Microscope writes beneath a metal surface

Physicists have discovered a method for etching microscopic features inside thin sandwiches of metal and semiconductor. The technique may yield new insights into electronic properties of the boundary between metals and semiconductors—a region crucial to the performance of many microelectronic devices. It may also lead to new structures for high-density data storage.

Previously, other scientists have found ways to record microscopic images on the *surfaces* of metals using a scanning tunneling microscope (STM) (SN: 11/17/90 p.310). But the STM couldn't rearrange atoms below the surface – a property essential for etching images there. Nor could it probe internal boundaries between structural materials – zones that can strongly influence the properties of electronic devices.

In 1988, researchers at NASA's Jet Propulsion Laboratory in Pasadena, Calif., developed ballistic electron emission microscopy (BEEM), a new method for investigating microscopic details of the interface between metals and semiconductors. They injected electrons from the tiny tip of an STM into a thin metal layer coating a semiconductor. At high enough energies, some of the electrons not only crossed the metal-semiconductor interface but also passed completely out the other side. How much current passed through both layers depended on the atomic structure of the metal-semiconductor interface at that particular location. Scientists went on to harness this relationship to chart atomic details of the interface.

Using a silicon semiconductor buried under a thin layer of gold, a group of researchers at Cornell University in Ithaca, N.Y., has now applied the BEEM technique at a higher voltage than ever before.

Unexpectedly, the high-voltage electrons rearranged some of the atoms near the interface without altering the gold surface, the team reports in the Dec. 24, 1990 Applied Physics Letters. This does not happen at lower voltages.

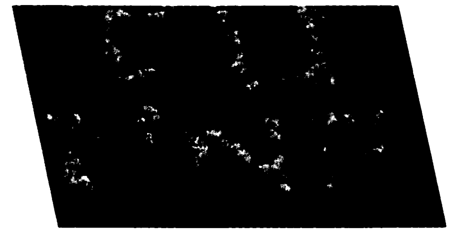
"It was a surprise. We discovered it by a student [Hans D. Hallen] saying, 'What happens if I go to a higher voltage?'" group leader Robert A. Buhrman told Science News.

By slowly moving the STM tip across the gold surface, the investigators found they could create lines at the subsurface interface just 8.5 nanometers wide – about one-ten-thousandth the width of a human hair. This represents the first time anyone has produced characters this small at a boundary between two materials, the researchers believe.

Although they haven't nailed down the mechanism behind the "writing" effect, they suspect that the powerful current moves loosely held gold atoms to form the lines.

"With this technique we can better understand the properties of such interfaces and how they change and deteriorate under electrical stress," Buhrman says. For instance, he says, researchers might induce defects in computer chips and watch them, to better understand how they form. Scientists may also be able to engineer better data storage by "writing" information onto the interfaces, then reading the information back electronically, he says.

The Cornell scientists plan to investigate the cause of the high-voltage effect more carefully and to apply their technique to metals other than gold. Although they're not sure where their studies will lead, "these things have a habit of growing," says John Silcox, who participated in the work. – *R.N. Langreth*



Cornell

After inscribing the letters CU (for Cornell University) and NNF (for National Nanofabrication Facility) using the BEEM technique at high voltages, the researchers used BEEM at lower voltages – which don't alter the metal-semiconductor interface – to record this image. Each letter stands 400 nanometers high.

Historic priapism pegged to frog legs

Collaborators from three universities seem to have solved a 100-year-old medical mystery, linking human consumption of frog legs to cases of priapism, or painful and prolonged penile erection. The research provides the first strong evidence that frog legs indeed caused two outbreaks of priapism reported by French doctors in the second half of the 19th century. But the risk of contracting the excruciating condition from these amphibious delicacies appears extremely small.

As historians with an interest in sexual disorders know, the medical literature links two memorable accounts of priapism to possible dietary causes, both among French soldiers in North Africa. Published in 1861 and 1893, the reports describe cases of "érections douloureuses et prolongées" among soldiers who had recently eaten frog legs.

Attending physicians noted that the symptoms resembled those seen in men who had overindulged in a drug called cantharidin – popularly known as Spanish fly – which is extracted from a particular beetle for its purported value as an aphrodisiac. In one of the North African cases, physicians dissecting a local frog found its guts full of these beetles. Until last month, however, nobody had shown that frogs eating these beetles could accumulate large enough concentrations of cantharidin to cause symptoms in humans who eat the frogs.

Thomas Eisner of Cornell University in Ithaca, N.Y., working with colleagues from the University of Missouri in Columbia and the University of Michigan in Ann Arbor, has now detected such concentrations in the legs of frogs fed experimental diets of cantharidin-producing beetles.

For a few days after eating the beetles, the frogs showed cantharidin levels ranging from 25 to 50 milligrams per gram of thigh muscle, the researchers report in the December Chemoecology. On the basis of sketchy preexisting pharmacological data, Eisner and his colleagues conclude that a meal of the cantharidin-contaminated meat could contain more than enough of the compound to cause priapism.

Gorging on these legs may lead to even more serious problems, Eisner adds. People consuming 200 to 400 grams of Spanish-fly-laden frog thighs in one meal could risk death from cantharidin poisoning, he says.

The work may finally explain what came over those unfortunate French troops, but it leaves several other questions unanswered. Why, for example, aren't frogs repulsed by cantharidin-containing beetles, which secrete the potent inflammatory compound as a defense against predators? To what extent do frogs choose these beetles as part of their normal diet, and what's the actual risk of human poisoning?

Eisner fears that most physicians today might not consider cantharidin toxicity as a cause for the priapism cases they encounter among their patients. Nonetheless, he says the lack of modern reports even hinting at a link between frog leg consumption and priapism suggests the risk is very small.

"I'm not saying, 'Watch out, don't eat frog legs' – although I'd like to say that, because frogs are endangered all over the world," Eisner says. But the work "leaves little doubt" that the North African cases have now been solved, he maintains.

As for cantharidin's effects on the frogs themselves, little is known. Anatomically, "we didn't notice any change whatsoever" in the beetle-fed frogs, Eisner says. However, he adds, "we didn't watch to see how it might have affected their behavior." – *R. Weiss*