A Congressional Perspective on the New Superconductors

Paul C. Maxwell

Congress, like everyone else, was excited by the discovery of the new high temperature superconducting materials announced by Dr. Paul Chu and others last year. Public interest, fanned by stories in *Time*, *Newsweek*, the *Washington Post* and elsewhere was, perhaps, best shown at Congressional hearings held last June. For the first time in memory it was necessary to have crowd control at a hearing on science. TV coverage was limited to a maximum of eight cameras, and a standing-room-only audience remained through most of the nine hours of testimony and questions.

What members heard at those hearings confirmed much of what they had been reading in the press—that these new materials offered the *potential* for vast, revolutionary changes in such diverse areas as microelectronics, transportation, communications, electrical energy, and medical instrumentation, among others. What they also heard but what was not emphasized in the press was that much work still remains before the potential of these exciting materials can be realized. Years, possibly decades, could be necessary to understand these materials in order to overcome inherent obstacles in their physical properties—brittleness, large anisotropy, and instability, among others—in order to use them at their full potential. Obviously, such long-range research and development will require a major long-term commitment of resources—estimated at hundreds of millions of dollars per year by both the private and public sectors.

These hearings were followed by numerous other meetings, symposia, and conferences, in the United States and abroad, including an unusual "presidential conference" on superconductivity for economic competitiveness held last July. An eleven-point presidential initiative was announced, several legislative proposals were introduced, and additional follow-up hearings were held last fall and this winter.

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In terms of dollars the current status of our federal programs in high temperature superconductivity looks reasonably bright. Beginning little over a year ago, our federal agencies raised funding from virtually zero to close to $50 million in FY 1987. Current estimates in FY 1988 exceed $90 million, and the presidentially requested budget indicates over $120 million dedicated to research on these new materials. That's the good news. The bad news includes the following:

- No national program exists—indeed it is hard to identify even individual agency program plans, with the Department of Defense being a possible exception.
- Most of the money, over two-thirds in FY 1988, is being directed through the Department of Defense rather than our civilian research agencies.
- Most of the effort focuses on basic and theoretical aspects of the new materials with only minimal amounts being directed to *processing* and *engineering aspects*.
- While our agencies communicate among themselves, there is no overall connection between the various programs and there seem to be significant overlaps.
- It is hard to see how these federal programs correspond to the needs of industry or to see where industry has an opportunity to provide input into current and future research plans.
- Finally, despite the enthusiasm shown by this administration, there are no guarantees that the next administration will be equally willing to pursue this work. History, in fact, suggests that lack of a *formal* long-term commitment guarantees only short-term programs.

What seems most apparent and what seems most lacking at the moment is the existence of a comprehensive national superconductivity program. In lieu of a clear definition of priorities and goals at a national, federal level, we have a multitude of priorities and goals, some articulated but most not. These are directed, not surprisingly, to individual missions as interpreted by individual agencies. Thus, we all seem to be heading in different, independent directions. Some have argued that diversity is necessary and a national program would inhibit flexibility. Obviously, any program would require sufficient flexibility, but just as obviously too much diversity leads to chaos. Perhaps, more importantly, a national program would signal our industries clear directions so that they could most effectively develop their own programs and correlate them appropriately.

Successful development of these superconductors requires a financial and policy commitment that exceeds the life of any one administration. While the good intentions of the current administration to aggressively push superconductivity are recognized, it is not evident that future presidents will share that view. The only way to provide such long-term commitment by the federal government is through law. Again, as with a clearly drawn national program definition, a formal long-term commitment of funds will allow our private sector to plan their own work with more certainty.

One of the greatest problems we've faced in the past several decades has been the transfer of our scientific knowledge from the laboratory to useful applications in society. The Japanese, on the other hand, excel in developing marketable high-technology products. Where we may win the Nobel prizes, they win the economic markets. It

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seems obvious that in order to promote the transfer of these new technologies, we must involve industry and academia early in the process of program development. In fact, the private sector must be an integral part of that process or our efforts are doomed to failure.

A number of questions relate to *balance* in looking at our superconductivity research. The first consideration is balance between basic and applied research. Outstanding questions remain from both scientific and technological points of view. Thus, we must strive to maintain strong support for our fundamental efforts in this new area. However, as suggested in the National Research Council review chaired by Dr. John Hulm, science and technology in this field are strongly intertwined, one sometimes leading and at other times following the other. Progress is thus required simultaneously in each.

Another balance relates to defense versus nondefense funding. Hypothetically, the source of funding, particularly in basic research, should not unduly influence the direction of research. However, experience suggests otherwise. The Department of Defense must, by law and by its internal inclination, focus primarily on the defense interests of the nation. Other considerations such as the economic viability of U.S. industries, even the defense-oriented industries, are secondary to that mission. Any technology that evolves from defense is most likely to focus on systems and products peculiar to defense needs. There is nothing wrong with this, but if our intent is to develop commercially viable technology, then the funding should also originate from agencies with nondefense missions in balance with those from defense.

Finally, we must be careful to balance new program monies with those from other "lower priority" or "less visible" research. A recent letter in the *New York Times* from Nobel-laureate Dr. Phillip Anderson complained of cuts of up to 12% in the National Science Foundation's Condensed Matter Physics program. Given that the majority of the superconductivity research dollars found in this year's budget were reprogrammed, it's certain other programs have been similarly affected. While reprogramming may make sense for short-term reallocation of budgets, we must be careful not to allow permanent distortion of other valuable research.

A number of legislative proposals were introduced last summer. In particular H.R. 3217 and H.R. 3024, proposed separately by Congressman Dave McCurdy (Democrat-Oklahoma) and Congressman Don Ritter (Republican-Pennsylvania), respectively, form the basis for compromise legislation to deal with the problems just outlined. Such a compromise would (1) include provisions to establish a five-year national federal program in advanced superconductivity research and development; (2) provide for private sector input through a Presidential Commission on Superconductivity; (3) outline broad research responsibilities of various federal agencies and departments; (4) establish an international program of *basic* research; and (5) provide basic funding for a five-year period of $120 million per year beginning in FY 1989. While prospects for enactment remain uncertain, Congressmen McCurdy and Ritter can expect to push hard for progress before adjournment this fall.

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On the scientific front, we continue to make astounding progress. This February researchers in Japan, and almost coincidentally with Dr. Chu here in the U.S., announced the discovery of a new family of non-rare-earth bismuth superconductors with critical temperatures higher than the yttrium-barium rare-earth materials discovered last year. IBM recently announced confirmation of the University of Arkansas' discovery of *thallium*-based materials with a critical temperature even higher (125 K). Seemingly each week new discoveries are made, and new progress announced. For many this suggests that room-temperature superconductivity, a truly revolutionary possibility, may become a reality.

In closing, we should be reminded that the establishment of a national program for superconductivity does not guarantee that our nation will succeed in competitively developing and applying these new superconductors. However, such a national program is *essential* if we are to have a chance of success.

The views expressed in this article are those of the author alone and not necessarily those of the House Committee on Science, Space and Technology.

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