Group details new superconductor production process

Cornell engineers have reported the details of their new process for producing thin films of high-temperature superconductors at lower processing temperatures and at lower cost. The new technique is reported in the Nov. 17 Applied Physics Letters.

The new method, called "high-pressure reactive evaporation," is a significant step toward making practical superconducting films for microelectronic applications. It was developed by applied physics graduate students Daniel K. Lathrop and Stephen E. Russek and by Robert A. Buhrman, professor of applied and engineering physics who heads the Superconducting Thin Film Group.

Last month, scientists at the University of Rochester reported using thin films produced by the new process to conduct electrical pulses as short as 10 to 15 trillionths of a second (picoseconds) without absorption or distortion and at very high levels of electrical current.

This discovery showed that superconducting digital data transmission lines could be built with far greater capacity than even optical fibers. It also showed that future computers could use superconducting transmission lines to move massive amounts of data rapidly among components on computer chips.

The lower processing temperatures of the new technique mean that superconducting films could be produced on computer chips with less danger of heat damage to other components.

The procedure is cheaper than other methods because the superconducting film is created on a zirconium oxide base, which is about one-tenth the cost of strontium titanate, the material used by other researchers. The new superconducting ceramic cannot be created on a substrate of silicon, the basis of most electronics, because it reacts chemically with silicon.

Superconducting films used to connect components on computer chips could become the basis for faster computers, too, because they could transmit data among components at far higher speeds than current metal connections and with no electrical resistance. Metal connections between components on chips cannot transmit information fast enough to keep up with new processors and their resistance creates unwanted heat.

Last year, scientists discovered a new class of ceramic materials that become superconductors — capable of carrying electrical current with no resistance — at "high temperatures" of up to 90 degrees above absolute zero (about -183 degrees Centigrade). Such superconductors could be cooled by cheap liquid nitrogen, which means that large numbers of practical applications of the materials are now feasible.

The new production process developed here consists of using beams of high-energy electrons to evaporate two of the components of the superconductor, yttrium and barium, inside a 700-degree-Centigrade chamber filled with oxygen at high pressures. The third component, copper, is evaporated from an electrically heated wire.

The vapors deposit as a thin film of yttrium barium copper oxide (chemical formula $YBa_2Cu_3O_{7-y}$) on the support, or substrate, material.

The resulting material became superconducting at a temperature of about 85 degrees Kelvin (about -188 degrees Centigrade) and could carry a current of about one million amperes per square centimeter, according to Buhrman. The high current densities mean that the films can carry enough electricity to make them useful as electronic components.

The researchers also found that they could improve the electrical and superconducting properties of the films somewhat by a "rapid thermal annealing" process in a different oxygen-filled chamber at temperatures of 700 to 900 degrees Centigrade for 1 to 5 minutes.

Such superconducting temperatures and current densities were previously produced by International Business Machines Corp. researchers on strontium titanate. Also, previous superconducting thin films were produced at higher temperatures of about 850 degrees Centigrade.

"These results show that it is possible to grow high-temperature superconducting ceramic on substrates whose crystal structure does not exactly match that of the film," Buhrman said. "Although we expect to improve these films considerably as we optimize the process, it's already clear that these growth procedures are a particularly promising approach to the rapid development of a successful superconductor thin-film technology." — *Dennis Meredith*

Law faculty, staff help co-worker through surgery

Claude Levet

Law School Dean Peter Martin congratulates Carolyn Lynn on her recovery from spinal surgery and return to her job. She spent ten months at home in a body cast.

A year ago, Carolyn Lynn, a secretary at the Law School, told her supervisor she would have to take medical leave to undergo spinal surgery. That started a 12-month sequence of actions by Law School faculty and staff that went far beyond sending the traditional potted plant to a hospitalized co-worker.

Shortly after Lynn's announcement, Law School Dean Peter Martin stopped by her desk to tell her he was sorry that she was facing major surgery. "Don't worry," he told her, "when you come back, your job will still be here." The assurance helped her and her family beyond words, Lynn said.

When the time came to leave for the hospital, more than 100 people surprised Lynn with a going-away party and gave her a Cornell teddy bear. "Believe it or not, I slept with that bear every night in the hospital," she recalled.

"Her toes wiggle!"

The Law School faculty and staff had reason to give Lynn extra support and indications of concern: They knew the surgery would be extensive and sensed she feared that she might not be able to walk if the operation failed. Fortunately, it was successful. The message "her toes wiggle!" was posted on the bulletin board outside the dean's office shortly after the operation.

Law School faculty and staff sent her more than 250 cards in the hospital, phoned her often and paid many visits. "I still chuckle over one professor, who called while I was coming out of anesthesia," she said. "I'm sure he thought I was cuckoo" because of her dazed responses.

During Lynn's 10-month recuperation at home — much of it in a body cast — her supervisor, Mary Ella Christie, visited her and drove her to and from the Law School where she had arranged "juice and brownie" sessions in Lynn's honor during weekly staff meetings.

A touching letter

This fall, after she had returned to work, Carolyn Lynn's husband, Richard, who is not a Cornell employee, wrote President Frank H.T. Rhodes to tell him about the support she had received from her colleagues before and after surgery.

"Cornell University and the entire Ithaca area are truly fortunate to have people like those at the Law School living and working in our community. The Lynn family will always be grateful," he wrote. The letter was signed separately by "Dick, Tracy, and Dagan Lynn."

In his reply, Rhodes expressed his pleasure that Carolyn Lynn had made a good recovery and was able to return to her secretarial job at the Law School. "I am so happy to know of the fine encouragement and support that she received from Dean Martin and many other colleagues in the Law School," the president wrote. "It is this kind of friendly relationship that makes Cornell such a special institution. Thank you very much for your thoughtfulness in writing to me."

"Mr. Rhodes was very touched by the letter," said Marcia Parks, executive staff assistant in the president's office. "He receives perhaps half a dozen spontaneous letters like that a year."

— *Joe Leeming*

Graduate Bulletin

Fellowships for Wellesley Alumnae: Fellowships valued at up to $14,000 available to Wellesley graduates. Deadline is Dec. 1. See Fellowship Office, 116 Sage Graduate Center for details.

Charlotte Newcombe Doctoral Dissertation Fellowship: Fellowship is for $10,000 for dissertation writing year. Deadline is Dec. 11.

CUINFO now has the Fellowship Notebook on line. It lists more than 100 fellowships for graduate students for 1988-89 under the categories: women, foreign students, minority students, study overseas and general. Eligibility requirements, amount of award, deadline and address for application are also included. More information is available at the Fellowship Office, 116 Sage Graduate Center.

Four-minute miler to address JGSM reunion

The first person to run one mile in less than four minutes will deliver the keynote address when the Johnson Graduate School of Management holds its Third Annual European Reunion in London March 18-20.

Sir Roger Bannister will speak on "Science, Sport and Medicine" at the reunion banquet on March 19 in the Inn on the Park at Hamilton Place, Park Lane. Bannister, a medical doctor, is master of Pembroke College, Oxford University.

In 1954, he was clocked at 3:59.4, becoming the first mile runner to break the four-minute barrier.

Curtis W. Tarr, dean of the Management School, will lead a group of faculty who will fly to London to conduct seminars and meet with alumni who work in Europe.

"These reunions enable the Johnson School to share with its overseas alumni the latest research in business management, and they help us keep in touch with graduates who occupy important positions in international trade and finance," Tarr said. "Our first two reunions were held in Brussels and Paris and were well attended. We are planning two reunions in 1989, one in Tokyo for alumni in Asian nations and another one in Europe."

Participating in the seminars will be Thomas R. Dyckman, associate dean for academic affairs; Harold Bierman Jr., a professor of business; and Richard H. Thaler, a professor of economics.

Other scheduled panelists include Jean-Marie Dermine, a French finance professor; Joseph A. Los, finance director of the Netherlands' Transport International Pool; J. Roger O'Neil, chairman of Mobil Oil Co. Ltd., U.S.A. and England; Dermot St. John McDermott and Dominic E. Collier, British businessmen; and Karel Vinck, a Belgian business executive.

Jacques Andriessens, vice president of Johnson Wax Consumer Products-Europe, will speak at a luncheon on March 20 in Pembroke College.

Seminar topics will deal with European financial markets, flexible financing and pitfalls in business decision making.

— *Albert E. Kaff*

$510 London fare

Members of the Cornell community can purchase reduced round-trip air tickets to London arranged for the Johnson Graduate School of Management's Third Annual European Reunion without participating in the reunion.

Reservations must be made before Jan. 5 for the special $510 fare on British Airways. The flight will leave New York City on March 16, and the return trip can be made anytime after March 20. For further information, telephone Jolan Becken in Cornell Travel Office, 255-4284.