CHEMISTRY

Linda Garmon reports from Las Vegas, Nev., at the meeting of the American Chemical Society

Liquid salts: Future electrode baths?

It is a chemical curiosity: The two substances each are solids at room temperature, but when combined, they form new materials that melt and stay liquid even when cooled to below room temperature. The new materials — mixtures of aluminum chloride and the organic, nitrogen-containing, five-sided ring compounds called dialkylimidazolium chlorides — are electrically conductive salts. And because these salts are liquid at room temperature, they are potential battery material, says one of their developers, John S. Wilkes of the U.S. Air Force Academy in Colorado Springs.

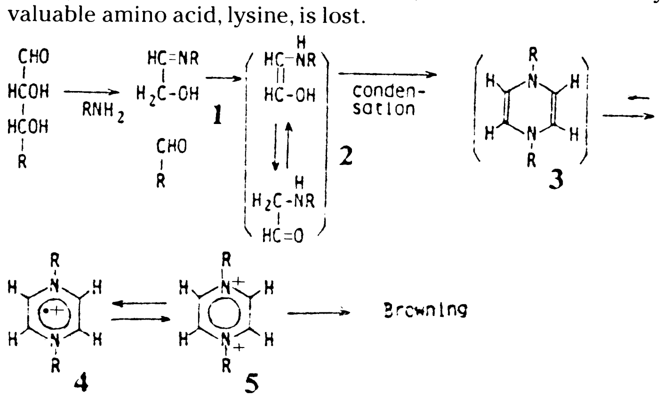
The essence of a battery is placement of positive and negative electrodes in an electrically conductive solution. In the conventional, widely used batteries, that solution usually consists of ions dissolved in the solvent water. But high energy-density batteries, which can provide a lot of power in a short period of time, require the more quickly acting electrolyte solutions of molten salts—completely ionic liquids with no inactive solvent component.

The problem with currently used molten salts is that they are only liquid—that is, in their active, electrically conductive form —at high temperatures, Wilkes says. Those high temperatures not only are inconvenient, he explains, but also are stressors, and therefore lifetime shorteners, of the other battery components. As a result, molten salt-containing, high energy-density batteries now are used only on a limited basis — to guide missiles or certain space probes, for example.

The new molten salts might render more convenient the use of high energy-density batteries in a wider range of applications that includes the electric car. Such applications, though, are much further down the road, Wilkes says. "We have just finished measuring a lot of basic properties of the molten salts such as conductivity, density and viscosity," he says. "This summer, we'll begin looking at them in batteries."

Lightly toasted, please

When pizza crust turns brown, the Maillard reaction is at play. The reaction occurs between amino acids and sugars when food is heated. Despite vast amounts of work to determine the precise mechanism of this browning process, much of it remains obscure, report Mitsuo Namiki and colleagues of Nagoya University in Japan. For instance, food chemists long have wondered why the reaction occurs so quickly. Now, Namiki and cohorts propose that fragmentation of a sugar (the process labeled "1" in the diagram) into an unstable radical (4) — a molecule highly reactive due to an unpaired electron — accounts for the reaction's swiftness. Food chemists strive to learn more about the Maillard reaction because of its sometimes undesirable effects. Cho Tsen and colleagues of Kansas State University report, for example, that the more bread is toasted, the more a nutritionally valuable amino acid, lysine, is lost.



PHYSICAL SCIENCES

Dietrick E. Thomsen reports from Phoenix at the 1982 topical meeting on Optical Fiber Communication and the 1982 Conference on Lasers and Electro-Optics

Gas lasers cut out Zils

Among the applications of lasers that demand extreme delicacy, such as eye surgery and the fabrication of integrated circuit chips, are those of a more heavy industrial nature, such as welding and metal cutting. Some participants in the meeting saw something rather rare in America, a Russian film on the application of lasers in heavy industry, particularly the operations of a plant making Zil automobiles.

The film was presented by a group from the P.N. Lebedev Physical Institute in Moscow, including N.G. Basov, E.P. Glotov, V.A. Danilychev and V.I. Yugov. Danilychev, who spoke for the group, talked mostly about an experimental high-power, high-efficiency laser that they have been developing for such applications. It uses a mixture of argon and xenon gases in a chamber one meter long and 10 centimeters in diameter to develop 20 joules of energy radiated at a wavelength of 1.7 microns. The gas is energetically pumped into the state appropriate for lasing by beams of electrons. Up to 6 percent of the input energy comes out as coherent light.

Future plans include installing heat exchangers and expansion refrigerators on the pumping cycle that keeps the gas flowing through the lasing chamber. This would cool the gas that enters the chamber and so increase the efficiency of the laser. It would also recover some of the energy otherwise wasted.

The film concerned the operation of a carbon dioxide laser of similar specifications—10 kilowatts operating power. The ability of such a laser to make quicker and cleaner welds than conventional methods and to cut 15-millimeter-thick sheet steel cleanly and quickly was graphically demonstrated. Americans familiar with the field judged that the technology they were seeing is roughly comparable to that available in the United States. What they found significant was that the Russians would be so forthcoming about one of their heavy industrial processes that they spent 26 hours flying halfway around the world to bring the film to Phoenix.

Cost is a significant factor in the spread of such technology in both the Soviet Union and the United States. The figure cited by the Russians for one such installation is 300,000 rubles. American experts cite a comparable $200,000 apiece.

How not to make a laser

There's one in every crowd. To a meeting called to celebrate the latest developments and applications of lasers came Daniel Kleppner of the MIT Research Laboratory of Electronics to tell "how to prevent lasers." He thought they would be interested, and they were.

Kleppner's work deals with the ways in which spontaneous emission of radiation by atoms can be inhibited. Spontaneous emission is likely when an atom has an excess of energy. Exactly how and when it occurs depends on how the energy states of the atom are linked to those of the vacuum. (For physicists the vacuum is not simply emptiness but is full of energy states that have a virtual existence. They can affect the behavior of actual observable atoms and particles and sometimes come into existence as real particles themselves.) The rates and probabilities of spontaneous emission also determine those of the special case of stimulated emission, which is basic to lasers.

Kleppner showed theoretically that putting an atom in a certain kind of energy "cavity" (a nonresonant one) could detune its relations with the vacuum and inhibit or suppress spontaneous radiation. Experimentally such a cavity can be designed, and Kleppner's laboratory has demonstrated inhibited absorption, which is the converse of inhibited emission. (If one works, the other should.) Studies of how not to do a certain thing, of course, provide fundamental information for those who want to do it.