1-2-3 contact: A new superconducting film

Using high-temperature superconductors for magnetically levitated trains and loss-free transmission of electricity remain dreamy prospects. But researchers have had success in depositing working thin films of the poorly understood superconductors onto silicon and other materials. New microwave communications technologies and faster computers made with denser, speedier chips may emerge as the first practical payoffs of the new superconductors, they say.

In new studies that complement and build on earlier ones, materials scientist Jagdish Narayan and his graduate students at North Carolina State University in Raleigh have developed a relatively low-temperature technique for depositing thin films of the now famous "1-2-3" superconductor – composed of one part yttrium (as counted by atoms), two parts barium, three parts copper and roughly seven parts oxygen – onto several materials including silicon, the basic substrate for most electronic devices.

The Raleigh researchers first vaporize small portions of a 1-2-3 pellet with laser pulses. An electrically charged ring between the pellet and the heated substrate, such as silicon or strontium titanate, steers vaporized ions to the substrate and homogenizes their speeds to ensure a smooth layering, Narayan says. A nozzle near the substrate adds oxygen, resulting in a 1-2-3 superconducting film thoroughly aligned with the underlying substrate's crystal structure. At the highest processing temperature his group studied, 650°C, "these films are defect free," Narayan told SCIENCE NEWS. At the lowest temperature, 500°C, the films and alignments are less pristine, he notes.

In a paper scheduled to appear in the June 5 APPLIED PHYSICS LETTERS, the scientists claim their crystalline films are near-perfect, stable and capable of carrying record-high currents, although other researchers point out that no standards have been established for measuring the currents and temperatures. Narayan's group also reports depositing its films at temperatures roughly 100°C cooler than previously reported by his group and others. Lower processing temperatures minimize chemical reactions and physical movements that can disrupt the substrate/film interface. But since lower temperatures also reduce the films' crystalline quality, choosing processing conditions is a delicate balancing act.

Getting the 1-2-3 films onto silicon has proved difficult because the two materials' crystal structures do not exactly match and they expand and contract at different rates as the temperature changes. After such hybrid structures are cycled through temperature ranges, "the films begin to look like the bottom of a riverbed," remarks physicist Venky Venkatesan of Bell Communications Research (Bellcore) in Red Bank, N.J. Moreover, silicon cannot withstand the higher processing temperatures typically used for making bulk 1-2-3 superconductors.

To overcome these incompatibilities, researchers can use expensive strontium titanate as a sort of material diplomat. Even at lower processing temperatures, strontium titanate's crystal structure can accommodate silicon on one side and the 1-2-3 superconducting films on the other to form a less stressed and more stable three-layer structure. Still, for commercial applications, Narayan and others continue to seek cheaper processes that do not require the extra layer.

In the past months, researchers at Bellcore, Hitachi and elsewhere have reported progress. High-quality 1-2-3 superconducting films are nearing practical applications in hybrid superconductor-semiconductor chips and in military and consumer communications devices that operate at extremely high frequencies in the microwave region of the electromagnetic spectrum, Venkatesan says.

– I. Amato

Analgesics can harm kidney

U.S. scientists have found that adults taking long-term, daily doses of the nonprescription painkillers phenacetin and acetaminophen – but not aspirin – run an increased risk of kidney disease. This study and one from Germany, which yielded similar results, provide the first epidemiologic data on the effects of long-term, daily use of acetaminophen, says study leader Dale P. Sandler at the National Institute of Environmental Health Sciences in Research Triangle Park, N.C. Phenacetin was taken off the U.S. market in the late 1970s because of its suspected link to kidney disease.

Beginning in 1980, Sandler's team conducted telephone interviews with 554 North Carolina adults newly diagnosed with renal disease and 516 matched controls, asking about their history of analgesic use. In comparing the two groups, they found daily phenacetin use associated with about a fivefold increased risk of kidney disease and daily acetaminophen use with about a threefold increase, the researchers report in the May 11 NEW ENGLAND JOURNAL OF MEDICINE. No increased risk stemmed from aspirin use.

The work should be repeated in other regions, Sandler says, but in the meantime, people who take acetaminophen every day should do so only with medical supervision. Occasional users need not worry, she emphasizes. □

Fraud debate aired on Capitol Hill

In two days of heated testimony, Rep. John Dingell (D-Mich.), the powerful chairman of the House Energy and Commerce Subcommittee on Oversight and Investigations, grilled a cast of witnesses including Nobel laureate David Baltimore, a bevy of Secret Service agents and Margot O'Toole, the postdoctoral student who triggered the most recent debate in the nation's capital regarding scientific fraud and misconduct.

The drama was played out May 4 and May 9 in the Rayburn House Office Building with a standing-room-only crowd of scientists, administrators, government officials, lobbyists and journalists. At the center of the uproar: an April 25, 1986 scientific paper published in CELL by a team of researchers led by Thereza Imanishi-Kari, formerly with the Massachusetts Institute of Technology and now at Tufts University School of Medicine in Boston. The team included Baltimore, director of the Whitehead Institute for Biomedical Research in Cambridge, Mass. The CELL paper claimed that foreign genes inserted into immune-system cells in mice generally are not expressed but instead affect production of antibodies directed by the animal's own genes.

It is this very conclusion that O'Toole continues to question. O'Toole, who worked in Imanishi-Kari's MIT laboratory, first raised objections to the CELL paper in May 1986 when she stumbled onto data pertaining to a crucial portion of the experiment described in CELL. "An examination of these records convinced me that the findings had been presented in a misleading fashion, and that a central claim of the paper might not be supported by experimental evidence," O'Toole told the subcommittee. She never accused Imanishi-Kari of fraud.

Dingell's staff scheduled the latest round of hearings to air forensic evidence suggesting that laboratory pages supposedly written in 1984 and 1985 were actually prepared in 1986 – after the CELL report appeared. John W. Hargett of the Secret Service testified that an analysis of Imanishi-Kari's laboratory notebooks showed that more than a dozen pages contained altered dates.

Imanishi-Kari steadfastly denied any implication that she had gone back and altered her lab books. "I do keep my notes in what seems to others a messy condition. But I know my notes. I know where they are and how to read them – that's what is important," she told the subcommittee, adding she had strong personal motives to be accurate. The CELL paper's results may help scientists understand lupus erythematosus, a disorder caused by a malfunctioning immune system. "Mr.

Chairman, I have lupus. My sister died from lupus," Imanishi-Kari testified, noting that manipulated data could thwart efforts to find a cure for the disease.

Despite such testimony, nagging questions remain. For example, at least one finding obtained by a scientist working under Imanishi-Kari was never entered in a notebook but was recorded directly on a chart published in the CELL report. In addition, Imanishi-Kari acknowledges she "reorganized" her notebooks after questions about the report arose.

"These revelations of unorthodox data-handling practices have prompted us to initiate a detailed audit," testified National Institutes of Health Director James B. Wyngaarden. NIH recently reopened its investigation of the case after learning of the Secret Service analysis (SN: 5/6/89, p.278). NIH had appointed a three-member panel of scientists to scrutinize O'Toole's complaint. Their report, issued in February, cleared Baltimore and colleagues of fraud but did find "significant errors of misstatement and omission" in the CELL report.

The hearing underscored another disturbing piece of evidence: a Sept. 9, 1986 letter written by Baltimore. "The evidence that the Bet-1 antibody [the experiment's key reagent] doesn't do as described in the paper is clear," Baltimore wrote to Herman Eisen, an MIT scientist investigating some of O'Toole's concerns. "Thereza's statement to you that she knew it all the time is a remarkable admission of guilt."

Baltimore says he wrote the letter in haste after learning Imanishi-Kari had told Eisen Bet-1 didn't work properly — a misunderstanding that was cleared up several days later. Imanishi-Kari, a Brazilian citizen who speaks several languages, "has difficulty communicating in English, as the history of this controversy painfully shows," Baltimore says.

The significance of the case goes well beyond the CELL paper, striking at the heart of how institutions respond to allegations of scientific error. On the one hand, Baltimore and his supporters decry congressional attempts to put a choker on the individual pursuit of scientific knowledge. Yet Dingell and other subcommittee members remain wary of the scientific community's ability and willingness to police itself.

Moreover, Dingell and a few members of the scientific community say they remain concerned about the fate of scientists — especially junior researchers such as O'Toole — who raise questions about scientific accuracy. O'Toole testified she has suffered personally from the controversy: "I was left without a recommendation. I was left without a job." Wyngaarden says he believes O'Toole's career was damaged simply because she pursued her convictions. The scientific community, he adds, must allow individuals to speak out. — *K.A. Fackelmann*

Mid-Atlantic Ridge survey hits bull's-eye

Oceanographers have spent decades studying the Mid-Atlantic Ridge — an underwater set of volcanic mountains and valleys running from the Arctic to the South Atlantic. In many ways, these researchers have resembled the legendary blind men who failed to identify an elephant because they studied only small patches of the immense object. But a recent mapping project has added a bounty of new information about the ridge, helping scientists glean new insights into seafloor spreading — the complex process that creates new ocean crust as Earth's plates slowly pull apart.

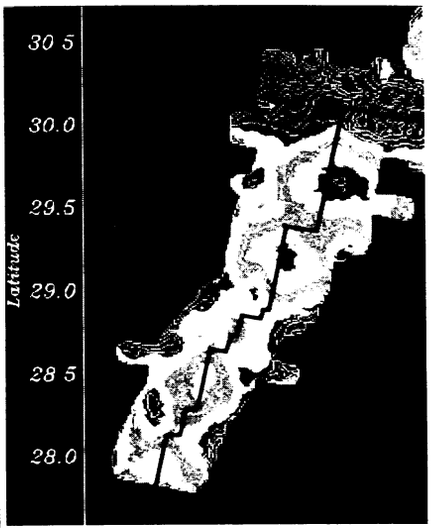
Using a high-resolution sonar bathometer called Sea Beam and other devices, researchers from the University of Washington in Seattle and the Woods Hole (Mass.) Oceanographic Institution completed a 900-kilometer-long survey of the Mid-Atlantic Ridge in January. Graham M. Purdy from Woods Hole says the information collected on these cruises dwarfs previous data. "The only other Sea Beam coverage on the Mid-Atlantic Ridge has been little postage stamp areas," he says.

At a meeting of the American Geophysical Union in Baltimore this week, Purdy and his colleagues described some important features of the ridge. In particular, they say, the ridge fails to live up to its traditional staircase-shaped image when viewed closely.

The Mid-Atlantic Ridge does not form a continuous line. Rather, it is broken into small, straight sections called spreading centers. In some areas, a perpendicular transform fault separates adjacent segments, forming an arrangement that looks much like a staircase. If the spreading sections represent the vertical jumps between stairs, the faults serve as the horizontal steps themselves. Transform faults allow blocks of ocean crust to slip past one another, and play an important role in seafloor spreading.

Traditionally, oceanographers have thought such faults separated most spreading segments in the Atlantic, but that turns out to be untrue, says Hans Schouten of Woods Hole. The researchers identified a string of 16 spreading centers, each 30 to 50 km long, separated by a variety of 5- to 25-km-wide nontransform offsets. In some, the end of one spreading center runs past the end of another. In others, the tips of the segments bend toward each other, reports Jean-Christophe Sempere of the University of Washington. Sempere thinks a diffuse area may take the place of a distinct transform fault in absorbing motion between the plates.

In addition to the nontransform offsets, the researchers found bull's-eye patterns in the mantle gravity field under the ridge. Jian Lin of Woods Hole says these may represent a number of different structures.



A recent survey found bull's-eye gravity patterns under the Mid-Atlantic Ridge. These low-gravity regions are thought to reside in Earth's mantle and may represent pools of molten rock under the crust. Black line shows approximate locations of spreading segments and nontransform offsets.

Geophysicists often use sensitive gravity meters to probe unseen material below ground, but these measurements can be difficult to interpret. Because Lin and his colleagues were interested in learning about the mantle, they attempted to remove mathematically the gravitation effects of the ocean water and the ocean crust, both of which influence the gravity measured near the surface. The leftover signal, they reasoned, should reveal information about the mantle beneath the crust.

After performing the corrections, the researchers found circular regions of low gravity under the middle of many spreading centers. Lin says these may represent plumes of molten mantle rising toward the volcanic regions of the ridge. Because hot, molten rock is less dense than cold, solid rock, it would show up as spots of low gravity.

Alternatively, Lin says, the pattern may indicate that the crust, whose rock is lighter than mantle material, is thickest in the center of the spreading segment. Future studies with seismic waves should resolve the differences between these two interpretations.

This is the first time researchers have identified a string of such bull's-eye patterns. Previous gravity measurements showed a couple of isolated circular gravity lows along the Mid-Atlantic Ridge, but until now investigators have lacked the high-resolution bathymetric maps needed to correct for crustal influences, says Purdy. — *R. Monastersky*