Liquids that tiptoe on the edge of solidity

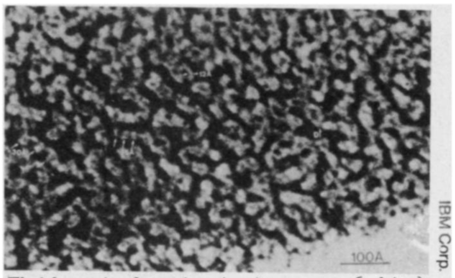
In extremely tight spots, liquids get away with some very unliquid-like behaviors, often masquerading as solids. Some refuse to freeze even when chilled far below their freezing point for weeks at a time. These surprising findings, described this week in separate reports at a meeting of the Materials Research Society in Boston, may help chemists to design better lubricants, electronic engineers to build faster chips, and petroleum hunters to detect hidden oil reserves.

In one set of studies, Jacob N. Israelachvili and his colleagues at the University of California, Santa Barbara, measured physical properties of ultrathin liquid films — sometimes no more than a single molecule deep — confined between a pair of supersmooth mica plates. With the plates far enough apart to sandwich at least 10 layers of liquid molecules, the molecules behave like a "normal," bulk liquid in a beaker. But pinching the plates together so that only a few molecular layers can squeeze between them elicits deviant behavior. "We get liquids that behave like solids," Israelachvili says.

These rigid liquid films display the orderly molecular arrangement of a solid. But when the researchers briefly apply a shear force by sliding the plates across each other, the molecules "melt" into the disordered structure of a liquid or a partially ordered, liquid crystalline state before "refreezing" into a solid-like state.

Israelachvili reports that the liquid films under shear force can have viscosities surpassing those of their bulk-liquid counterparts by a factor of 10 billion. That's such a dramatic difference that he now questions whether viscosity — a fundamental property of bulk liquids and liquid lubricants — can apply to ultrathin liquid films, which seem to hover on the edge of solidity.

In other studies, a team led by David D. Awschalom of IBM's Thomas J. Watson Research Center in Yorktown Heights, N.Y., confined fluids within tiny compartments — some no more than 20 atoms across — in specially prepared glass blocks. Even when chilled as much as 40 percent below their normal freezing temperatures, liquid oxygen and some other fluids can spend weeks in a remarkably stable liquid state, the researchers report. Awschalom suggests chip designers might exploit the effect to cool superdense circuitry with minuscule "integrated refrigerators," consisting of channels micromachined into the chip's silicon base and filled with a supercooled fluid.



IBM Corp.

Fluids resist freezing in tiny pores (white) in a glass block.

The group also found that sound travels through the confined, supercooled fluids at the same speed and dampens over the same distance as it would in a solid. Usually, sound travels more slowly and dampens more quickly in liquids. Awschalom speculates that arctic oil hunters who rely on sound data may mistake supercooled oil for rock.

— I. Amato

Genetic propensity to common cancers found

Researchers have identified an inherited gene defect that heavily predisposes individuals to breast cancer and some other malignancies. Cancer scientists say the finding provides a new window on the molecular underpinnings of hereditary cancers and should lead to tests that identify people likely to get the diseases.

"All this will presumably be extremely helpful in early diagnosis of people at risk," says David Malkin of the Massachusetts General Hospital Cancer Center in Boston, who participated in the research effort. "We'll be able to say, 'Yes, you carry this mutation . . . and you are at risk,' or 'No, you don't.'"

Early diagnosis and treatment provides the best insurance against death from cancer, Malkin and others note. In the case of breast cancer, women who recognize they are at high risk may initiate a range of options from frequent breast exams to hormonal therapy to — in extreme cases — preemptive mastectomy.

The discovery emerged in a study of a rare syndrome called Li-Fraumeni. Family members who inherit the condition have healthy childhoods. By age 30, however, nearly 50 percent develop one or more of several different cancers, including brain tumors, osteosarcoma, leukemia, and especially breast cancer. More than 90 percent develop cancer by age 70. In the Nov. 30 Science, Malkin and researchers at four U.S. medical centers describe five Li-Fraumeni families in which individuals with syndrome-linked cancers all carry inherited mutant versions of a gene called p53, while most unaffected members do not.

"It's a very important finding," says Alfred G. Knudson of the Fox Chase Cancer Center in Philadelphia, who has followed the work. Until now, he says, the only gene defects known to cause adult cancers were those that accumulated through a lifetime. "Now for the first time we have a gene in the germ line shown to be a high risk factor for a common adult cancer, namely breast cancer."

Scientists are familiar with the p53 gene, which in its normal form helps control cell division and prevent cancer. Indeed, researchers frequently find damaged p53 genes in tumor cells from noninherited cancers, but the gene's role in inherited cancers went unrecognized. The question, Knudson explains, has been whether p53 simply exacerbates the effects of other cancer-causing genes or whether it's a major player on its own. He says the new study "shows that it can be very, very critical indeed."

Malkin says he and others are now screening broader populations of cancer victims to see what percentage of various malignancies may be due to flawed p53 genes. "We're not suggesting that every familial cancer syndrome involves p53," he says. "But the data suggest it may be a very important player in breast cancer."

Still, says co-author Stephen H. Friend of Massachusetts General, "People shouldn't think that p53 is *the* gene for hereditary breast cancer, because there are likely to be several of them. We have no idea what various genes may be responsible for this very heterogeneous group of diseases we call hereditary breast cancer."

— R. Weiss

San Andreas fault may have many faces

A close examination of last October's Loma Prieta earthquake and the great San Francisco quake of 1906 has yielded a surprising conclusion: The two shocks appear to have ripped different faces of the San Andreas fault. If so, geoscientists may have underestimated the seismic hazard remaining in the Santa Cruz region after last year's deadly jolt.

"We have to be awfully cautious about saying we understand a certain area and we know what its seismic potential is," says Paul Segall of Stanford University and the U.S. Geological Survey (USGS) in Menlo Park, Calif.

Both the 1989 and 1906 earthquakes broke the San Andreas fault on a segment that runs through the Santa Cruz Mountains. To compare the two events, Segall and Mike Lisowski of the USGS examined surveying data indicating how Loma Prieta Mountain (part of the Santa Cruz range) shifted during each quake.

For last year's quake, scientists gauged ground changes in the region with lasers, satellite signals and even the radio waves from distant quasars. These measurements were then fed into computers.

At the turn of the century, however, surveyors used telescopes to judge the angles between mountaintops and then