Chemistry

Hydrogen molecule captured whole

Hydrogen gas (H_2) can be almost violently reactive. And when it combines with other elements or molecules, the H-H bond always breaks and the resulting compounds have very different properties from the hydrogen gas. Until recently, hydrogen molecules have never been observed unbroken as part of a larger molecular complex. Now, a group at Los Alamos National Laboratory in Albuquerque, N.M., has succeeded in binding a hydrogen molecule to a metal complex. The result might stimulate new research in the study of bonding forces in molecules.

Gregory J. Kubas and his colleagues grew crystals of a metal complex composed of three carbon monoxide molecules, a phosphorus atom attached to three organic groups and the hydrogen molecule surrounding an atom of tungsten metal. The positively charged tungsten atom is unstable until surrounded by "ligands," ions or molecules that stabilize a central atom or ion. Finding the hydrogen as one of the six stabilizing ligands was "sort of surprising. There was a chance that calculations would not show a stabilization in hydrogen at all," says Kubas. The crystal structure is being analyzed by Phillip J. Vergamini, another member of the team, using an instrument he designed. In the single crystal pulsed-neutron diffractometer, a high-intensity neutron source bounces these particles off the crystals and records a three-dimensional scattering pattern. The crystal structure can be reconstructed from this pattern.

The Los Alamos team's observations may stimulate a better understanding of an interesting and commercially important reaction, the addition of hydrogen to metals. "What we're seeing is a frozen-out form of the reaction," says Kubas. The capture of the hydrogen molecule in the metal complex "is the first step of that reaction." The next step is for theorists to adapt current theories of molecular bonding to this discovery, and it might ultimately also have practical applications. "Catalytic hydrogenation," the addition of hydrogen to a chemical, is catalyzed by metals. The catalytic hydrogenation of hydrocarbons such as petroleum results in a wide variety of products like oils, synthetic fuels and polymers. Facilitating this reaction would be a potential boon to the petrochemicals industry.

Helium, diamonds and primitive earth

Helium gas locked in the crystal lattices of diamonds may influence theories of the origin of earth.

Much of earth's ancient atmosphere was "degassed" from earth's rocks during cooling. The extremely stable, unreactive noble gases such as helium were among the atmosphere's earliest components. A strong, resistant "time capsule" such as diamond might have captured helium gases as the diamond formed, in the same relative proportions as existed at the time of the diamond's formation, according to two scientists at the Geophysical Institute of the University of Tokyo. Therefore, since many diamonds are thought to form in the earth's mantle, they believe, some might bear gases in proportions that existed when dust particles first coalesced to form the earth's interior.

Minoru Ozima and Shigeo Zashu converted 13 industrial-quality diamonds into graphite by heating them in a vacuum. There the diamonds released helium-3 and helium-4, two isotopes of helium. Isotopes are atoms of the same element with different atomic weights. They measured the ratio of helium-3 to helium-4 for each stone and compared these to the ratio observed in the present atmosphere. In a paper in the March 4 SCIENCE, they report finding extremely high ratios relative to the present atmosphere, but close to those observed in the sun, in two of the stones. These ratios probably represent helium trapped "soon after the formation of the earth," before the mantle rocks began to degas. Samples with lower ratios were formed later on as degassing preferentially depleted the mantle rocks of the lighter helium-3.

Science & Society

OSHA ordered to set stricter EtO rule

On March 15, an appeals court overturned U.S. District Court Judge Barrington Parker's order (SN: 1/22/83, p. 55) that the Occupational Safety and Health Administration adopt immediate stricter ethylene-oxide (EtO) exposure standards. The appeals court did concede, however, that OSHA's current timetable for dealing with the chemical is unreasonable (OSHA expects to have a new rule out by late next year), given the growing body of data pointing to the chemical's "grave" hazard. As a result, the appeals court gave OSHA 30 days to propose stricter standards, with an expectation that these new standards will be in place "within a year's time."

An estimated 100,000 U.S. health care workers are exposed to EtO, a confirmed mutagen and suspected carcinogen. Hospitals use the chemical to sterilize surgical tools.

Even as the appeals court was rendering its opinion, Janice Yager and colleagues at the University of California School of Public Health in Berkeley were reporting on the finding of rather subtle chromosome changes — known as sister-chromatid exchanges (SCEs) — in the white blood cells of hospital workers who had been exposed to permissible levels of EtO for as little as 3.6 minutes a day for six months. "These data suggest that EtO elicits an increase in SCE frequency at average levels of exposure that are low in comparison with the current OSHA standard of 50 [parts per million in air]," the researchers said in a March 11 report of their work in SCIENCE. What's more, they noted, their data suggest that "humans may be considerably more sensitive to SCE induction than animals."

Sister chromatids are the two daughter strands of a chromosome after it has duplicated. In sister-chromatid exchanges, chromatids break and mix. When fragments rejoin, they do so with pieces originally belonging to other chromatids, not their own. Slightly elevated sister-chromatid exchange levels do not necessarily signal an individual has been seriously injured. Rather, they may prove a sensitive and early warning of genetic risk: because a number of exchange-inducing agents are known mutagens and carcinogens, sister-chromatid exchange has been proposed as a potential screening test for chemical mutagenicity and carcinogenicity.

When researchers need a child's assent

Not only a parent's consent, but also a child's "assent" will be needed for research involving children that is funded by the Department of Health and Human Services. Beginning June 7, those proposing research on children must follow stricter guidelines to protect a child's rights, "depending on the degree of risk involved . . . and the extent that the research is likely to be a benefit to the subject or relate to a subject's illness." Generally exempted from the new rules, issued March 8, is that research where a child's "public behavior" is observed (by a researcher not actively participating in the child's activities); where data have already been collected or documented; or where educational tests, or accepted educational settings, and practices are used. The rules offer guidelines for determining how and when assent and consent will be needed.

News notes

- The United States claims exclusive rights to all mineral and other resources in waters extending 200 miles from U.S. coasts — some 400 million nautical square miles. President Reagan's March 10 announcement results from objections to deep-seabed-mining provisions of the Law of the Sea Treaty.
- The nation's water use has more than doubled in 30 years, according to the Interior Department. An average of 2,000 gallons per person, or 450 billion gallons of water per day, is withdrawn from the nation's surface and groundwater supplies.