Atomic faces peek through lead shroud

Scientists can now gaze on silicon through a lead coating as if it were glass. They do this by using a scanning tunneling microscope in a new way. The technique permits the unprecedented feat of seeing individual units of crystal lattice patterns in a silicon surface buried under as much as 10 nanometers of lead.

If the new method can be made to peer through other coatings, in particular those of semiconductors, it may help researchers trying to develop smaller, faster electronic devices, says Dongmin Chen of the Rowland Institute for Science in Cambridge, Mass. Integrated circuits typically employ successive coatings built up on a silicon base. As chip makers shrink circuits ever smaller, making them increasingly vulnerable to tiny defects, researchers will need ways to monitor surface smoothness and atomic order at boundaries between the layers.

Chen, Igor B. Altfeder of Rowland, and Konstantin A. Matveev of Duke University in Durham, N.C. describe their technique in the June 1 PHYSICAL REVIEW LETTERS.

The team's ability to peer through lead relies upon the quantum behavior of electrons in the metal. Consequently, the method also offers a novel way to probe how boundary irregularities alter quantum energy states of electrons, Chen says. The theory behind increasingly popular experiments with confined electrons—held in quantum dots or wells, for instance—assumes perfectly smooth, orderly boundaries, but the real world is not so ideal, he says.

Scanning tunneling microscopes position an extremely fine needle just above a material's surface in a vacuum, detecting electrons that jump, or tunnel, across the gap via quantum effects.

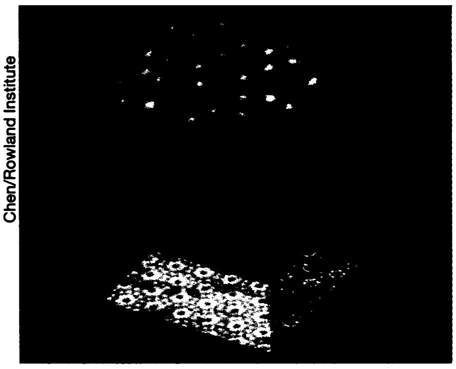
In earlier research, Chen and his colleagues grew flat-topped "islands" of lead on silicon surfaces etched with steps descending one atom per step. The researchers found that the steps buried beneath the smooth lead plateau can be detected as changes in the current flowing through the tip of the microscope. The difference in spacing from step to step causes electrons in the metal, behaving as waves, to alternately add together or cancel as the microscope probe moves across the plateau, Chen explains.

When they started their latest experiments, in which they placed lead onto a flat silicon surface, the researchers laid odds against seeing any fine detail of the silicon's crystal structure. They expected electron waves striking the lead-silicon boundary to splash back in all directions, sloshing into a uniform blur.

To their surprise, the electrons scattering sideways didn't get far before electrons racing vertically breached the lead's top surface, carrying with them an image of the underlying silicon lattice. An asymmetric drag on electrons may underlie the technique's success, the researchers speculate.

Other scientists have used electron microscopes to peer at steps and other boundary features through substances such as silver, but seeing crystal units in the hidden surface is a first, says physicist Ellen D. Williams of the University of Maryland, College Park. "That's very nice," she said of the result. "It's also a really neat demonstration of quantum mechanics." —P. Weiss

Chen/Rowland Institute



Through a lead coating (purple), quantum electron waves project an image (top plane) of the crystal pattern in the underlying silicon layer (bottom plane) to a scanning tunneling microscope probe (blue cone).

Picturing pesticides' impacts on kids

Heavy exposure to pesticides appears to have impaired child development in a Yaqui Indian community in Mexico, a new study finds. However, observes Elizabeth A. Guillette, the University of Arizona anthropologist who led the research, "I don't think the kids' exposures are either more or less than might occur in other agricultural areas"—even in the United States.

Seven years ago, researchers at the Technological Institute of Sonora in Obregón, Mexico, showed that children in Sonora's Yaqui Valley are born with detectable concentrations of many pesticides in their blood and are exposed further through breast milk. Valley farmers apply pesticides 45 times per crop cycle, and they grow one or two crops per year. Area families also tend to use household bug sprays daily. In the new study, Guillette and the Obregón team screened preschoolers for possible behavioral effects of such exposures.

They recruited 33 children from the valley and another 17 from Yaqui ranching villages in the nearby foothills, where families swat indoor bugs and avoid using agricultural chemicals to control garden pests. The foothills' only major exposure to pesticides comes from government spraying of DDT to control malaria.

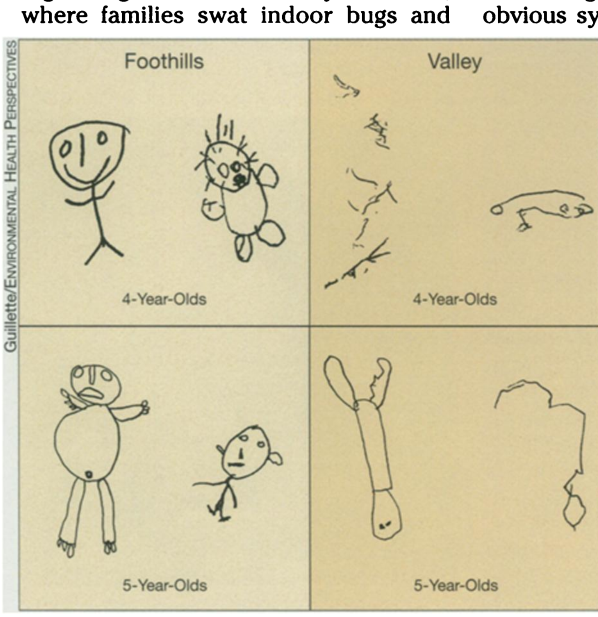
The scientists asked 4- and 5-year-olds to jump up and down as long as possible, catch balls, drop raisins into bottle caps, perform memory drills, and draw pictures of people. In the June ENVIRONMENTAL HEALTH PERSPECTIVES, they report that valley children demonstrated significantly less stamina, gross and fine eye-hand coordination, 30-minute recall, and drawing ability than preschoolers from the foothills communities.

"I know of no other study that has looked at neurobehavioral impacts—cognition, memory, motor ability—in children exposed to pesticides," says neurotoxicologist David O. Carpenter of the State University of New York at Albany. "The implications here are quite horrendous," he says, because the magnitude of observed changes "is incredible—and may prove irreversible."

"Though the children exhibited no obvious symptoms of pesticide poisoning, they're nevertheless being exposed at levels sufficient to cause functional defects," observes pediatrician Philip J. Landrigan of Mount Sinai Medical Center in New York.

"To ignore these data would not be sound," concludes Landrigan, who is directing the development of the new federal Office of Children's Health Protection. — J. Raloff

Guillette/Environmental Health Perspectives



These pictures of people are representative examples drawn by children relatively unexposed to pesticides (foothills) and those heavily exposed (valley).