Materials Science

Making silver film fall flat

A cross section of a computer chip reveals multiple layers of metals, insulators, and semiconductors—a materials sandwich that would make Dagwood Bumstead proud. Now, researchers have added an improved sandwich-building skill to their repertoire—depositing an especially flat metal film on top of a semiconductor.

In films, flatness denotes flawless crystal structure—a characteristic critical to a chip's performance. Usually, the spacing of the metal and semiconductor atoms must be very well matched, says Chih-Kang Shih of the University of Texas at Austin, a requirement that limits the possible combinations available to manufacturers. However, Shih and his colleagues have found a way to deposit a flat silver film on gallium arsenide, a metal and a semiconductor with very different atomic characteristics.

In addition to the work's potential practical applications, it suggests an "ideal interface" for studying theoretical models of surface interactions, Shih says. The group reports its results in the July 12 SCIENCE.

Silver atoms tend to form islands when deposited onto gallium arsenide at room temperature. To get around this problem, the researchers chilled the gallium arsenide to -138°C, taking away the energy the atoms need to move around. On this cold substrate, the silver atoms collected in nanometer-scale clusters only one-hundredth the size typical of islands at room temperature. Then, after the film warmed back up, the nanoclusters rearranged into a flat film with a critical thickness of 1.5 nanometers.

This particular combination of materials probably won't make "a great impact on any emerging devices," says Lloyd J. Whitman, a physicist at the Naval Research Laboratory in Washington, D.C., who studies the structure of material interfaces. But, he adds, the work may eventually lead to useful systems like aluminum on silicon.

Electricity used to test composites

The secret to the superior strength of many composite materials lies in the bond between the components. A new technique developed by researchers at the State University of New York at Buffalo provides an accurate, nondestructive way to determine the strength of that bond.

The researchers, Deborah D.L. Chung and Xuli Fu, first tested the method on cement reinforced with whisper-thin steel fibers. The prevailing way to assess bond strength is to see how much force it takes to yank out one of the fibers. This pull-out technique often produces a range of values, even for supposedly identical samples. Without any way to cross-check, scientists attributed that variation to experimental error.

The new method, presented on July 23 at the Third International Conference on Composites Engineering in New Orleans, can serve as that check. The researchers attached wires to the fiber and the cement and measured how difficult it is to pass electricity between the two. This value, the contact resistivity, correlated to the subsequently measured bond strength. They concluded that the variation observed in previous pull-out tests represents real differences in bonding, not measurement errors.

So far, the technique seems to work on other composite materials also, as long as they can conduct some electricity. The researchers have tried it on carbon-fiber-reinforced cement, as well as on concrete reinforced with thick steel rods—"the same idea on a bigger scale," Chung says. Once the method is refined, scientists expect to predict bond strength from resistivity—eliminating the need to pull out fibers. "Measuring bond strength always meant breaking things," Chung says. "This is a nondestructive way to measure it."

Nutrition

Get Granddad to take his vitamin E

While it's not a fountain of youth, it sometimes resembles a spring of middle age. In a variety of studies, the antioxidant tocopherol—better known as vitamin E—has exhibited an impressive ability to retard not only some features of atherosclerosis and cancer, but also the development of cataracts and other degenerative conditions that accompany aging.

Now comes a study in the elderly that addresses the overriding question: Does the supplement lengthen life?

Katalin G. Losonczy and her colleagues at the National Institute on Aging in Bethesda, Md., analyzed consumption of the antioxidant vitamins C and E among 11,178 people age 67 to 105. In the 6 years during which their health was followed, 3,490 of these men and women died. After adjusting for age and sex, the NIA researchers found that individuals who were taking vitamin E capsules at the time of the initial questionnaire were only two-thirds as likely to have died during the course of the study as those who hadn't taken the vitamins.

Indeed, vitamin E users were only half as likely to die of heart disease as those taking no supplements and just 77 percent as likely to die of cancer, Losonczy's team reports in the August AMERICAN JOURNAL OF CLINICAL NUTRITION. Tocopherol's benefits were even more pronounced in people who had taken the vitamin for a long time—through at least two questionnaires, administered 3 years apart. Compared to those eschewing supplements, they were less than 40 percent as likely to have died of heart disease and 41 percent as likely to have succumbed to cancer.

Vitamin C supplements alone had no apparent effect on death rates from any cause, nor did consumption of multiple-vitamin and mineral supplements, though the latter probably contained small amounts of extra E. The reason may trace to dose. Although Losonczy and her coworkers had no data on the amount of vitamin E in the supplements that had been consumed, they note that most vitamin E capsules contain at least 100 international units—more than three times the amount typically found in multivitamin supplements.

A food preservative from what?

The same oxidative reactions that can contribute to degenerative disease in people also occur in what they eat—causing rancidity and spoilage. Manufacturers must rely on antioxidants to preserve food quality. In recent years, a move has been afoot to substitute natural alternatives for these largely synthetic chemicals. Among the more exotic candidates is an extract from the sperm glands of salmon.

To protect sperm from potentially mutagenic damage by oxidants, the salmon bathes the tissue surrounding these germ cells with antioxidants. Since fish processors generally discard sperm glands, Eric A. Decker of the University of Massachusetts in Amherst and his colleagues at the Hokkaido (Japan) Food Processing Research Center investigated recycling it into a food additive.

A colorless, flavorless extract of this tissue, containing just its smallest molecules, proved highly effective in curbing the oxidation that damages red-pigmented protein in meat, they now report in the July JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY. The surprise, Decker says, is that the known antioxidants that they expected to be protective—compounds with such unappetizing names as putrescine, cadaverine, spermine, and spermadine—accounted for only a small fraction of the effect. His Hokkaido colleagues are now homing in on what's responsible for the bulk of the protection.

While Decker suspects that people in the United States will turn up their noses at fish-derived food preservatives, he has higher hopes for Asian cultures. Indeed, a few Japanese grocery stores currently market salmon sperm glands as food.