Materials Science

A bacterium's silver touch

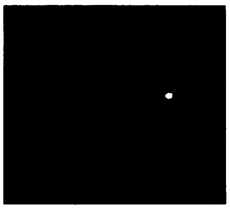
Silver is highly toxic to most microbes. Nonetheless, researchers have discovered several strains of bacteria that thrive in silver-laced ore deposits. Materials scientists now report that one of these metal-munching bacterial strains can synthesize silver-containing crystals with well-defined compositions and distinct shapes, including equilateral triangles and hexagons. Tanja Klaus and her colleagues at Uppsala University in Sweden describe their findings in the Nov. 23 Proceedings of the National Academy of Sciences.

Up to 200 nanometers across, the crystals are embedded between a bacterium's plasma membrane and outer cell wall. One type of crystal is almost pure metallic silver, and another is largely silver sulfide. "The cells can accumulate silver in large quantities," the researchers say.

The results provide new insights into microbe-metal interactions. They also suggest direct biosynthesis as a potential route for producing silver-based, nanometer-scale particles for microelectronic devices and other applications. "The possibility of synthesizing metal particles directly in an organic matrix points toward new uses of metal-containing bacteria as precursors in thin films and surface-coating technology," the researchers note. —*I.P.*

Pressuring oxygen to turn red

Applying tremendous pressure to crystals can force drastic changes in the chemical bonds between atoms. At pressures greater than 10 gigapascals (GPa), for example, solid oxygen undergoes a significant volume reduction and a dramatic shift to a deep red color, signaling the formation of a new molecular structure. Now, physicists report spectroscopic evidence suggesting that in this red, high-pressure form, neighboring pairs of oxygen molecules, each consisting of two oxygen atoms, combine into four-atom units. Federico A. Gorelli and Roberto Bini of the University of Florence and their coworkers report their findings in the Nov. 15 Physical Review Letters.


Gorelli et al.

An unusual, high-pressure form of solid oxygen has a distinctive red color.

The formation of O_4 molecules may serve as a crucial step in oxygen's transformation into long chains, then into a metal at even higher pressures, the researchers conclude. Last year, a Japanese team reported that solid molecular oxygen becomes a superconducting metal at pressures exceeding 100 GPa, about 1 million times atmospheric pressure (SN: 7/18/98, p. 47). —*I.P.*

Ceramics from segregated polymers

Mixing polystyrene, the stuff of plastic cups, and polyisoprene, a material used for making automobile tires, is like trying to combine oil and water. The two polymers repel each other vigorously. Nonetheless, chemists can force them together so the substances assemble themselves into a so-called block copolymer, in which the two materials are inextricably linked (SN: 9/3/88, p. 151).

Now, researchers have put a silicon-containing block copolymer to use. They demonstrated that the copolymer can serve as the starting material in a simple, versatile process for making thin ceramic films containing a network of connected pores or linked struts. Edwin L. Thomas and Vanessa Z.-H. Chan of the Massachusetts Institute of Technology and their collaborators describe the fabrication technique in the Nov. 26 Science.

By carefully choosing the polymer proportions, the researchers can tailor the resulting ceramic structure to serve as a membrane, catalyst, or photonic material. —*I.P.*

Physics

Pushy lasers sweep into ion race

Compared with huge particle accelerators, lasers are little. The possibility of using intense laser beams to accelerate electrons to high speeds in a limited space has sparked numerous lines of research (SN: 2/10/96, p. 95; 9/5/98, p. 157). Now, scientists find that lasers can also accelerate much heavier particles, such as protons and still weightier ions.

At the American Physical Society Division of Plasma Physics meeting in Seattle last month, three independent research groups announced the discovery of this promising laser talent. Their findings suggest that relatively compact, laser-based accelerators may be on the horizon for use in medical treatments, isotope production, and electronics manufacturing.

To scientists at Lawrence Livermore (Calif.) National Laboratory, the new laser capability came as a surprise. In their experiments, they used the world's most powerful laser to rip electrons from thin gold targets and propel them to nearly the speed of light. "We found ions efficiently accelerated to high energies," says Scott C. Wilks, a member of the research team. The ions—a searing beam of 30 trillion protons, with energies up to 50 million electronvolts (MeV)—burst from the far side of the target.

Not ordinarily at large in gold, the protons must have come from a film of oil and other contaminants that had settled on the target, says Livermore's Stephen P. Hatchett II. For controlled proton sources, laser accelerators could use plastic targets cleaned of contaminants by a weaker pulse, he says.

In other experiments, researchers at the University of Michigan in Ann Arbor reported accelerating some 10 billion protons to energies of about a tenth of those reached with the Livermore laser. They used a much smaller laser with one-thousandth the power of the Livermore machine.

Meanwhile, researchers at the Rutherford Appleton Laboratory in Oxfordshire, England, announced detecting not only protons at energies up to 17 MeV but also lead ions accelerated to 420 MeV. Those heavy ions, however, did not emerge as a beam. —*P.W.*

Sandpile style: Poured or rained

Two identical-looking piles of sand can differ in a curious way: One will exert the most pressure under its central peak, while the other's greatest load lies further out.

Scientists who study granular materials explain the difference as the result of grains forming arch-like structures within some piles. Like the flying buttresses of cathedrals, the structures steer forces away from the center (SN: 8/19/95, p. 127; 9/20/97, p. 186). However, why some piles develop the arches while others don't has remained a puzzle.

In a new experiment, researchers in France and North Carolina show that the way sand falls onto a pile can determine how its load gets distributed. Loïc Vanel of the University of Pierre and Marie Curie in Paris and his colleagues measured pressures beneath piles made either by pouring sand through funnels or letting it rain through sieves.

In the November Physical Review E, the researchers report that the funneled sand, which flows onto a small section of the mounting heap, consistently produced piles with off-center maximum pressure. Sieved sand, which fell evenly across the entire platform, built into mounds with on-center maximum loads.

Research team member Robert P. Behringer of Duke University in Durham, N.C., explains that funneled sand repeatedly avalanches down the pile's outwardly slanting slopes as it accumulates. Consequently, grains can settle into arches that shift weight away from the center.

By contrast in sieved mounds, the grains fall straight down, he says, so the maximum pressure lies under the heap's tallest part, its center, as one would expect. —*P.W.*