ELECTRONICS

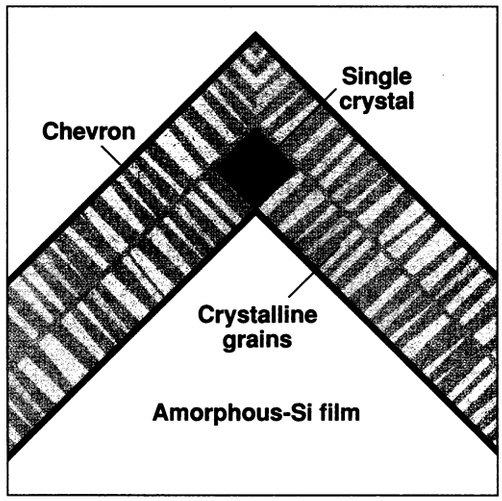
Bringing Order to Amorphous Silicon

SAN JOSE, CALIFORNIA—Amorphous silicon is the semiconductor of choice for large-area, low-cost electronics such as solar cells and the displays in laptop computers because it can easily be laid down from a vapor over large areas. But its disordered arrangement of atoms cuts into the performance of these devices. To do better, manufacturers would have to turn to single-crystal silicon (the material used for high-end computer chips), but it is prohibitively expensive to put down as a thin film over a large area. Now a team of researchers from Columbia University in New York City may have found the perfect compromise.

At the Photonics West meeting here last month, materials scientists James Im, Robert Sposili, and Mark Crowder reported that they have come up with a laser technique that allows them reliably to create islands of crystalline silicon in a thin amorphous silicon film. Their colleagues, Paul Carey and Patrick Smith at Lawrence Livermore National Laboratory in California, then crafted transistors over these crystalline regions and found that they performed as well as devices made on conventional crystalline silicon wafers. The new technique "is definitely of interest," says Jim Boyce, a silicon device expert at the Xerox Palo Alto Research Center in California, adding: "This may well be a scheme that provides the path to single-crystal silicon" for large-area electronics.

Im and his colleagues are not the first to try crystallizing amorphous films with laser light, which can break bonds in an amorphous material, allowing the atoms to rearrange themselves into a crystalline form. Using powerful ultraviolet beams, other groups have managed to create crystalline silicon, but the results have been inconsistent and impossible to control. Instead of reconnecting into a continuous crystalline lattice, the atoms often formed an array of tiny crystallites or some other amorphous jumble.

Two key innovations enabled Im and his colleagues to produce large islands of crystalline silicon reliably. The first was to start small, melting a region just a few micrometers across. The second was to shine their laser light in bursts through a chevron-shaped slit in a metal template, or "mask." The bursts melt the amorphous silicon film just in this region, which cools and begins to solidify almost instantly. The chevron shape is important because as the silicon resolidifies, it preferentially forms elongated crystalline grains. The grains grow from the outer edges of the chevron into the melted region in the middle, orienting themselves perpendicularly to the edges. This produces an unusual result just below the peak of the chevron: Here the initial grain boundaries growing up from the bottom edge of the chevron's two arms diverge, leaving a diamond-shaped single-crystal region in the middle.



R. SPOSILI *ET AL.*, COLUMBIA

Fine point. Melting amorphous silicon through a chevron-shaped mask is key to creating single crystals.

To expand this region, the researchers simply move the mask up about a micrometer and hit the silicon film with another laser pulse over an area that overlaps the first chevron. The light melts the new amorphous silicon and part of the crystalline silicon produced by the previous pulse. As this new melted region cools and solidifies, its structure follows that of the crystalline area produced earlier. By simply repeating the process over and over, the researchers could grow crystalline regions 100 micrometers square, which they then patterned with working high-performance transistors. By shining laser pulses through masks bearing thousands of chevron-shaped slits at once, Im and his colleagues can grow thousands of crystallites in parallel, patterning a region the size of a display screen in less than 5 minutes, he says.

"Melting and resolidifying materials is one of the oldest technologies around," says Im. But in this case it may bring new order to future high-tech electronics.

–Robert F. Service

BIOMEDICAL FUNDING

New NIH Grants for Clinical Research

Research that involves human subjects makes heavy demands on hospital staffs, requires complex ethics reviews, and burns up lots of money. And insurers don't want to pay for it, says William Crowley Jr., director of clinical research at Massachusetts General Hospital in Boston. As a result, he says, young doctors "have been getting killed" by the adverse economics of this field. Last week, National Institutes of Health director Harold Varmus offered some relief: He unveiled three new NIH grant programs designed specifically for clinical researchers.

Speaking at the Howard Hughes Medical Institute in Chevy Chase, Maryland, on 23 February, Varmus sketched out details of these new awards for the first time. Each is meant to provide assistance at a different level of the system:

- For young M.D.–investigators going into clinical research, NIH is creating a new category of "career development awards" that will provide up to $75,000 per year to cover 75% of the salary of M.D.s who have finished their specialty training and have committed to a research career. These grants, known as K-23s, will also provide $20,000 to $50,000 per year for research support. NIH hopes to make 80 of these awards in 1999, and the total would level off at about 400 after 5 years.
- NIH is also planning to provide new grants (K-24s) to "particularly talented early- and midcareer investigators doing clinical research" who want to train new investigators. The 5-year grants will provide $62,500 to support 50% of the investigator's salary and $25,000 annually for research assistance. They will be renewable once. Varmus said the goal is to make 50 to 80 awards in 1999, leveling off in 5 years at a total of 250 to 400 grants.
- To help institutions develop curricula for clinical researchers, Varmus said, NIH will establish a new category of 5-year renewable grants, each worth $200,000. He said NIH hopes to award 20 of these grants.

Clinicians such as Crowley and neurologist Guy McKhann of Johns Hopkins University, who have been appealing for help from NIH for some time, said they welcomed the new initiatives. And William Kelley, dean of the University of Pennsylvania School of Medicine, expressed approval from the audience at the Hughes meeting. "Harold," he said, "that's great news."

–Eliot Marshall