University of Copenhagen, "Both records cannot be correct." In fact, Dansgaard concludes gloomily, "maybe neither is."

Though the news is disappointing, the problems aren't all that surprising, the ice corers note. At depths corresponding to the interglacial period, just a few hundred meters above the bedrock, the record is vulnerable to distortion by ice flow. At those depths, "there are much higher stress levels," says Ken Taylor of the Desert Research Institute, who works on GISP2. "If you're going to run into problems, you'd expect it to be there."

The crushing pressures can thin softer ice layers or even squeeze them out of the layer-cake climate record altogether, like ripping random pages out of a novel. And the flow of ice across the bedrock generates shear stresses that can fold the layers, sandwiching older ice between younger or vice versa. That process could create the appearance of an abrupt climate shift where none had occurred, says Taylor—as if a key scene had been inserted in the wrong chapter.

Ice from the lowermost 200 to 300 meters of the GISP2 core shows ample signs of trouble. The millimeters-thick annual layers of ice are tilted and contorted, in places vanishing entirely. And those small-scale disturbances probably signal bigger trouble, says Taylor, including folding that could seriously scramble the chronology.

Some GRIP investigators, however, aren't ready to abandon their conclusions about interglacial climate just yet. They are pinning their hopes on the fact that the first tilted layers found so far in their core are more than 100 meters lower than they are in the GISP2 core. That raises the possibility that the GRIP core's record of the last interglacial has escaped distortion, says Dansgaard. On the other hand, Taylor reported that he could correlate some features in the two electrical conductivity records only if he assumed that squeezing and folding began at the same place in both cores, casting doubt on the idea that GRIP has an extra 100 meters of clean ice.

Until investigators know for sure whether or not the GRIP record can stand on its own, their conclusions about the last interglacial are as unstable as they recently assumed the interglacial climate was. Researchers are now discussing one way to get a firmer answer: measuring an isotopic signal in ancient air trapped within the GRIP ice to see whether it matches readings from Antarctic ice dating from the last interglacial period. A good match might bear out the GRIP investigators' hopes that they have an accurate record of the last interglacial. But if not, disappointed investigators will be left scrutinizing the crystal fabric and chemical makeup of the ice cores for ways to write the true version of this climatic mystery story.

–Tim Appenzeller

MATERIALS SCIENCE

Is the Future Here for Gallium Arsenide?

In the world of semiconductors, where silicon is king, a cynical jest has circulated for years among materials scientists. Gallium arsenide, they say, is the material of the future—and it always will be. Over the years this promising material—which can be six times as fast as silicon in microelectronic circuits—has proven less reliable and more difficult to exploit than silicon. Now, Gallia Inc., a small startup company in Weston, Massachusetts, hopes to change that by eliminating a key barrier to the compound's application in semiconductor manufacture.

Specifically, the obstacle is an inability to easily coat the compound with a stable, protective layer of insulation, a process known as passivation. Without such a layer, it is impossible to take full advantage of gallium arsenide's electrical properties and create, for instance, a counterpart to the most popular type of silicon transistor. But at a recent materials meeting,* Gallia scientist Andrew MacInnes reported that his company can for the first time permanently passivate gallium arsenide with a novel form of gallium sulfide.

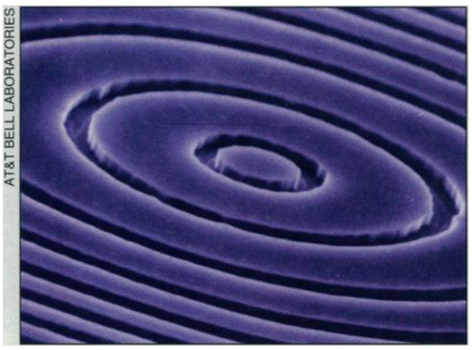
If Gallia's new passivation method meets industry approval, it could boost the material's fortunes and may one day lead to more robust and powerful lasers, better solar cells, and faster microcircuits. "It's very interesting work. They've done a good job," says passivation expert Jerry Woodall of Purdue University. He adds, however, that industry's proficiency with silicon is now so great that even passivating gallium arsenide may not be enough to dethrone silicon.

Gallium arsenide's promise has intrigued researchers for years, not only for its speed, but because gallium arsenide is a direct-band gap material. That means that it can easily absorb and emit light, making it a natural choice for photonics applications and solar cells and lasers. Yet gallium arsenide has always lagged behind silicon, in large part because silicon can be easily passivated by a simple thermal oxidation procedure that creates a shell of silicon dioxide.

But because gallium arsenide doesn't form a passivating oxide layer, researchers were forced to take another tack. Six years ago, for example, Claude Sandroff and his colleagues at Bell Communications Research discovered they could passivate gallium arsenide by immersing it in solutions of inorganic sulfides, a process that formed a few monolayers of gallium sulfide on the surface (*Science*, 2 October 1987, p. 27). But this approach does not lend itself to large-scale commercial application, especially since the coatings quickly decay when exposed to air.

MacInnes and his colleagues at Gallia have now improved on Sandroff's approach. In their work, spun off from research at Harvard University and the National Aeronautics and Space Administration, they use chemical vapor deposition (CVD) to lay down stable layers of a novel cube-shaped gallium sulfide crystal onto gallium arsenide. In this process, an organic gallium sulfide precursor molecule is vaporized, releasing gallium and sulfur atoms that combine to form gallium sulfide molecules that are deposited onto a substrate. The CVD method should be easy to integrate into current semiconducting manufacturing, MacInnes says.

Gallia is exploring several immediate applications for its new technique. The company has shown, for instance, that their passivated gallium arsenide lasers operate at much higher powers than conventional gallium arsenide lasers without blowing up. Another company goal is to find out more about the properties of their gallium sulfide: It, too, is a direct band-gap semiconductor, one that might be used to make an ultraviolet laser.


AT&T BELL LABORATORIES

Coming on target. Passivation may improve gallium arsenide lasers like this one.

There is another, more far-reaching hope as well. Silicon has so dominated the semiconductor industry partly because its silicon dioxide coating allows the creation of a switch called a MOSFET (metal oxide semiconductor field effect transistor), which is used in almost every digital circuit. At the meeting, MacInnes asserted that, thanks to their new passivation technique, they can now make a MOSFET-like switch with gallium arsenide. There have, however, been false claims of gallium arsenide MOSFETs in the past, so Gallia's claim will certainly meet skepticism for some time. As Sandroff, who now consults on surface passivation, points out, "So far no one has been able to do it." Gun-shy after all these years, it seems that no one is about to predict the gallium arsenide revolution until it happens.

–John Travis

* *The Materials Research Society meeting was held from 29 November to 3 December in Boston.*