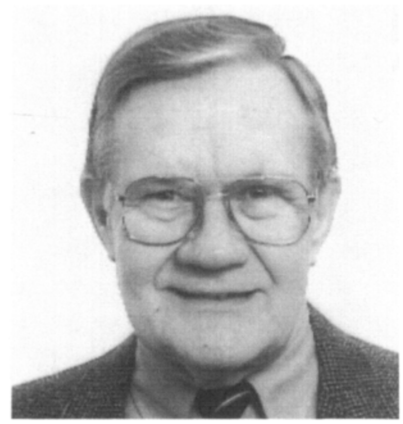
Editorial

Superconductivity



About ten years ago, the world was shocked by the news that researchers at the University of Houston had found methods to process materials so that, upon cooling, they became electrical superconductors at the amazingly high temperature of 94 K. At this temperature, all electrical resistance was lost; an electrical current, once started, would continue undiminished "forever." The discovery was exciting because materials can be cooled to 94 K with liquid air—at a cost about the same as that of many consumer beverages.

The newspapers were full of all sorts of futuristic scenes of magnetically levitated trains that glide effortlessly along tracks supported by intense magnetic fields (because this superconductivity phenomenon has a strong magnetic effect associated with it); power lines that are buried in tubes of liquid air and are really lossless as they transmit electrical power to us from remote power stations far away from population centers; and all kinds of new electronic circuits based on the Josephson Effect, especially important in spacecraft electronic systems where the materials would be superconductors in the natural environment of the cold side of a satellite.

In July 1996, a workshop was held to review the status of work in this area of materials processing and, in particular, on the status of materials processing relating to the manufacture of superconducting cable for electrical transmission. The Japanese Technology Evaluation Center/World Technology Evaluation Center (JTEC/WTEC) Workshop on Power Applications of Superconductivity in Japan and Germany was held July 30, 1996 at Loews L'Énfant Plaza SW in Washington, D.C.

The workshop was organized by the International Technology Research Institute at Loyola College of Maryland, R.D. Shelton, Director, and coordinated in Washington by Geoff Holdridge. Our contact was Bob Williams (Fig. 1).

Participants heard reports from a team of scientists and technologists chaired by Professor Larbalestier, Applied Superconductivity Center, University of Wisconsin (Fig. 2). The group had visited laboratories in Japan and Germany and reported on the progress being made in those countries.

Masaki Suenaga, Brookhaven National Laboratory (Fig. 3), reviewed progress being made in the development of cables from the low-temperature superconductors (LTS), primarily in Japan. These materials, primarily NbTi and Nb_3Sn are "state of the art materials" and are used in devices that are now in the marketplace (Magnetic Resonance Imaging Systems).

Robert Schwall, American Superconductor Corporation (Fig. 4), reported on the Japanese superconducting magnetically levitated train, the "Yamanashi Maglev Test Track," over 40 km (25 miles) long. This track is mostly in tunnels because its route from Osaka to Tokyo cuts through numerous mountains. In some portion

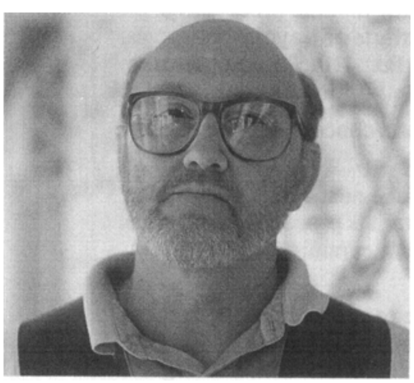


Fig. 1 Bob Williams

Fig. 2 David Larbalestier

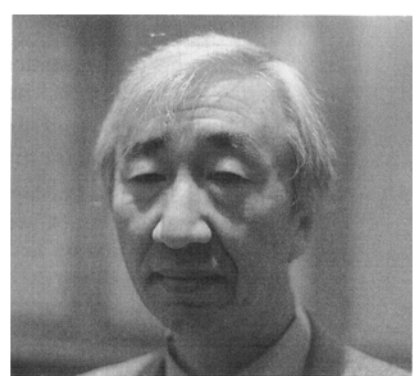


Fig. 3 Masaki Suenaga

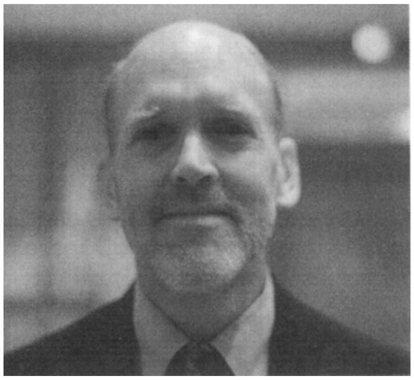


Fig. 4 Robert Schwall

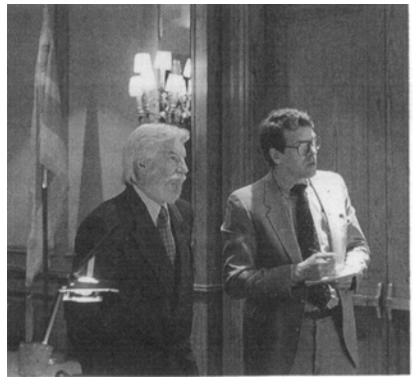


Fig. 5 Dr. Paul Grant (left) with a representative from Technology Today

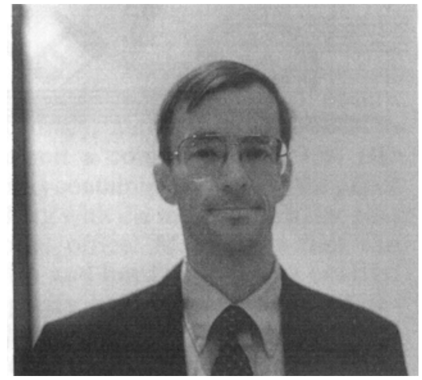


Fig. 6 Jeffrey Willis

of the route, the grade is an unbelievable 40%. The superconducting material is NbTi, a material of proven low-temperature superconducting performance.

Paul Grant, Electrical Power Research Institute (EPRI) (Fig. 5), gave the group the perspective of the electrical utility industry in the USA and compared the situation with that in Japan.

Jeffrey Willis, Los Alamos National Laboratory (Fig. 6), summarized progress in Japan in making cable that complied with several performance criteria. The criteria varied from organization to organization but seemed to be the following:

- The material must be superconducting at 77 K (liquid air).
- At 4.2 K (liquid helium temperature), the current carrying ability of the cable must be about 10^5 amp/cm^2 when it is in its final state of readiness for use (coiled).
- The cable must be capable of being made many kilometers long.

The materials that comprise the superconductor are known now simply by their abbreviations:

- BCCO is bismuth-calcium-copper oxide
- Y-123 is $Y Ba_2Cu_2O_x$—although YBCO is also used for this formulation
- Bi-2223/Ag is $Bi_2Sr_2Ca_2Cu_3O$ powder in a sheath of silver.

The abbreviations serve the purpose of identifying the materials as well as the "apparent chemical formulas" because in many cases, the formulas given for the materials are, in fact, only the compositions of the starting batches of ingredients expressed in terms of stoichiometric coefficients.

Additional and highly informative presentations were given by Donald Gubser, Naval Research Laboratories (Department of Defense Applications), by Robert Sokolowski, Intermagnetics General-Advanced Superconductors (Power Transmission Cables and Transformers) and by Richard Blaugher, Midwest Research Institute (Energy Storage).

It is tempting to summarize and discuss each of the papers because each contained significant content for the materials engineer/scientist. Space prohibits this. Instead, it is good to know that the proceedings of the workshop will be published by the International Technology Research Institute of Loyola College as a final report. The publication cost is $25.00. Particulars can be obtained from fax: 410/617-5123 or from williams@loyola.edu. The workshop view graphs are on the Internet at www.wttp.//itri.loyola.edu.

So far I have relayed to you, the materials/metallurgical community, the bare facts concerning a workshop. Permit me, as your editor, to offer a few words of opinion.

First of all, this technology of superconductivity is the materials technology of the next century. Everyone agreed on this point. All the end-use applications are critically dependent on materials processing, and there is a great deal of work to do. The new high-temperature superconductors are brittle ceramics (really brittle), and they must be aligned in a specific crystallographic orientation to be useful.

I know that our readership includes materials engineers and scientists who have responsibilities in their organizations for thinking long-term goals and markets and products; that is persons who must look beyond the "bottom line" for this year and think of what must be done now in order to be sure the bottom line is still good 10 to 20 years from now.

This area of materials processing of advanced superconducting materials is certainly one such area to watch, and a very useful way to do this is to keep an eye on the work of the World Technology Evaluation Center at Loyola College of Maryland for overviews, especially for those overviews that cover the international scene.

Also, keep an eye on the pages of this ASM journal for the details (the little details that make or break a product) in processing these new superconducting materials.

Remember the words of the philosopher: "The devil is in the details."

John R. Ogren