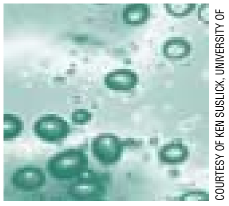
Chemists Shed Light on Temperatures of Bubbly "Microfurnaces"

Blasting liquids with ultrasound creates tiny gas bubbles that are nearly as hot as the surface of the sun. Now chemists at the University of Illinois Urbana–Champaign have, for the first time, measured these fiery but fleeting temperatures by borrowing a technique from astronomers.



COURTESY OF KEN SUSLICK, UNIVERSITY OF ILLINOIS AT URBANA–CHAMPAIGN.

Microfurnace bubbles.

When such ultrasound-generated bubbles collapse, they create hot spots that emit light—a phenomenon called sonoluminescence. To measure the temperatures of these spots, researchers examined the spectra of their light, just as astronomers do to tell the temperatures of stars.

In their experiments, the group produced sonoluminescence in solutions containing volatile metal compounds. The relative intensity of light emitted by the excited metal atoms at different wavelengths could then be used as a thermometer. And the temperature could be controlled by altering the contents of the bubbles.

"It is amazing that in an otherwise cold liquid sitting on a desktop, we can create small hot spots with temperatures as high as a star surface, pressures as great as the ocean bottom, and lifetimes shorter than a lightning strike," said University of Illinois chemistry professor Ken Suslick (ACS '75), whose team reported the findings in the Oct. 21 issue of *Nature*.

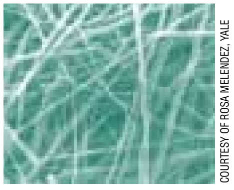
Those hot spots, he explained, are like "microscopic furnaces that can drive high-energy chemical reactions." Suslick has previously used intense ultrasound to destroy chemical wastes in liquids and to create designer compounds with tailor-made properties. But other applications of so-called sonochemistry are possible. Cavitation—the formation and collapse of bubbles—is responsible not only for the noise that boiling water makes but also for the noise produced by submarine propellers and for the erosion of turbines.

"By understanding the conditions inside the bubbles, we can learn to control cavitation and its chemical and physical effects," Suslick said.

CO_2 Gel Makes Environmentally Safer Solvent…

For the first time, scientists have turned supercritical CO_2 into a gel. The achievement is a potential boon to industry, because the new gel could serve as an environmentally friendlier alternative to organic solvents.

The researchers, based at Yale University and the University of Pittsburgh, originally set out to design molecules that would increase the viscosity of supercritical CO_2. To their surprise, they discovered a molecule that gelled the highly pressurized CO_2.



COURTESY OF ROSA MELENDEZ, YALE UNIVERSITY.

Microscopic structure of a CO_2 gel.

"Then we had another surprise," said Yale chemist Andrew Hamilton (ACS '81), whose team's findings were reported in the Nov. 19 issue of *Science*. "When we released the pressure, the CO_2 evaporated from this gel and left behind a solid material made up of interconnected networks of our designed molecules, and it had extremely low density."

One application for the new gel would be to use it instead of water to extract oil from the ground. The advantage, Hamilton explained, would be that once the oil is extracted, the supercritical CO_2 would simply evaporate or be recycled. The process would not only be safer to the environment but also reduce the cost of oil extraction.

The next step, he said, will be to improve the viscosity-enhancing properties of the CO_2-gelling molecules and simplify the material's structure in order for it to be produced in bulk commercially.

…While Swell Gels Deliver Drugs, Keep Diapers Dry

Cornell University scientists have developed new hydrogels—super-swelling, jellylike materials that can hold many times their weight in water—that could be used in everything from tissue regeneration to gene therapy to super-absorbent diapers.

The promising materials are not only biologically compatible with the human body but also stronger and more stable than other hydrogels, said Cornell biomaterials scientist C. C. Chu. His team's latest research, originally reported at the ACS national meeting in New Orleans last August, was scheduled to appear in the *Journal of Biomedical Materials Research* and *Journal of Polymer Sciences, Polymer Chemistry*.

The secret behind Chu's patent-pending hydrogels is the careful combination of different components, including synthetic biodegradable polymers such as polylactide and dextran, a sucrose polymer produced in fermentation, and carbohydrates such as polysaccharides. The resulting compounds have both hydrophilic (water-attracting) and hydrophobic (water-repelling) properties that can be controlled for specific applications.

Chu and his graduate students have already demonstrated that one type of their new hydrogels can release anti-inflammatory and cancer-fighting drugs as well as human insulin. Another type, Chu noted, could serve as a three-dimensional network on which to grow skin cells and compounds for repairing blood vessels or be used to deliver viruses into the body for gene therapy.

New "Molecular Sieves" Tackle Big Molecules

Metal–organic materials aren't just the stuff of science fiction cyborgs. They're also the basis of a new breed of catalysts that can serve as "molecular sieves" for capturing and chemically modifying large molecules.

The new materials could be used to isolate and modify compounds that previous catalysts have been unable to handle, according to chemists at Arizona State University and the University of Michigan, who reported their work in the Nov. 18 issue of *Nature*.

By combining zinc oxide and terephthalic acid, the researchers developed a "metal–organic framework"