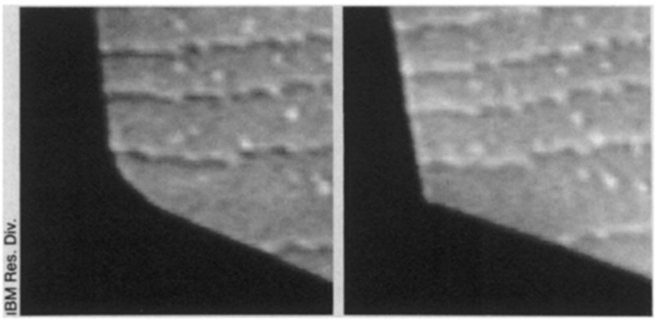
Shape oscillations mark crystal growth



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Sharpening of a corner occurs during growth of a silver crystal on a silicon substrate. Horizontal lines represent steps at the silver-silicon interface.

Salt crystals grown by slow evaporation of water from concentrated brine generally develop a characteristic cubic shape with sharp corners and flat faces. In contrast, crystals produced by vapor deposition — in effect, one atom at a time — can actually oscillate in shape between a sharp-cornered and a round-cornered form as they grow.

This novel, cyclic phenomenon, first observed by researchers at the IBM Thomas J. Watson Research Center in Yorktown Heights, N.Y., is most apparent when the growing crystal is small—only 1 micron or so in size. As the crystal gets larger, the physical conditions responsible for the shape oscillations exert less influence, and the crystal reverts to its sharp-cornered form.

Under certain growth conditions, "small crystals differ from large ones in a fascinating and unanticipated way," Jerry D. Tersoff, A.W. Denier van der Gon, and Rudolf M. Tromp report in the Feb. 22 PHYSICAL REVIEW LETTERS. Their theoretical analysis reveals that shape oscillations are a "fundamental feature of the equilibrium shape of small crystals."

Tromp and van der Gon first noticed these surprising oscillations while studying the growth of silver crystals by depositing silver atoms onto a silicon surface. At first, the researchers assumed that the shape oscillations they unexpectedly observed were an artifact of their technique. But further analysis by Tersoff suggested thermodynamic reasons why such cyclic shape changes could occur naturally under the given conditions.

Made up of ragged steps, a crystal's rounded corners are actually quite rough on an atomic scale. Thus, a small, rounded crystal has rough corners and smooth, flat faces.

Because atoms require less energy to settle in a rough region than to start the formation of a new layer on a smooth face, they first go exclusively to the corners. Eventually the corners fill in, and deposited atoms have no other choice but to start forming an "island" on a smooth face.

Once established, this island acts as a reservoir, absorbing extra atoms from the corners, which become rounded again. After the island grows into a complete layer on one face, additional atoms have nowhere to go but the rounded corners, and the cycle begins again. *— I. Peterson*

No-'stick' tips for heart-healthy diets

With the addition of hydrogen, unsaturated oils undergo a transformation that straightens out a kink in their natural form. These stiffer "trans" fats permit stick margarine and shortening to remain solid at room temperature, as saturated fats do. But new research with human volunteers now confirms earlier reports that such fats also increase cholesterol concentrations in the blood.

Three years ago, a Dutch team came to the same conclusion (SN: 8/25/90, p.126). But that group fed a laboratory-concocted margarine-like product to young, healthy volunteers eating a traditional, high-fat diet.

"We took that a step further," says Alice H. Lichtenstein of the U.S. Department of Agriculture (USDA) Human Nutrition Research Center on Aging at Tufts University in Boston. Americans typically derive 35 percent of their calories from fat; she cut fat in her trials to 30 percent of calories, a level the American Heart Association recommends.

Her team then recruited 14 men and women age 44 to 78 with "borderline high" cholesterol (238 milligrams of cholesterol per deciliter of blood) and charted changes as they switched between a typical U.S. diet and two 32-day diets, all with the same number of calories. The first alternative derived two-thirds of its fat from corn oil, the second from a commercial corn-oil margarine. Both corn-oil-based diets contained proportionately about half the saturated fat of the baseline diet.

Many lipids in the blood fell in both the lower-fat and less-saturated-fat diets, Lichtenstein's team writes in the February ARTERIOSCLEROSIS AND THROMBOSIS. But compared to margarine, liquid corn oil fostered larger drops: 12.7 versus 7.4 percent in total blood cholesterol and 17.4 versus 10.4 percent in "bad," or low-density-lipoprotein, cholesterol.

These results "are very definitive" in pointing out the advantages of reducing overall fat and switching to products that contain unsaturated fats, says Lichtenstein. An even longer, more involved study by USDA scientists in Beltsville, Md., finds much the same thing, says Joseph T. Judd, who led the still-unpublished trial involving 29 men and an equal number of women.

The USDA group's paper "adds one more block to the argument that trans fatty acids should be reduced in the American diet," says Scott M. Grundy of the Center for Human Nutrition at the University of Texas Southwestern Medical Center in Dallas. However, he says, stick margarine "is still better [for the heart] than butter — by far." And soft margarine — with less trans fat — is better than hard, he adds.

David Kritchevsky of Philadelphia's Wistar Institute also notes as interesting the Boston group's finding that margarine did not raise concentrations of the cholesterol carrier Lp(a) in the blood; it had in the Dutch study. This might prove important, he argues, since high Lp(a) can slow the natural breakdown of blood clots — a leading cause of strokes and heart attacks. *— J. Raloff*

Probing the ancestry of supernova 1987A

Six years have passed since astronomers witnessed the dazzling debut of supernova 1987A, glowing with the luminosity of 100 million suns. While the brightness of this exploded star has waned, the intense interest in it remains. Astronomers are still puzzling, for example, over the character of the star that gave birth to this nearby supernova.

A new model supports speculation that the parent star did not live its life as a loner. Rather, it may have had an orbiting companion that significantly influenced its history.

The new study attempts to explain a ring of fluorescent gas surrounding supernova 1987A that formed from material ejected by the supernova's parent star more than 20,000 years before the explosion occurred. During that era, the compact parent evolved into a bloated star known as a red giant, which blows a low-speed, high-density wind of material into space. Later, just a few thousand years before the supernova explosion, the red giant apparently lost some of its girth, forming a blue giant, which emits a faster, lower density wind. In time, this wind caught up with the wind from the red giant. The resulting collision compressed the gas in the red giant wind, sculpting it into a shape that became visible when