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International Superconductivity Industry Summit

ISIS -14

Tsukuba, Japan

October 27-28, 2005

Joint Communique

EXECUTIVE SUMMARY

The 14th International Superconductivity Industry Summit (ISIS-14) was held at the Tsukuba International Congress Center, Japan, on October 27-28, 2005. More than 30 delegates, from 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. Invited guests from Korea and New Zealand also participated in the discussions. The main theme of this year's summit was "Commercialization and Future Market."

ISIS is an international forum that allows delegates 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.

Much effort toward the commercialization of this technology has been and continues to be made. MRI is one of the most successful examples of this commercialization. Superconductor technology is also an indispensable element for nuclear fusion and high-energy physics. After the discovery of high temperature superconductors, research and development of new materials was accelerated. Current industry developments are laying the groundwork for an enormous expansion of superconductor applications and commercialization.

Recently, oil prices have skyrocketed, reaching over $70 per barrel at their peak. The demand for all forms of energy is steadily increasing, and there is an especially close relationship between electrification of energy use and the continuing expansion of the global economy. This trend will certainly continue in the future. People are also paying more and more attention to environmental protection aspects of the energy cycle, and global warming is becoming a big issue. Superconductor technology and applications enable very large quantities of electricity to be transported through congested regions of the power grid, on a more controllable basis, using smaller rights-of-way, and with extremely low electrical losses. They also improve the reliability and quality of electric power for existing electric power grids.

In the field of communication, we are encountering a flood of information. Today, movies can be sent, processed and received through wired and wireless communication networks. Even high-definition movies will be transported through communication networks in the near future. Superconductor-based technologies could play a critical role in supporting the forecasted increase in global data traffic as a result of this growing demand, for example through improved cell-station technology. Superconductor electronics devices consume very small amounts of energy and are very fast. They can operate at more than 100 GHz without heat-related problems.

New technologies based on superconductors have the potential to bring innumerable benefits to our future society. However, both technological and commercial obstacles remain, which are of a scope beyond the means of any single commercial company. Therefore, organizations, universities and companies promoting research, development and commercialization of superconductor technologies still require the active partnership and financial support of governmental agencies to ensure that superconductor technologies can be developed to meet these pressing societal needs and help to enable sustainable future growth.

In reaction to these circumstances, the delegates discussed many aspects regarding the facilitation of superconductor technology commercialization, feasible methods for overcoming foreseen obstacles, and future market provisions. Discussions centered on the progress being made in superconductor applications, including various electric power and electronics applications, such as HTS power cables, transformers, fault current limiters, SMES, HTS utility generators, HTS motors and ship propulsion systems, MRI and NMR systems, specialty magnets, filters and network devices.

TECHNOLOGY DEVELOPMENT TOWARD COMMERCIALIZATION

Delegates reviewed significant advances in several areas of technology. The substantial progress towards commercialization, the demonstrated viability and benefits of installed prototype products based on superconductor technology, and the future additional promises of research were all examined.

(1)Technologies for Electric Power Applications

The demand for electricity in Europe, the United States and Japan has steadily increased; presently, however, developing BRICS countries (i.e., Brazil, Russia, India, China) have the highest growth rates of energy consumption. On the other hand, energy is becoming increasingly expensive, and constraints with regard to environmental protection are becoming more stringent. If global economic growth is to continue ? a condition widely regarded as essential to global stability ? appropriate measures must be taken to ensure both an adequate supply of energy as well as a robust, reliable energy delivery infrastructure. The energy issue is considered to be closely related to national security. In the USA, the “Energy Policy Act of 2005” was recently signed by the President of the United States after four years of deliberation in the US Congress. Modernization of the power delivery grid is a cornerstone of this major new law, and superconductor technology is stipulated as one of the most important and promising new energy-related technologies available to meet this pressing need.

The manufacturing of superconductor wire and cable is a basic technology for various applications, including electricity transmission. The use of superconductor cables for electricity transmission and distribution offers many benefits, especially in urban areas. LTS wire is commercially available and is used in MRI and NMR magnets. LTS wire is also indispensable for the construction of fusion reactors and particle accelerators. As for HTS, first-generation BSCCO wire is already available in commercial quantities. Rigorous research and development for second-generation YBCO coated conductor wire is now being conducted. In Japan, a five-year national program for coated conductor development began in FY2003. The target of this program is to develop a 500-m YBCO wire with a critical current of more than 300 A/cm-w by FY2007. So far, Japan has successfully produced a 1 cm-wide, 212 m-long wire carrying 245 A at the liquid nitrogen boiling temperature. The US goal is a 100-m length of 300-A per cm-width of second generation wire by 2006. So far, the U.S. has achieved a performance of more than 100 A in a 1 cm-wide 206-m length of second-generation wire as well as a performance of 165 A/cm-width in a 4.4 mm wide 85-m length of second-generation wire. The possibility of processing long lengths of second generation wire in strips as wide as 4 cm has also been demonstrated. In Europe, the goal is a 250-m second generation wire by 2007. Research and development on MgB2, which was discovered 5 years ago and is the newest superconductor material for practical application, are ongoing. In Europe, a new company was founded for the commercialization.

In the USA, three cable demonstration programs are under way: (1) a 13.2-kV, 200-m, 3-kA “triaxial” distribution cable project in Columbus, OH, (2) a 34.5-kV, 350-m, 800-A “triplex” cable project in Albany, NY, and (3) a 138-kV, 600-m, 2.4-kA transmission cable project in Holbrook, NY. Cable demonstrations are also planned or underway in Europe, China, Korea and Mexico. These demonstration projects all utilize alternating current (AC) cables, which is the main form of electricity utilized around the world. The US Congress, in the Energy Policy Act of 2005, has legislated additional demonstration of AC transmission voltage, very low impedance, controllable HTS power cables. It has also mandated the demonstration of direct current (DC) HTS power cables.

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 motors, synchronous condensers, power generators, windpower turbines, fault current limiters, magnets for magnetic separation, transformers, SMES systems and flywheels. Japan is continuing its effort to develop MAGLEV technology. The US is now strongly pursuing the development and demonstration of HTS ship propulsion motors and generators for ship propulsion systems. Europe and Japan are now starting to develop such motors and generators for all-electric ships.

MRI and NMR magnets using LTS wires have already been successfully commercialized for many years. The superconductor magnet is an indispensable element for MRI and NMR systems, the benefit and value of which is already fully acknowledged in the market. Large-scale superconductor magnet systems are also core parts in fusion reactors and particle colliders. Recently huge quantities of LTS magnets (including HTS current leads) have been fabricated and delivered to the CERN Large Hadron Collider in Switzerland, and new opportunities are opening up for the multinational ITER fusion program. HTS second generation wire offers much higher upper critical magnetic field strength than niobium-based LTS materials, and so might be a candidate for promising new applications, including very strong magnets for ultra high frequency NMR and future nuclear fusion projects.

(2)Technologies for Electronics Applications

The volume of information that we have to deal with is increasing day by day. Today, it is not exceptional that a single person may send and receive a giga-byte volume of information through communication networks like the Internet. In wireless communication, we have already entered into the 3G era. In 2010, 4G wireless communication systems are expected to be in service. Some of the US carriers have already been incorporating superconducting filters because of their superior filter performances and economical benefits.

Superconducting Single Flux Quantum (SSFQ) devices have an extremely fast switching time and their energy consumption is extremely low, when compared with existing silicon devices. These features of SSFQ devices offer great promise in addressing the information and communication flood that will be seen in the near future. In Japan, the “Superconductors Network Device Project” was started in FY2002. Under this project a five-year LTS device development program was initiated in FY2002. In FY2003, a four-year HTS device development program for A/D converter and sampler technology was begun. These programs include the research and development of design and fabrication technologies for superconducting devices. The basic technologies required for superconducting network devices will be established by FY2006. The network devices include a switching module for a high-speed router and a processor module for a server computer. In the course of research and development, an eight-bit shift register with an operational frequency of 120 GHz was realized in 2005. 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.

Magnetoencephalography (MEG) and magnetocardiography (MCG) technologies using superconducting quantum interference devices (SQUIDs) provide non-invasive methods for diagnosing diseases that cannot be identified by any other available method. The development of these medical-related superconductor technologies has been making exciting progress. Steady progress is also being observed in the commercialization of HTS SQUIDs in various specialty markets, such as non-invasive testing and geophysical exploration.

FUTURE OF THE SUPERCONDUCTOR MARKET

At present, LTS and LTS-related applications are occupying the largest portion of the existing superconductor-related market, which includes materials, wires and various application devices. Among these, MRI and NMR systems are two of the most successfully commercialized applications in which superconducting magnets comprise an indispensable component. Additional planned large-scale accelerators and fusion reactors cannot be realized without superconductors as well. As for the medical applications of superconductor electronics, MEG and MCG systems are already on the market and are establishing the status of new clinical diagnostic instruments. There are almost no alternative technologies to compete with superconductivity in the above-mentioned application fields. Therefore, superconductors will continue to be major players in these markets. It is also notable that a number of LTS-based small size SMES systems are installed at utility sites, providing an important grid stabilization or power quality function.

Almost 20 years have passed since the discovery of HTS materials. In the meantime, R&D activities to realize the commercialization of superconductor technologies, both LTS and HTS, have been rigorously carried out. Among them, superconducting filters with HTS technology are already commercially available, and some US carriers have already adopted them in wireless communication ground stations. At present, the superconducting filter market is not so large, but its future is promising as the volume of traffic through wireless communication networks increases and interference problems become too large to be neglected, especially in urban areas. After 2010, we will see a few tens of Mbit/sec data packets exchanged through wireless networks, and filters with superior performances will become increasingly valuable.

As for power applications using superconductor technologies, devices including power cables, generators, motors, fault current limiters, magnetic separation systems, SMES, flywheels and transformers are in a pre-commercial stage. An HTS synchronous condenser with a 12-megaVAR reactive power rating is being offered commercially, as are HTS research magnets and current leads. Concerted efforts to hasten and expand commercialization are still needed, and obstacles that are impeding progress need to be overcome. One of the most important requirements for commercialization is to make customers confident that these technologies are economically and technologically viable and superior to alternative technologies. Demonstration programs are one of the most persuasive ways to encourage customers to adopt these new technologies, as they demonstrate the ability and practicality of superconductor technologies in direct sight of the customers.

Commercialization cannot occur without customers' confidence. In the course of demonstration programs, technical and operational problems for commercialization can also be clarified, enabling technological and managerial measures to be taken in future commercialization efforts. Demonstration programs for HTS applications will likely be carried out using mostly first generation HTS wires over the next two to three years. In the next two years, as second generation wires become available in sufficient quantities and at a sufficiently attractive cost, they will be used in many demonstration programs. The availability of lower cost second generation HTS wires will facilitate the further expansion of commercialization because of the expected cost effectiveness.

At present, an accurate prediction of the actual market size for these superconductor power devices is difficult. But the delegates of ISIS believe that the future is very promising, especially considering various recent energy-related problems such as limited energy resources, the increasing global demand for energy all over the world, and the mounting power delivery problems typical of the world's rapidly-growing "mega-cities" ? problems that will persist in the future.

Thanks to their ultra high-speed and extremely low energy consumption, superconductor electronics technologies, including superconductor routers and superconductor computer servers, are expected to play very important roles in the coming IT era, where huge amounts of information will be seamlessly communicated through wired and wireless networks. To realize this, it is also important to have users acknowledge the superiority of superconductor technologies, with regard to their practicality and economical competitiveness. In this context, prototype systems should be realized and their high-speed system performances should be demonstrated to persuade customers to adopt superconducting network device technologies for practical applications.

It is incumbent on the global superconductivity community to engage in a concerted effort to realize full commercial utilization of these new technologies that will help ensure the sustainable future growth of our planet. ISIS-14 delegates are committed to this endeavor and expressed their sincere hope that these strong efforts will be continued with a strong will and focused goals.

NEXT SUMMIT

Details of ISIS-15 will be announced later.