Atomic shadow-puppetry reveals structure

Those educational films shown in grade school would seem incomplete without little fingers jutting in front of the projector to animate the screen with wiggly rabbits and flying birds. When properly staged, atoms accomplish a remarkably similar effect, according to five chemists who say they have learned both to produce atomic shadow-shows and to interpret them as structural revelations of a solid material's topmost atomic or molecular layers.

The group already has used the new technique — called angular distribution Auger microscopy, or ADAM — to map surfaces of pure metals with and without other atomic or molecular coatings. "It produces very sharp and straightforward images of atomic structure," says research leader Arthur T. Hubbard of the University of Cincinnati.

The first scientists to apply ADAM to their work will be solid-state physicists interested in the details of how atomic layers stack into, say, semiconductor devices such as thin-film lasers, Hubbard predicts. The technique should also prove useful for studying polymer films, catalysts and even dynamic phenomena such as atomic vibrations, he adds.

French researcher Pierre Auger discovered the underlying principle in 1925. Bombarding an atom with radiation, such as X-rays or high-energy electrons, tends to dislodge and expel an electron circling in one of the atom's inner orbitals. A less tightly bound electron orbiting farther away then falls into the more internal vacancy while the atom ejects a third, "Auger" electron. Since atoms of particular elements eject electrons at characteristic energies, measuring the energies of the fleeing Auger electrons identifies the parent atoms. Scientists have used Auger electrons since the mid-1960s to determine the elemental compositions of materials.

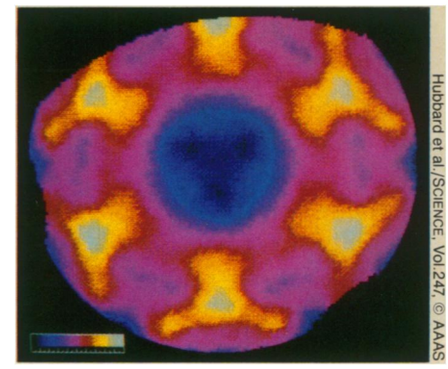
Many researchers have noted that the number of Auger electrons measured varies as the electron detector's angular view of the sample changes. They have attributed these variations to several factors, including diffraction effects and quantum mechanical fluctuations of individual atoms.

By building a novel instrument capable of measuring Auger electrons from any angular perspective, the Cincinnati chemists say they have uncovered a more likely origin for the angular distribution of Auger electrons. "The distributions are composed of 'silhouettes' of surface atoms 'backlit' by emission from atoms deeper in the solid," they write in the Jan. 12 SCIENCE. Computer simulations based on this unconventional interpretation of Auger signals agree closely with data from actual ADAM analyses, they report.

In one example, Hubbard's group analyzed a platinum base coated with a single layer of silver atoms, which in turn was topped with iodine atoms. They used ADAM to map the angular distribution of silver's Auger electrons. "We used the silver monolayer as the light bulbs and the iodine atoms as the shadow-creating scatterers," Hubbard says. Since virtually any element can serve as an emitter or a scatterer, he says the technique should have wide applications in analyzing solids and should also complement other surface-analysis techniques such as scanning tunneling microscopy.

"This thing ought to be checked out a lot more carefully," cautions chemical physicist William F. Egelhoff of the National Institute of Standards and Technology in Gaithersburg, Md. He says the silhouette interpretation flies in the face of several independent quantum mechanical explanations of the distribution of Auger electrons. But chemist Neal R. Armstrong of the University of Arizona in Tucson says chances are good that Hubbard is right and that ADAM will emerge as another useful analytical tool.

— *I. Amato*



Color-coded representation of ADAM data from a platinum surface coated with an atomic layer of silver and then topped with iodine atoms. The central blue circle represents the Auger electron shadow formed by an iodine atom situated directly above a silver atom. Electrons from silver atoms get through to the detector in a hexagonal pattern defined by the overlying, electron-blocking iodine atoms.

Women and alcohol: A gastric disadvantage

It's no secret that men and women respond differently to alcohol. For instance, compared with a man of similar size who has imbibed the same amount, a woman winds up with more of the alcohol in her bloodstream. And women are much quicker to develop alcohol-related ailments, such as liver disease, than are men with the same drinking history. A team of U.S. and Italian researchers now suggests most of the difference traces to the stomach, where gender-related factors appear to influence the activity of alcohol-degrading enzymes.

"This is the first report of this type of enzyme in the human stomach," says coauthor Charles S. Lieber, who directs the Alcohol Research and Treatment Center at the Veterans Affairs Medical Center in New York City. Until now, he says, scientists viewed the liver not only as the major site of alcohol breakdown but also as the place where that breakdown begins. But his team's research, involving 20 male and 23 female volunteers in Trieste, Italy, shows that the same family of alcohol-dehydrogenase enzymes that initiate alcohol breakdown in the liver actually get their first shot at ingested alcohol in the stomach. The group reports its findings in the Jan. 11 NEW ENGLAND JOURNAL OF MEDICINE.

This makes alcohol the only known example of a drug whose "first pass" metabolism is initiated at the stomach wall, Lieber says. Animal data obtained by the same team suggest this pharmacologic phenomenon can remove as much as 20 or 30 percent of the alcohol ingested. But in humans, only men break down such a large proportion of their alcohol in the stomach, the new study indicates. For reasons yet unexplained, among the 31 volunteers who routinely consumed less than 2½ ounces of alcohol weekly, stomach enzymes broke down less than one-fourth as much alcohol in women as in men. The extent of alcohol degradation in the stomach proved even lower among the 12 alcoholics in the study, with the six alcoholic women showing virtually none at all and the six alcoholic men showing only about half as much as nonalcoholic men.

Lieber notes that studies of males reported by his team in the February 1989 GASTROENTEROLOGY indicate that some drugs — including cimetidine, widely prescribed to control gastric ulcers — can inhibit the stomach's first-pass metabolism of alcohol.

"We usually recommend that people drink moderately," Lieber says. But his group's findings suggest clinicians need to redefine moderate alcohol consumption, because "what's moderate for a man is not moderate for a woman" — or for patients taking certain prescription drugs.

This is "very exciting work," comments liver specialist Steven Schenker of the University of Texas Medical School in San Antonio. Not only might it explain why women suffer so much more from alcohol than do men, he says, but it also "opens up a new area of research" — the role of the stomach, including the drug interactions that occur there, in a person's susceptibility to inebriation and alcohol-related disease.

— *J. Raloff*