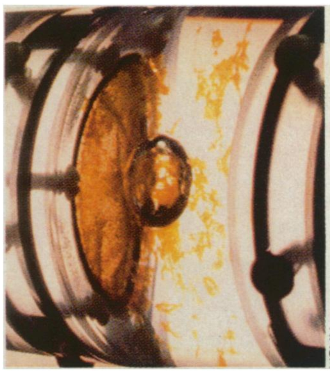
Chemistry

Janet Raloff reports from Miami Beach at the American Chemical Society's fall national meeting

Better crystals? It's a matter of space



Lead iodide crystals grown last year aboard the space shuttle Discovery show unexpected differences from those produced on Earth with identical techniques, reports Steven L. Suib of the University of Connecticut at Storrs. The shuttle crystals – the first grown in space from an aqueous solution and the first in space using a template to direct growth – proved not only purer and more symmetrical but also less dependent on a template to initiate crystallization. The reason for these differences remains unclear, says Charles W.J. Scaife, at Union College in Schenectady, N.Y., who, along with S. Richard Cavoli, designed the tests.

The University of Connecticut/Union College team produced five cylindrical crystal-growth reactors. Each three-chambered reactor carried solutions of lead acetate and potassium iodide – one chemical at each end – initially separated from a chamber containing water with the template in the middle. In orbit, when valves isolating the inner chamber opened, each solution began diffusing toward the membrane. Video recordings of the 40-hour experiments show crystals beginning to form on the membrane 30 to 120 seconds later.

In two experiments on Earth, with the reactors oriented so that their lattice templates stood vertically, yellow lead iodide crystals formed only on the lower half of each lattice. A deep, horizontal, lead iodide shelf marked the upper boundary of crystal growth. Crystalline supports flared out beneath it, and a beard that grew from the shelf began dripping crystals onto the growth chamber floor within 20 minutes.

In contrast, a relatively even coating of crystals smothered the entire surface of the template membranes in each of the three space-borne reactors. Additional satellite growths (see photo) crystallized throughout the adjacent liquid – a phenomenon that Scaife notes has never been witnessed in Earth-grown crystals offered a template on which to adhere.

For unknown reasons, significantly higher levels of carbon appear to have migrated out of the growth reactors on Earth, Scaife says. Shuttle-grown crystals contained only about one-tenth the carbon contamination of those produced on Earth. Purer lead iodide crystals could boost the sensitivity of X-ray and gamma-ray film – potentially allowing physicians to reduce patient X-ray exposures without sacrificing image quality. Scaife says the Rochester, N.Y.-based Eastman Kodak Co. has already shown interest in the data. But the shuttle experiments also suggest space-grown crystals might yield significant quality improvements for "molecular sieves," a commercially important class of chemical filters made from tightly packed crystals.

Canned produce: Mush no more

Crunch. That's the sound of teeth biting into a canned green bean – not just any green bean, but one canned by Malcolm Bourne, a food chemist with the New York State Agricultural Experiment Station in Geneva. A new treatment he developed can restore most of the firmness – and crispness, if desired – now lost during commercial food canning. It's resuscitating their polymers that puts the snap back, Bourne says.

Polymers are macromolecules formed by linking a chain of identical molecules such as pectins – a class of water-soluble, gluey substances in plants. Cooked fruits and vegetables lose much of their original firmness as heating uncouples the links in polymeric pectin, explains Bourne. The reason so many canned goods end up mushy, he says, is that the temperatures used today to blanch and sterilize commercial canned goods far exceed what's needed to achieve the tenderness most consumers desire.

Bourne has discovered that by dropping canning temperatures from 220°F to just 145°F, an enzyme naturally present in the foods activates and begins binding pectin molecules back together by chemically crosslinking their calcium atoms. The longer the blanch, the more time the enzyme has to reestablish firming links between pectins. Supplementing the product with extra calcium "dramatically" enhances the process, Bourne says, allowing a restoration of crispness. Every food he's tested so far – carrots, snap peas, zucchini, onions, bell peppers, apples, peaches, peas, cherries and potatoes – firms up under his processing. And because the calcium crosslinks resist thermal breakdown, cooks can reheat foods firmed up with them for hours without mushing. In fact, this process holds out the prospect for pies with fruit fillings even firmer than those Grandma baked from scratch.

The temperatures Bourne uses won't prevent growth of nontoxic "flat-sour" microbes that can spoil the flavor and appearance of foods. To prevent their growth during blanching, processors must change blanch waters more frequently, lower the pH of their product to less than 4.5 (Bourne adds a tangy bit of citric acid) or blanch with steam or microwaves.

Bake-offs may not cure 'sick buildings'

Several states are considering regulations to ward off "sick building syndrome" – where chemicals cause illness among occupants – in public facilities, including schools. Building owners or employers would have to turn up the thermostat for three or more days before allowing occupancy of new or renovated buildings, to accelerate the offgassing of potentially toxic chemicals from new structural materials and furnishings. But studies by Charlene W. Bayer at the Georgia Tech Research Institute in Atlanta now suggest such proposals may be premature.

Bayer's experimental attempts to bake off volatile organic chemicals emanating from new modular room partitions and particle-board samples (taken from an Atlanta office building) failed to eliminate the chemicals' smell and offgassing. In fact, her data indicate that a three-day bake-out at 90°F – a regime being considered by New Jersey – may actually create new indoor air-pollution headaches.

Bayer's tests show, for example, that if a space is not heated evenly, condensation can collect in "cold spots." Because she found that alcohols, oxygenated compounds and chlorinated chemicals preferentially dissolved in this condensate, she now worries that in the real world such condensation might transform previously benign materials, such as older carpets, into new concentrated reservoirs of potentially toxic chemicals. And cold spots may prove common, she says. Data collected by others indicate that once air temperatures reach 90°F, it may take another three days before the rest of the furnishings do. Moreover, she found that bake-out temperatures can volatilize some compounds that don't evaporate at normal room temperatures.

More surprisingly, even though her studies indicate that bake-out drives off significant quantities of volatiles, the offgassing rates at the end of the bake were hardly lower than prebake emissions, though the gases' chemical makeup may have changed. The take-home message, she believes, is that manufacturers should let new products volatilize to harmless levels for several months in their warehouses – before selling them – rather than in people's living and work spaces.