Chemistry

A tight squeeze for high-energy X-rays

To delve into the nooks and crannies of materials whose structures are not well known, scientists often turn to X-rays. Using diffraction, spectroscopy, and small-angle X-ray-scattering techniques, they can reveal the makeup of molecules and materials as diverse as the human cold virus, the enzyme HIV-1 reverse transcriptase, some high-temperature superconductors, and many crystals.

Now, scientists report the highest-resolution scanning X-ray image ever made with hard X-rays. Physicist Donald H. Bilderback of Cornell University and his colleagues report using tapered glass capillaries to condense high-energy X-rays into ultrasmall beams, providing "unprecedented spatial resolution" in some materials. They describe their work in the Jan. 14 SCIENCE.

"This isn't like making an optical image with a lens, as in a camera or microscope," Bilderback says. "A better analogy is a funnel. We're concentrating, or squeezing, the beam down from a big size to a small size, making a thin stream from a thick one, the way a funnel does with water."

To make such an X-ray concentrator, the scientists heated lead glass tubing, then drew out needle-like ends. They then etched a thin gold film with lines 300 nanometers wide. Using the Cornell High-Energy Synchrotron Source for X-rays, they first scanned the film's surface with a beam that was 95 nanometers wide and had an energy range of 5 to 8 kilo-electron-volts. With these tools, they could resolve details on the gold film as small as 50 nanometers wide.

Then, using a slightly wider beam of 360 nanometers, they performed a Laue diffraction on a tiny crystal. There, they successfully resolved the smallest sample ever probed by X-ray diffraction — a volume measuring five one-thousandths of a cubic micrometer.

"Now that we have these small images, we can move other X-ray diffraction techniques down to this scale. From that point of view, it's a breakthrough," Bilderback says. "This technique will be important to material scientists, polymer chemists, or anyone interested in atomic structure. This work will have future payoff in many research areas."

Pesticide breakdown — here comes the sun

The pesticide methyl isothiocyanate, a soil fumigant commonly sprayed on crops, has long caused concern about its ultimate health effects in wildlife and people.

Scientist know that, in the short run, the chemical is highly toxic to pests and irritates human skin and mucous membranes. But its long-term effects remain less clear, including how long the compound persists in the environment. In 1991, U.S. farmers sprayed 21,000 metric tons of metam-sodium, which contains this compound, on their crops.

Ramón A. Alvarez and C. Bradley Moore, both chemists at the University of California, Berkeley, have found that sunlight will effectively break down the pesticide. Based on their results, they say that "photodissociation by sunlight is an effective pathway for its removal from the atmosphere." The report appears in the Jan. 14 SCIENCE.

Measuring the effect of ultraviolet light on methyl isothiocyanate's breakdown in the troposphere, where many sprayed particles end up, the chemists saw the pesticide degrade into methyl isocyanide and atomic sulfur. Exposed to sunlight with a noontime intensity, the compound breaks down within 41 hours, they estimate. Compared to other reactions in the atmosphere or removal by rain, breakdown by sunlight "could be the chief removal pathway" for the pesticide, they conclude.

As a caveat, though, they urge further study of this pesticide's breakdown products to determine their long-term effects on health.

Environment

Making manufacturers come clean

The Environmental Protection Agency plans to require manufacturers to air more of their dirty laundry.

Industries have had to tell EPA how much of 330 toxic chemicals they dispose of, recycle, or discharge into the environment. The agency lists this information in its Toxics Release Inventory (TRI) database, which the public may review. At a Jan. 6 press conference, EPA Administrator Carol M. Browner proposed making manufacturers report 313 additional chemicals. The public has 90 days to comment on the proposed rule, which EPA intends to make final on Nov. 30.

In a separate action, the agency also plans this year to expand the types of industries that must report TRI chemicals, Browner said. Currently, only manufacturers must do so.

The most commonly discharged chemicals that EPA would add to the TRI are carbon monoxide, sulfur dioxide, and nitrogen dioxide. The list also includes common drugs such as tetracycline hydrochloride, an antibiotic believed to harm fetuses, and phenytoin, an anticonvulsive that may have carcinogenic effects. EPA anticipates receiving about 26,000 more reports and hearing from 2,400 more facilities after the rule change.

Environmentalists at the press briefing said that to avoid bad publicity, industries try to reduce their discharges of the chemicals they must report. The TRI, begun in 1989, has provided community activists access to previously unavailable information about local industries.

Expanding the list would "discourage companies from substituting one chemical for another that doesn't happen to appear on the list," said Deborah A. Sheiman of the Natural Resources Defense Council.

The pesticide industry has complained to EPA about the proposal, saying that the active ingredients in pesticides would make up more than half the additions. The amount of pesticide manufacturers discharge "is too small to be of interest to anybody," Kevin Bromberg, a lawyer for two associations representing pesticide companies, told SCIENCE NEWS. EPA only needs to include about 10 of the 170 pesticide ingredients it proposes adding to TRI, he says.

Under the proposed new rule, EPA may excuse from the reporting requirement those companies that have very small or no releases of TRI chemicals, Browner said.

Manufacturers don't have to make public tiny discharges of certain chemicals, but this may change, Browner added. Substances such as dioxins and radionuclides are very toxic even at levels that companies need not report, Sheiman contends.

Where the wild things are

African conservation managers face an urgent question, says Derek Pomeroy of Makerere University in Kampala, Uganda: Which of their protected areas have the greatest value and, therefore, merit the greatest attention?

Pomeroy makes a start at answering that question in the December CONSERVATION BIOLOGY by describing areas of Africa rich in different species of plants and animals.

"In the case of plants, the countries with the highest relative species richness are, in order, South Africa, Tanzania, Cameroon, Gabon, and Swaziland," he writes. In the case of mammals, it's Uganda, Togo, Kenya, Cameroon, and Zaire. Zaire heads the list for butterflies. Nonaquatic bird species tend to concentrate in the vicinity of Mt. Cameroon, the East African Highlands, and parts of Angola. Waterbirds flock to much of eastern Africa, he adds.

Often, but not always, an area is important to more than one taxonomic group, Pomeroy explains. South Africa has probably the highest concentration of species of flowering plants in the world but only a handful of endemic birds.