ART RESTORATION

Keeping it clean

Langmuir **23,** 6396–6403 (2007)

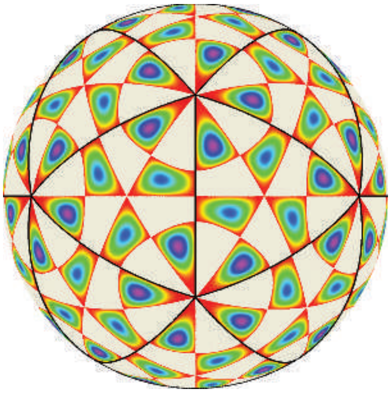
The appearance of works of art can be disrupted by unwanted substances being deposited on their surfaces. Restoring them to their original state requires a delicate cleaning process that removes the coatings without disturbing the underlying materials. Organic solvents are efficient removal agents, but are often very invasive. However, when these solvents form nanodroplets in an oil-in-water microemulsion they have proved to be effective without any detrimental side effects.

Piero Baglioni and colleagues at the University of Florence, Italy have used this approach to clean a specific type of wall fresco that has very fragile and detachable paint. A pure organic solvent would penetrate the porous structure of the painting and disrupt the original paint layers. But by using a microemulsion, a much lower volume of oil can efficiently solubilize the coatings because the nanodroplets have such a high surface area, making this method a lot safer. Furthermore, they have also been effective in removing a particularly insoluble coating found on many paintings, containing salts as well as polymers. Both components can be removed in a single step — the polymers are dissolved by the oil nanodroplets and the salts are dissolved by the water.

The technique has been successfully tested on two works of art, proving its potential as a low-impact cleaning tool in cultural heritage conservation.

VIRUSES

Cover story



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The genetic material in a virus that lets it infect other cells is enclosed in a protein coat, called a capsid. Nearly fifty years ago, virologists set forth a simple geometric model to explain how proteins are arranged in these protective shells. However, new high-precision techniques that can measure the structure of some of the smallest viral capsids are revealing many exceptions to this long-held picture.

Vladimir Lorman and S. B. Rochal from the Université Montpellier in France have, therefore, tried to develop a less restrictive model that can explain how proteins crystallize to form small capsids. Applying Landau's theory of phase transitions — which has been used to understand problems from superconductivity to melting — they calculate the distribution of proteins in capsids of varying sizes and compare their results with experimental structures that cannot be explained by the old model.

An important part of the French group's simulations is that they contain detailed information about the protein distribution in the capsid, which is now understood to play an important role in the way viruses infect cells.

NANOCRYSTALS

Catalysts take shape

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Most metallic nanocrystals usually adopt a simple polyhedral shape — such as a cube or octahedron — in which the faces are defined by low-energy planes of the crystal structure. These stable surfaces are often formed in preference to so-called 'high-index' planes, which have a greater amount of reactive sites because of atomic defects such as steps and kinks.

Now, a team led by Shi-Gang Sun from Xiamen University in China and Zhong Lin Wang from the Georgia Institute of Technology in the USA have made polyhedral platinum nanocrystals that have 24 high-index surfaces. The unusual tetrahexahedral structures — more easily described as a cube in which each face is completely capped with a pyramid — were made from platinum nanospheres in an electrochemical synthesis using a square-wave potential. The size of the nanocrystals simply depends on how long they are grown for, and they are thermally stable up to 800 °C.

When normalized to account for differences in surface area, the catalytic activity of the tetrahexahedral nanocrystals for the oxidation of small organic compounds is shown to be superior to that of platinum nanospheres. This enhanced activity, caused by the presence of a relatively high density of reactive defect sites on the high-index faces, may make these promising materials for catalytic converters and fuel cells.

TOP DOWN BOTTOM UP

Strength in numbers

Materials scientists and mechanical engineers have joined forces to find out just how strong carbon nanotubes can be

Although thousands of papers have been published on the properties of carbon nanotubes, it was a lack of papers on their fatigue properties that prompted Pulickel Ajayan of the Rensselaer Polytechnic Institute (RPI) to assemble a multidisciplinary team to fill this gap in the literature. Comprising Jonghwan Suhr, a mechanical engineer from the University of Nevada, Ajayan and colleagues in the materials department at RPI, and researchers at Princeton University and Shanghai Jiao Tong University in China, the team focused on a specific question: how do carbon nanotubes and their aggregates behave when subjected to repeated compression?

The materials scientists on the team optimized the formation of the nanotubes and their assemblies, while the mechanical engineers measured their mechanical properties. The team found that when arrays of vertically aligned multiwalled nanotubes were subjected to repeated high compression, they displayed viscoelastic behaviour that was similar to that seen in soft tissues such as tendons and muscles (see page 417). Moreover, no fatigue failure (damage) was seen over half a million cycles of compression. This combination of outstanding fatigue resistance and soft-tissue-like properties suggest that these materials could form artificial tissues for various implant applications.

"In the future the big breakthroughs will come from the boundaries of multidisciplinary research," says Ajayan. "My advice is to never be afraid to initiate a discussion with someone who is in a very different field. The experience is like learning a new language. It can be difficult at the beginning but in the end, the experience can be very rewarding."

The definitive versions of these Research Highlights first appeared on the *Nature Nanotechnology* website, along with other articles that will not appear in print. If citing these articles, please refer to the web version.