Superconductivity: Two teams, one view

Progress in science depends on independent confirmation of research results. But rarely does a finding receive simultaneous verification, as it did in recent work with high-temperature superconducting films. Using scanning tunneling microscopy (STM), U.S. and European research teams have produced strikingly similar images of the surfaces of ceramic thin films. These images show that the films have a rough topography landscaped with spiraling terraces.

Christoph Gerber and four co-workers at the IBM Zurich Research Laboratory in Switzerland report in the March 28 NATURE that yttrium-barium-copper-oxide ceramic films contain several billion of these spirals, called screw dislocations, per square inch. And in the March 29 SCIENCE, Marilyn Hawley and her colleagues at the Los Alamos (N.M.) National Laboratory report nearly identical results.

The consistency of the new images provides "a good affirmation of scientific research," says physicist Theodore H. Geballe, a superconductor specialist at Stanford University. "And it shows that nature is consistent from one side of the Atlantic to the other."

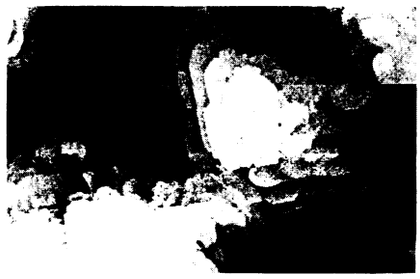
The detailed resolution of STM, which produces three-dimensional, atomic-scale views of surfaces, helped the two teams resolve that these films start out as islands of material and do not build layer by layer as some had thought, says Ian D. Raistrick, a materials scientist with the Los Alamos group. The islands grow by spiraling up and out until the spirals merge with adjacent islands.

The findings partly explain why these films make such good superconductors, and they point to ways to improve this property.

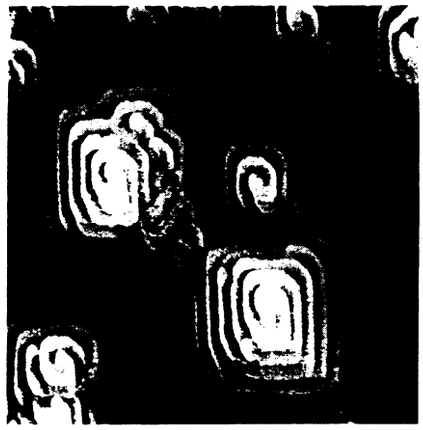
Geballe cautions, however, that the work "is very enlightening for one class of films, but it doesn't cover all films." Both teams used films made by a process called sputtering, one of several approaches to producing thin films.

Although superconductors conduct electricity with almost no resistance, this ability disappears when they try to conduct large currents. The problem is that conduction generates a magnetic field that interferes with electron flow if the current – and consequently the magnetic flux – is strong enough.

Superconducting thin films can handle much more current than can bulkier forms such as wires. Experts theorize that microscopic defects enhance the thin film's superconducting properties because the flux gets stuck, or "pinned," in the defects and can no longer impede conduction. "In these materials, one would like to have as many pinning sites as possible," physicist Darrell G. Schlom of the IBM team told SCIENCE NEWS.



IBM Research



Hawley/Los Alamos National Lab.

Whorls apart? These STM images, made by separate research teams in Switzerland (left) and the United States, provide remarkably similar views of the terraced surfaces of superconducting films.

The spirals provide pinning sites, the IBM scientists say. Increasing the number of spiral defects might increase the amount of current a superconductor can carry, they suggest.

Defects that form where the grains meet may actually be more important pinning sites than the spiral cores, the Los Alamos group proposes, because these imperfections are much more numerous. Introducing such defects might improve the superconductivity of wires and other bulk forms, Raistrick says.

Either way, says Schlom, the new findings imply that "if we can control the defects, maybe we can control the properties [of the superconductor]."

– E. Pennisi

Virus-smoking synergy causes malignancy

A sexually transmitted virus and a carcinogen found in tobacco smoke apparently join forces to cause mouse malignancies that resemble human cervical cancer, according to early results from an ongoing laboratory study.

The research may eventually yield the first laboratory model of human cervical cancer, giving scientists a long-awaited glimpse into the cellular transformation that leads to the deadly disease, says Randall E. Harris, an epidemiologist at Ohio State University in Columbus.

Cervical cancer kills approximately 4,500 women in the United States each year. While epidemiologic studies have suggested a link with cigarette smoking (SN: 3/18/89, p.166), some scientists believe smoking alone does not heighten the risk of developing the disease. They point to research indicating that only smokers infected with certain types of human papillomavirus (HPV) show an increased incidence of cervical cancer.

A team led by Lenora R. Garrett at the Fred Hutchinson Cancer Research Center in Seattle now presents the first demonstration that HPV and tobacco toxins can join together in a cancer-causing partnership. Garrett reported the group's preliminary data last week at the American Cancer Society's annual science writers' seminar in Phoenix, Ariz.

The researchers started by culturing normal epithelial cells obtained from human foreskin samples. These skin cells resemble the epithelial cells lining the cervix but are easier to grow in the laboratory, Garrett explains. The team inserted DNA from HPV-18 – one of the papillomaviruses previously linked to cervical cancer in smokers – into the epithelial cells and then doused those cells with low doses of N-nitrosomethylurea, a cancer-causing chemical derived from the nicotine in tobacco smoke. After 24 hours, they harvested the treated epithelial cells and injected them beneath the skin of mice.

Six weeks later, 20 of the 24 mice injected with the treated cells had developed malignant tumors resembling those of humans with cervical cancer. When the researchers removed and analyzed the tumors, they detected chromosome damage associated with the loss or inactivation of genes responsible for controlling normal cell growth, Garrett says.

Another group of 24 mice received epithelial cells treated with HPV-18 or N-nitrosomethylurea, but not both. None showed evidence of tumors during the six-week study.

Garrett and others speculate that a two-step process sets the stage for human cervical cancer. HPV delivers the first blow by causing epithelial cells to divide rapidly, she explains. These proliferating cells, though not invasive, will then progress to malignancy if exposed to a second insult – in this case, the carcinogen from tobacco smoke, Garrett suggests.

The Seattle team now hopes to demonstrate the virus-smoking synergy in experiments with human cervical cells. The researchers recently took the first step toward that goal, Garrett says, by getting human cervical cells to grow in a laboratory culture.

– K.A. Fackelmann