December 20, 2002

Official Communique

The 11th International Superconductivity Industry Summit
"Keys Toward Commercialization"

November 17-19, 2002
Keio Plaza Inter-Continental Tokyo, Japan

EXECUTIVE SUMMARY AND RECOMMENDATIONS

The 11th International Superconductivity Industry Summit (ISIS-11) was held at the Keio Plaza Inter-Continental Tokyo, Japan, on November 17-19, 2002. Approximately 50 participants, mostly members of the Consortium of European Countries Determined to Use Superconductivity (CONECTUS, EU), the Coalition for the Commercial Application of Superconductors (CCAS, USA), and the International Superconductivity Technology Center (ISTEC, Japan), attended the summit, which was co-sponsored by these three organizations. The main theme of this year⊐s summit was 〆Keys Toward Commercialization.Ŧ

The first ISIS meeting was held from May 11- 13, 1992, in Washington, D.C. Since then, international leaders in government, industry, and academia interested in promoting the industrialization of superconductivity have gathered once a year, with the support of various governments and academic circles. This year, the eleventh such meeting was held.

ISIS is an international forum that allows entrepreneurs to meet under one roof to discuss their common goals of promoting and providing leadership for the industrialization and commercialization of superconductor technology. The annual summits have helped to deepen the general understanding of the benefits of commercial superconductor applications and to accelerate their earliest market adoption.

The first superconductor magnet was created in the 1960s. The industrial application of superconductor technology began with so-called low-temperature superconductors (LTS) in the 1970s. In the 1980s, high-temperature superconductors were discovered. Sixteen years have now passed since the discovery of high-temperature superconductor (HTS) materials. During the intervening years, much progress has been made to promote research and development, and steady progress has been made in the commercialization of these promising materials into useful applications that will benefit the near-term global community. Over the next decade, superconductor technologies and applications of superconductor technology with tremendous energy-saving potential will be further advanced. Several of these applications will be commercialized in the near-term; still other new applications will be introduced as commercialization is expanded. Many technical, manufacturing and market obstacles remain to be overcome during this period.

We are living in an age of information, and a revolution in telecommunication technology is upon us. In the near future, enormous amounts of information will be sent, received and processed on a global basis. On the other hand, available resources are finite, and concern for the environment requires the development of new products based on superconductor technology and power electronics that allow energy to be used more efficiently and effectively than those technologies that have been deployed for the past century.

However, according to the International Energy Agency's (IEA) energy outlook for the next thirty years, world-wide energy consumption and energy-related carbon emissions are expected to grow by two-thirds and 70%, respectively, from the present levels; these estimates assume a reference scenario in which the energy-efficiency and ecological policies and measures so far adopted remain as is.

Superconductor technology and applications enable electricity to be transported with extremely low loss and allow information to be processed and relayed with ultra-high performance. They also improve the reliability and quality of electric power not only for existing electric power grids, but also for energy-consuming integrated internet data centers. These commercial internet data centers are able to transfer, store and process a large amount of data. These features of superconductivity offer great promise, today and in the future. However, to enable this technology to become fully commercialized, reliable superconductor products that address specific market opportunities must be available at a reasonable price, which is expected to be achievable with large-scale production. These products must also be able to deliver value-added benefits to customers. In this regard, efforts are still required to promote various applications of superconductor-based products. For this purpose, appropriate funding from industry and government must be available.

In reaction to these circumstances, the ISIS-11 participants discussed many aspects regarding the facilitation of superconductor technology commercialization and feasible methods for overcoming foreseen obstacles. Specific types of superconductor applications mentioned at the summit included various electric power and electronics applications, such as HTS power cables, transformers, fault current limiters, HTS utility generators, HTS motors and ship propulsion systems, MRI and NMR systems, specialty magnets, filters and network devices. In particular, refrigeration technology was noted, without exception, to be one of the most crucial supporting technologies required for all superconductor applications. In this context, the present status and future developments of refrigeration technology were also discussed.

The ISIS-11 delegates discussed these issues for two days and came to a consensus on the following points:

(1) The worldwide demand for electricity is steadily increasing and will likely continue to increase because of economic growth, especially in the information and telecommunication industries and in Asian countries. However, effective energy utilization will also become increasingly important for the protection of the Earth's precious environment. Superconductor technology is one of the most promising and viable solutions for dealing with these issues.

(2) To accelerate the commercialization of superconductor technology, efforts and investments must be focused on specific promising and viable fields of application.

(3) To realize the expansion of superconductor technology commercialization, the superconductor industry must ensure that customers are thoroughly aware of the benefits of superconductor technology.

(4) The commercialization of superconductor technology should be associated with its standardization. To realize the standardization of superconductor products, international efforts should be centered on presently available commercial products as well as products in the R&D stage.

(5) The role and contribution of CCAS, CONECTUS and ISTEC in promoting international

cooperation was widely recognized. The participants urged these organizations to continue their present activities.

TECHNOLOGY DEVELOPMENT TOWARD COMMERCIALIZATION

(1) HTS Technologies for Electric Power Applications

The demand for electricity in Europe, the United States and Japan has steadily increased; presently, however, developing Asian countries have the highest growth rates of energy consumption. On the other hand, concerns over environmental protection, such as the CO2 emission problem, are deepening. Under these circumstances, the effective generation, transmission, and utilization of electricity is urgently required. The quality of the electricity supply has also become an important issue. Superconductor technology should contribute to the solution of these various problems.

The manufacturing of superconductor wire and cable is a basic technology for various applications, in addition to electricity transmission. The use of superconductor cables for electricity transmission and distribution offers many benefits, especially in urban areas. The low impedance electrical characteristics of cold dielectric superconductor cables will change the way that electrical networks are designed and upgraded. Transmission system designers can take advantage of this characteristic and strategically place superconducting 'backbones' and 'jumpers' in existing transmission systems to significantly improve power flow without the costs involved with a complete system upgrade.

Many cable demonstration programs have been performed during the first phase of the commercialization process for HTS power cables, which has run from 1996 through to the present time. Cable demonstrations started in 1996 with TEPCO/Sumitomoﾕs and EPRI/Pirelliﾕs initial tests of HTS cables in their high voltage-test facilities. Additional tests have since been run in Japan, Europe and North America. In Japan, TEPCO/Sumitomoﾕs 3-phase/100 m, 66 kV/114 MVA cable demonstration program at CRIEPI was successfully completed in June 2002, underscoring the compactness of superconductor cables. In Europe, a 3 phase/30 m, 60 kV/104 MVA cable developed by NKT Cables has been successfully tested in the power grid of Copenhagen, Denmark since 2001, supplying power to 50,000 customers. In the United States, Southwireﾕs 3-phase/30 m 12.4 kV/27 MVA cable demonstration project has been in operation since February 2000, supplying load to Southwireﾕs production facility in Carrolton, GA. Also in the United States, Pirelli installed and initiated the testing of a 3-phase/130 m, 24 kV/100 MVA cable demonstration in a substation in Detroit; however, although much was learned, this demonstration fell short of its goals because of leaks in the cryogenic cooling system. In Mexico, Condumex completed the successful test of a 1-phase/5 m/2 kA cable demonstration.

All of the demonstrations in Phase I of the HTS cable commercialization process have been highly successful with the exception of the Detroit cable test. In Phase II of the commercialization process, which is expected to be underway during 2003 through 2005, some 8 ﾐ 10 new HTS cable demonstration projects are expected in Japan, Europe, the U.S., Korea, China and Mexico. This second, pre-commercialization phase, which will utilize first-generation HTS wire, is expected to lead to commercial HTS cable operations after 2005.

In the meantime, second-generation superconductor wire is being rigorously developed;

this new generation of wire should expand the scope of potential superconductor power applications even further. The upper critical magnetic field strength of YBCO was recently confirmed to reach more than 100 T at 4.2 K. This result may open promising new applications for HTS technology, such as very strong magnets for nuclear fusion, nuclear magnetic resonance (NMR) for research in the biosciences, and high-performance superconducting magnetic energy storage (SMES) systems.

Superconductor power devices are energy-efficient, compact and lightweight and are expected to play important roles in various aspects of the future power industry. The technical research and development of power applications in areas other than electricity transmission is underway around the world. Attention has been focused on SMES systems, flywheels, transformers, motors, power generators, fault current limiters and magnets for magnetic separation. Japan is also continuing its effort to develop LTS-MAGLEV technology, with a new effort underway focused on introducing HTS technology to MAGLEV. The United States Navy is now strongly pursuing the development and demonstration of HTS ship propulsion motors and generators for ship propulsion systems. Siemens is also developing such motors for commercial cruising cargo ships.

Among these applications, magnetic resonance imaging (MRI) is an excellent example of the benefits of superconductor technology. Customers have fully acknowledged the advantages of using superconducting magnets for imaging, and the market for these products is well established. Additionally, a small-scale commercial SMES using low-temperature superconductor (LTS) wires is already available.

ISIS-11 participants expressed their sincere hope that these steady development efforts be continued with a strong will and a clear goal, as these efforts will be a key factor in successful commercialization.

(2) Superconductor Technologies in the Electronics Industry

We are entering into a new era of information sharing and global telecommunications. Personal communication demands are expanding, and the volume of shared information is increasing. Broadband wireless telecommunication systems have been introduced in Europe and Japan. In the United States, wireless carriers are incorporating superconducting filters into their cellular networks, and the superconducting filter industry has taken a giant step towards large-scale commercialization. US carriers appear to have recognized the financial benefits of using cellular base stations containing superconducting filters. Although superconducting filters are not yet in service in Japan and Europe, field tests have been performed and the participating carriers have confirmed the benefits of these superconducting systems.

In Europe, Cryoelectra has developed superconducting filter systems for current and 3G wireless communication networks and has successfully performed field tests in cooperation with European service providers. In a joint European project, Infinion Technologies Wireless Systems Sweden AB is developing an Analog-to-Digital-Converter using superconductor-semiconductor hybrid technology for software-defined radio for evolving 3G communication networks. In Japan, R&D projects aimed at using digital LTS and HTS rapid single flux quantum (RSFQ) devices in the measurement and communications fields are continuing to progress. Beginning in 2002, Japan also started a new development program for superconductor network devices with low energy consumption, including a switching module for a high-speed router and a processor module for a computer server. These programs are expected to contribute to the realization of jam-free networks and ultra-low-power-consuming devices that will be indispensable for the future IT age, where an astronomical volume of information will be communicated and processed. In addition, researchers have pointed out that magnetic flux propagating through a Josephson junction may exhibit a solitonic nature. Integrated superconductor devices utilizing this characteristic can be envisioned in the future IT world.

As for medical applications of superconductor electronics technology, efforts to develop magnetoencephalography (MEG) and magnetocardiography (MCG) using superconducting quantum interference devices (SQUIDs) are also showing exciting progress. These technologies provide non-invasive methods for diagnosing diseases that cannot be identified by any other available method. MEG systems have gone beyond the basic research stage, and a number of units are already being used clinically. MCG is expected to become available as a clinical diagnostic instrument in the very near future. Steady progress is also being observed in the commercialization of HTS SQUIDs in various specialty markets, such as non-invasive testing or geophysical exploration. The development of scanning SQUID microscopy and its successful commercialization portends promising commercial opportunities for applications in semiconductor chip quality control.

(3) Supporting Technologies: Cryocoolers

Cryogenic technology, including cryocoolers, is a crucial supporting technology for superconductor applications, without exception. However, commercially viable refrigeration products must be reasonably priced, highly reliable, energy-efficient, compact and easy to use. The key technical aspects that must be taken into consideration are the different specifications required for various applications. Generally, for power applications, the most important application issues are reliability and redundancy problems; for electronics applications, reliability, cost and, possibly, temperature stability are critical issues. Cryocoolers might be used in various temperature regions in the future, depending on their applications; at present, operation temperatures of 4.2 K and 77 K are standard. Existing cryocoolers have been built for applications other than superconductivity. For example, Gifford-McMahon (GM) cryocoolers, which have been developed and are commercially available for MRI and cryopumps, have been used for a number of larger scale superconductor applications. However, GM cryocoolers may not be suitable for very-large-scale power applications, such as power transmission cable refrigeration. Conventional Stirling cryocoolers have been used in the Japanese 3-phase/100 m, 66 kV/114 MVA cable demonstration program, the Denmark cable program, transformers and the fault current limiter in Europe. As for electronics uses, small-sized Stirling cryocoolers designed for passive applications, such as the cooling of infrared detectors, are used with mobile superconductive filter systems. However, there are still cost and efficiency issues to be resolved with present cryocooler technology. Pulse-tube cryocoolers might be a promising solution for some power and electronics applications.

The participants of ISIS-11 unanimously agreed that the development of cryocoolers must be earnestly pursued, since these components are vital to the future of the superconductor industry. Efforts should be focused on developing a family of cryocoolers, suitable for both electronic and power applications, that are more energy-efficient, more reliable, more compact and less expensive than what is currently available commercially. The concept of establishing an international consortium to accelerate the development and maturing of cryogenic technology that will meet the needs of the superconducting community was discussed. The results of such a consortium would eventually be made available to the superconducting community and cryocooler venders.

NEXT SUMMIT

The next summit hosted by CONECTUS will be held in Europe, probably in close connection with the European Conference on Applied Superconductivity (EUCAS), September 14-18, 2003.

Participating Organizations and Countries in ISIS-11:

CONECTUS (Europe)
CONECTUS, EU
Forschungszentrum Karlsruhe GmbH, Germany
NKT Research & Innovation A/S, Denmark
Vacuumschmelze (VAC), Germany

CCAS (USA)
American Superconductor Corporation
Argonne National Laboratory
Cardiomag Imaging, Inc.
IGC-SuperPower, Inc.
M. Nisenoff Associates
University of Houston

ISTEC (Japan)
Central Research Institute of Electric Power Industry
Hitachi Cable, Ltd.
Hokkaido University
ISTEC
Kyushu Electric Power Co., Inc.
NEC Corporation
New Energy and Industrial Technology Development Organization (NEDO)
Nihon University
Railway Technical Research Institute
Science University of Tokyo
Sumitomo Electric Industries, Ltd.
Sumitomo Heavy Industries, Ltd.
The Furukawa Electric Co., Ltd.
Tokyo Electric Power Company
Toshiba Corporation
University of Tokyo