres with an almost monodisperse size. The vesicle-like shells have a radius of 45 nm and contain ~1165 nanowheels.



Structure of a $\{Mo_{154}\}$ nanowheel (left) and a diagram of a vesicle formed from nanowheels (right). (Courtesy of Tianbo Liu and Achim Müller.)

The researchers suggest that the nanowheel clusters lie flat on the surface without touching each other. The scientists believe that the anionic, hydrophilic clusters are held together by a balance of van der Waals forces, repulsive electrostatic interactions, and hydrogen bonding involving bound water molecules.

“This is of tremendous interest for materials science,” says Müller. “For example, magnetic transition metal centers can be integrated at well-defined positions of each wheel in the vesicles.”

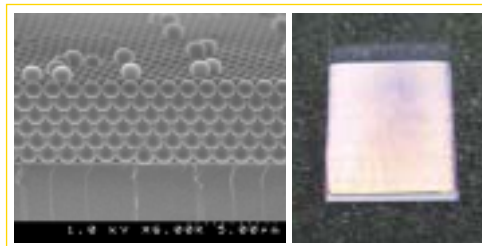
Depositing colloidal crystals to order

OPTICAL MATERIALS

A simple method for making high-quality colloidal crystal films developed by researchers at the University of Toronto, Canada could be used in optical communication devices [Wong *et al.*, *J. Am. Chem. Soc.* (2003) ASAP Article 10.1021/ja0379969].

The self-assembly of colloidal spheres into opaline, crystalline arrays offers a simple way to produce photonic crystals, explain Geoffrey A. Ozin and colleagues. For this to become a practical route to making optical components, however, the spheres must be organized into ordered structures with few, if any, imperfections.

Ozin's group uses a technique they have named isothermal heating evaporation induced self-assembly (IHEISA) to make colloidal crystal films with long-range ordering. The procedure starts with a dispersion of silica spheres in ethanol. A substrate is inserted into a cylindrical vial of the dispersion, which is immersed in a heat bath. As the ethanol evaporates over a period of 2-3 hours, a colloidal crystal film is deposited onto the substrate.



Scanning electron micrograph (left) and photo (right) of silica colloidal crystal films. (Courtesy of Sean Wong, Vladimir Kitaev, and Geoffrey Ozin.)

“Our method is a really simple, robust, and reproducible procedure,” says Sean Wong. “It can be implemented in any scientific laboratory.” Optical spectroscopy and scanning electron microscopy demonstrate the quality of the films, which consist of 5-10 layers of organized spheres. Perfect domains with sizes of 100×100 spheres were routinely obtained. The researchers find that the monodispersity of the silica spheres (less than 1.5% variation) and absence of impurities are crucial to this high degree of order.

Nanoparticles the green way

FABRICATION AND PROCESSING

The preparation of metal nanoparticles generally involves the reduction of metal ions, either in solution or a high temperature gaseous environment. Most methods use organic solvents and highly reactive reducing agents. This is contrary to the principles of green chemistry, which promote the use of nontoxic chemicals, environmentally benign solvents, and renewable materials.

Scott L. Wallen and colleagues at the University of North Carolina have demonstrated the first synthesis of metal nanoparticles using ‘green’ chemistry processes [Raveendran *et al.*, *J. Am. Chem. Soc.* (2003) **125**, 13940]. Ag nanoparticles are produced using glucose as the reducing agent, starch for stabilizing the particles, and water as the solvent throughout the process. A mixture of $AgNO_3$ solution, soluble starch, and glucose is heated at $40^\circ C$ for 20 hours. Ag^+ is reduced inside the nanostructured starch matrix present in the solution. Starch hydroxyl groups also stabilize the nanoparticles. The final solution is light yellow, indicating the formation of Ag nanoparticles. Optical spectroscopy and transmission electron microscopy confirm the presence of Ag nanoparticles <10 nm in size.

“The Ag nanoparticles produced have been stable for longer than 10 months and show no signs of precipitation,” says Wallen. “This approach provides a simple, robust means of producing nanoparticles that could be transferred to biological systems, utilized in water-soluble pharmaceuticals and potentially as an *in situ* sensor material.” The team hopes to be able to control the particle size and size distribution, as well as incorporate the particles into biological systems, Wallen explains.