TO Norm, from Jack -- see NBS
patent/royalty procedure
in particular

SUPERCONDUCTIVITY

I SIGNIFICANCE

This development has very great importance for the global economy if it is assumed that continued progress will be made toward reproducibe, near-room temperature superconductivity. A major effect will be upon the sourcing, the distribution and the decreased cost of energy in the world.

- o Potentially, superconductivity may produce very high energy density electrical storage devices (batteries) that in ship or airplane form can be charged up at sources of low cost energy and delivered anywhere in the world. (Geothermal steam and hydroelectric power in Iceland, flared natural gas in remote locations and in underdeveloped countries are examples)

- o Low cost energy makes possible "energetic" activities not now economically attractive, such as desalination of salt water to irrigate deserts, magnetically levitated transportation etc.

- o Also, distribution efficiencies approaching 95-99% and electrical energy storage would rapidly convert the

U.S. to an all-electric economy. Utilities would run flat out night and day at much higher efficiencies and charge up sub-stations in off-peak hours. This would add about 1/3 generating capacity to each power station with no additional capital investment, and decrease power line losses by about 90% or more of those now experienced.

- Electric vehicles would rapidly displace internal combustion engines resulting in much greater efficiency and vehicular life (perhaps more than a million miles of service vs. 100,000 for current vehicles). This would obviate import of some 40% of oil consumption now used for gasoline, and reduce trade deficits. A major restructure of automobile and all other forms of vehicular transportation would result.

- Thousands of applications also would be found for superconductivity (magnets ten times more powerful that would reduce electric motor sizes by ten times, vastly expanded communications and computing capabilities etc.)

II ISSUES

Critical issues involved in the rapid exploitation of this remarkable development include those of (1) control of the technology (2) removal of unnecessary barriers, and (3) the need for specific incentives to mitigate the considerable risks involved in very large investments in the development of both new process technology and product manufacturing facilities (this includes a simultaneous write-off of existing investments).

Control

Normally, a discovery of this sygnificance is not first announced until very comprehensive composition-of-matter patents have been filed covering many conceivable combination of elements (all of the lanthanide transition and transuranic series, for example, in combination with at least selected alkali and alkaline earth metals). IBM may control the technology, at least in the U.S., where patents are issued for "first discovery" rather than "first to file."

However, if patents were not filed within the one year period from first publication, then the technology is in the public domain and free for anyone to exploit. (The Japanese already have mounted an around the clock systematic screening of all possible compositions. They have also filed the only two patent applications known to have been filed with the U.S. Patent Office on the new superconductivity).

Barriers to Exploitation

o The economics of the technology will not be in the cost of the materials involved. Rather, enormous capital investments will be required. Methods of generating this capital include:

a) A capital gains tax approaching 0% after a 5-10 year holding period.

b) rapid write-down of existing facilities that will be obsoleted by the new technology.

c) Accelerated write-offs of new facilities

d) Investment tax credits.

All the above may be essential to incentivize new investment as rapidly as possible and to obtain as much market share as possible.

- The Technology Transfer Act of 1986 now provides Government Agency authorization for federally funded technology to be licensed to the private sector and also permits cooperative efforts between industry and government laboratories. Rapid implementation of this law is important, and needs to take the form of decentralizing these authorities to each laboratory where the action is.

- Process technology will take the form of thin film, tape, and wire systems that may require collaborative efforts among groups of companies to achieve economies of scale required to be competitive. Section 7 of the Clayton Act currently is a barrier to such collaborative efforts. What is needed is "rule of reason" which allows any joint manufacturing activity to take place that is pro-competitive in the global context (not the domestic context).

- Process technology can be patented in the U.S. but not in most other countries. Foreign companies therefore can practice U.S. process technology and import the products that result into the U.S. without penalty. Protection against this strategy is urgently needed.

- Clarification is needed of intellectual property rights for private sector use and ownership.

Incentives Needed

The appropriate government role is to provide the best possible non-interventionist climate for private sector initiatives. This can best be done by removing unnecessary barriers, providing incentives and catalyzing the formation of collaborative efforts that pool resources, skills and capabilities and that avoid unnecessary duplication.

- Small business entrepreneurial activity would be increased enormously if the 20% incremental R&D tax credit would be allowed for organizations "not yet in business" (specifically R&D Limited Partnerships). Much of the potential of superconductivity will emerge in thousands of niche markets, thereby creating many new jobs.

- A private sector managed and directed, but government funded, task force could catalyze the formation of university-industry-government lab consortia in market driven initiatives.

- A computerized central clearinghouse of data may be advisable, combined with a continuous scan of world-wide developments, for immediate communication to all laboratories involved in the <u>multitude</u> of initiatives that will result.

- Public Presidential recognition of the importance of cooperative efforts might be useful.

NEXT

FRIDAY, MAY 1, 1987 THE WASHINGTON POST

Japan Could Win Superconductor Race With U.S., Scientists Warn

By Michael Specter
Washington Post Staff Writer

Scientists leading the intense effort to develop a new class of superconductors, which carry electricity without losing energy, warned yesterday that the United States must act quickly to compete with the strong national effort under way in Japan.

Speaking at a House forum on high-technology competitiveness, researchers from government, industry and the academic world expressed fear that American companies have not prepared for the fierce race to market the new ceramic materials used to make superconductors.

"Most of the fundamental knowledge has come out of U.S. labs," said Kent Bowen, professor of ceramics engineering at the Massachusetts Institute of Technology. "But the Japanese are already making devices. If we don't get our act together, we don't have a chance."

On almost the day that the new ceramics were devised, Japan's Trade Ministry organized a national consortium of experts to work on all aspects of development.

At the forum, several politicians called for creation of a similar U.S. national board to oversee superconductor research and help bring new products, such as wires and computer chips, to market.

Speakers repeatedly mentioned that, although the United States was first with color television and videocassette recorders (VCRs), those markets have been ceded almost completely to Japan.

"We go on inventing, and they go on producing," Sen. David F. Durenberger (R-Minn.) said. "The stakes are just too high to let superconductivity go the way of the VCR industry."

The financial implications may be enormous. Superconductors that could transport electricity—whose power is not diminished by the customary resistance in transmission—would have a vast array of potential applications, from power lines to high-speed trains and powerful computers.

If scientists find materials that conduct electricity at room temperature with no loss of power, the discovery would transform electronic technology. Conventional superconductors must be cooled by liquid helium to hundreds of degress below zero. Liquid helium is rare, expensive and difficult to handle.

Progress in the laboratory has moved at a blistering pace, but leading researchers have voiced increasing concern that, as in the past, the United States could yield to Japan in practically applying the new technology.

"It is very important to be the first with the results and the first to get a new material to market," said Robert Laudise of AT&T Bell Labs. "Without both, one doesn't matter."

Laudise said one U.S. industrial weakness involves processing materials, "the art and science of making things," as he put it.

"When you really try to cultivate process as science, things go well in manufacturing," he said. "When you don't, you lose the whole ball game."

All speakers said much remains to be learned about the new materials, their structure and how they work.

Scientists from several disciplines—among them physics, materials research and chemistry—have joined to try to determine how the new ceramics work and what might work better.

Laboratories nationwide have begun fabricating wires, tapes and thin films that could be deposited on computer chips. But, because the ceramic mixture is brittle and carries only light loads of electrical current, most devices are far from ready for commercial use.

Rep. Don Ritter (R-Pa.), who organized the forum, said he has urged the White House to consider forming a task force to monitor the industry's growth and development.

To dramatize his point, Ritter released a report from Sumitomo Electric Industries, a major Japanese manufacturing firm, that revealed highly detailed concentration on commercial applications of new materials.

"One year in the past is one day now," the memo read. "We should seek for a new-style management in order to conduct basic research and applied research simultaneously."

Enthusiasm Over Superconductors Is Tempered by Daunting Problem

By JERRY E. BISHOP
Staff Reporter of THE WALL STREET JOURNAL

As initial excitement over newly discovered electrical superconductors subsides, it is becoming clear that a major problem remains to be solved before scientists' futuristic ideas can be transformed into reality.

In the past few months, laboratories around the world have announced breakthroughs in superconductivity, whereby certain materials conduct an electrical current without resistance when cooled to temperatures near absolute zero. New ceramic-like materials exhibit the same properties at much higher temperatures—and at much lower costs. The new materials, physicists say, could lead to the development of, among other products, supercomputers, magnetically levitated trains and super-efficient electric motors.

But such enthusiasm is being tempered by a substantial problem. The amount of electrical current that can be pushed through the new superconductors is so small that—in their present state—they are useful only for minor applications, such as magnetic detectors. Scientists say they are confident they can solve this current-density problem, as it is called. But, they concede, so little is known about the new materials that their confidence is based as much on faith as on science.

A Series of Hurdles

"I don't want to say we're optimistic; I'd rather say there's no reason we know of to be pessimistic," says Fred M. Mueller, head of a new superconductor task force at Los Alamos National Laboratory in New Mexico.

Even if researchers are able to increase the superconductors' ability to carry a current, chemists and engineers still must figure out how to design and produce the new superconductors in the form and quantities needed for practical applications. For example, despite several recent announcements of superconducting wires being made in laboratories, scientists say it will be at least five years, possibly longer, before they can develop manufacturable wire that could be used in superconducting magnets.

"I'm 64 years old. . . . I only hope I can live long enough to see some of these applications," says John Hulm, head of Westinghouse Electric Corp.'s superconductor effort. "But then I'm fairly healthy."

The world-wide excitement generated by the new superconductors was justified—if a bit excessive, scientists say. In 1911, a Dutch physicist, Heike Kamerlingh Onnes, discovered that some metals, including lead, lost all resistance to the flow of an electrical current when cooled within a few degrees of absolute zero, the temperature (minus 460 degrees Fahrenheit) where all molecular motion stops. Ever since, scientists have sought materials that are superconducting at higher temperatures.

By the 1960s, physicists had found other materials that were superconducting at temperatures as high as 23 degrees above absolute zero, or 23 K on the Kelvin scale. But even these superconductors still had to be immersed in expensive liquid helium, the only refrigerant cold enough to make them work.

The elation that swept through physics laboratories recently was sparked by two International Business Machines Corp. scientists in Switzerland. Last spring, they reported that they had found some ceramic oxides that were superconducting at 35 K, breaking the 23 K record. In short order other researchers in the U.S., Japan and China reported superconductivity in the ceramic materials at even higher temperatures. In late January, university researchers in Texas and Alabama reported superconductivity in the ceramic materials at temperatures of 95 K.

The new, higher-temperature superconductors mean that, for the first time, superconductors can be maintained immersed in liquid nitrogen, a refrigerant that costs only about 22 cents a gallon compared with $11 a gallon for liquid helium. The new materials have been hailed as opening the way to superconducting computer parts that are smaller and faster than present-day room temperature computer parts. Meanwhile, the production of superconducting electromagnets—smaller or more powerful than conventional magnets—could result in tiny, highly efficient and less-costly electric motors.

> **'I'M 64 YEARS old,' says the head of one research effort. 'I only hope I can live long enough to see some of these applications.'**

More Than Temperature

Researchers now concede that in their excitement they might have glossed over the fact that keeping a material in a superconducting state depends on more than just temperature. Even if it is still tremendously cold, a superconductor will suddenly resist the flow of a current if the ratio of current to wire diameter exceeds a certain level. For older, helium-cooled superconductors this "critical current density" is fairly high, enabling engineers to use them in powerful superconducting magnets for atom smashers and in some medical equipment.

But the new ceramic materials suddenly lose their superconductivity if the current density exceeds a level roughly equal to that in common household wiring, scientists say. And this level applies, they note, in the absence of a magnetic field—in which critical current densities might be even lower.

Unless the current density can be raised by 10- or 100-fold, use of the new superconductors could be severely limited, researchers say. It may be possible to make superconducting power lines by simply making the wires bigger and increasing their voltage, notes Donald W. Capone, a physicist working on the new materials at the Department of Energy's Argonne National Laboratory run by the University of Chicago. But for most important applications of superconductivity, he adds, "you can't get too far away from the need for higher critical current density."

Computers, for example, use circuits with high current density. If a wire made of the new superconductor is shrunk down to the microscopic size used in microchips, the amount of current it could carry would be so small as to be useless, researchers explain. And magnetic coils made of the new materials would produce electromagnets too weak to have any advantage over conventional magnets or magnets made with older superconductors.

The scientists are counting on their experience with older superconductors to tell them how to raise the current density of the new materials. Theory holds that lack of certain minute imperfections in the materials may actually limit their ability to carry large amounts of current and remain superconducting. Thus, it may be a matter of getting the right molecular recipe. The new materials consist of various combinations of at least four elements: yttrium, barium, copper and oxygen.

Strong Magnetic Fields

"These materials are only six months old, and we've only looked at about a dozen (combinations) of them when there are perhaps 1,000," notes Mr. Mueller in Los Alamos.

Another problem is the strength of the new materials. Experiments so far indicate they will retain their superconductivity in magnetic fields far stronger than older superconductors. But as the strength of a magnet increases so do the forces that try to push the magnet apart. Thus, the superconducting wire must be both ductile enough to wind into a magnetic coil and strong enough to withstand the pressures of intense magnetic fields. In older superconductors, it took 10 years to develop such wire by imbedding filaments of the superconductor into copper.

"It's going to be a big materials processing problem and it's going to take literally years," says Westinghouse's Mr. Hulm.

Researchers at Argonne are hoping to have a laboratory version of a superconducting wire useful for power transmission and magnets for medical imaging machines within three years, says Mr. Capone. "We don't think that's unrealistic," he says. "Of course, that's only for a short piece of wire. After that you have to think about making kilometer lengths of it and that may take another two years to make the first prototypes," he says.