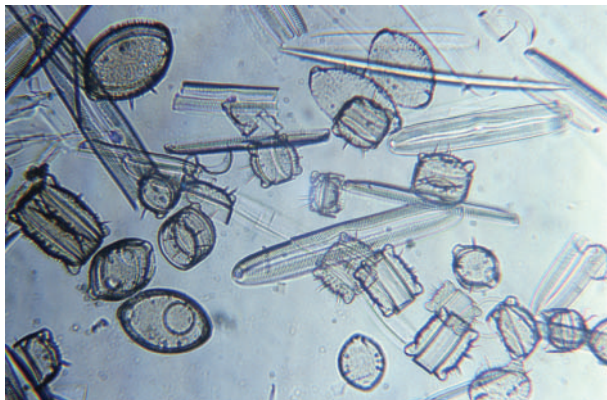


Material mosaics



Marine diatoms (see image) and sponges use biopolymers and proteins to construct intricate silica structures, such as macroporous shells and skeletal networks. In the laboratory, material scientists try to mimic the formation of these highly ordered materials by using structure-directing agents during silica crystallization. Johan Martens and colleagues in Belgium have succeeded in making silica superstructures with two levels of porosity and structural order by linking together nanoscale slabs of

crystalline silica into a three-dimensional mosaic (*Advanced Materials*; <http://dx.doi.org/10.1002/adma.200305266>). The authors build on earlier work in which they made uniform nanoslabs of a zeolite — robust microporous materials used for molecular sieving and catalysis. In this study, the crystalline building blocks are assembled from solution into three-dimensional patterns by exploiting their interactions with organic molecules — either a surfactant or triblock copolymer. Depending on

the preparation conditions they obtain three different superstructures in which the nanoslabs are linked at their corners, edges or faces. In each case, once the organic molecules are removed, a mixed microporous and mesoporous silica structure remains. One of the new zeolites even contains two types of channels, triangular and hexagonal, within the same material. The authors suggest their approach offers an alternative route to generating new families of zeolite frameworks.

Recording atomic vibrations

Many fundamental processes — such as the evolution of new phases in solids and the kinetic pathways of chemical reactions — occur as a result of atomic vibrations on the femtosecond time scale. Tracking these atomic motions and transient structures at sufficient detail and at such short time scales is quite a challenge. Time-resolved X-ray diffraction has been used to study ultrafast processes in the past, but gives only a limited picture of the atomic motions. J. Cao and colleagues at Florida State University have now developed an electron-diffraction system capable of measuring transient structures in solids on the 400 femtosecond time scale (*Applied Physics Letters* **83**, 1044–1046; 2003). The femtosecond electron pulses are generated by photoemission from a cathode illuminated with femtosecond laser pulses, and the electron gun can deliver around 2,000 electrons with a pulse width of less than 300 femtoseconds. Cao and colleagues have demonstrated the ability of their system to obtain diffraction images good enough to reveal long-range lattice order with only a single electron pulse containing around 4,000 electrons. Femtosecond electron diffraction therefore offers great promise for the direct determination of transient atomic structures during ultrafast processes such as melting.

Cholesterol counting

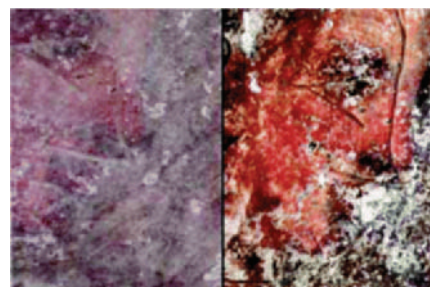
Everyone knows the importance of keeping our body cholesterol levels low, but we are generally unaware of the difficulties in quantifying its content in food samples. An organosilica additive now greatly improves the performance of an enzyme matrix for the analysis of cholesterol, leading to a stable and reliable biosensor for this enemy of our health (Wu, X. J. & Choi, M. M. F. *Analytical Chemistry* **75**, 4019–4027; 2003). The analysis of cholesterol is not trivial

with current techniques, due to the stringent and somewhat conflicting requirements imposed both by the enzyme performing the biosensing function — cholesterol oxidase — which requires water to function, and by cholesterol itself, which needs a hydrophobic carrier to reach the active site of the enzyme. Immobilizing cholesterol oxidase in a matrix is desirable from a practical viewpoint, but it has inevitable drawbacks in terms of reduced reaction rate and

sensitivity. Unless, as Wu and Choi discovered, you add octadecylsilica particles into the matrix. By creating some hydrophobic sites, this reverse-phase silica gel greatly improves the response time and sensitivity of the biosensing reaction within otherwise inefficient matrices. Moreover, this method makes it now possible to quantify cholesterol directly in an organic solvent, avoiding the normal extra step of aqueous micelle preparation.

Reversing conservation

Researchers in Italy have developed micellar and microemulsion systems specifically for the removal of acrylic and vinyl polymers from works of art (*Langmuir* **19**, 7867–7872; 2003). These polymers have traditionally been used as a protective layer on paintings and frescoes — but they have their own drawbacks. Thermal and photochemical activity on the polymer surfaces cause depolymerization and crosslinking reactions, resulting not only in a yellowing effect, but also mechanical stress on the paint layers and the formation of microfractures. The authors tested several four- and five-component micellar or microemulsion systems for solubilizing the polymers away from the artwork. They found, for example, that a particular composition of the quaternary micellar system containing propylene carbonate (PC), 1-pentanol (PeOH), the surfactant sodium dodecyl sulphate (SDS) and water, completely removed the vinyl polymer layer covering the 16th-century fresco by Pozzoserrato in Conegliano, northern Italy (see image). The authors suggest that the removal mechanism can be explained by the synergism between the highly active surface



formed by the presence of SDS micelles, and their interface that is rich in PeOH and PC — a mixture forming a good solvent for aged vinyl polymers.

LIQUID-CRYSTAL SWITCHING

Liquid crystals near a surface don't behave as they do in the bulk. Indeed, under such conditions their orientation is governed by the chemical functionality and topography of these surfaces. The application of an electric field across such a liquid crystal allows its bulk configuration to be modified but not its surface orientation — an effect encountered in technological applications such as liquid-crystal displays. Nicholas Abbot and Yan-Yeung Luk, reporting in *Science* (**301**, 623–626; 2003), propose a way to chemically functionalize electrodes to electrically drive the orientations of liquid crystals at the surface rather than in the bulk. Their approach is based on the electrochemical control of the oxidation state of ferrocene-decorated electrodes that results in a change of the electrical properties at the interface when ferrocene is oxidized to ferrocenium. This mechanism is believed to be generic, and the authors suggest that the use of these decorated electrodes may find applications in electro-optical devices as well as chemical sensors.