超電導 Web21 Superconductivity

FALL, 2002 Date of Issue: October 15, 2002

Superconductivity Web21

Published by International Superconductivity Technology Center
5-34-3, Shimbashi, Minato-ku, Tokyo 105-0004, Japan Tel: 03-3431-4002, Fax: 03-3431-4044

Contents:

Top of Superconductivity Web21

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Published by International Superconductivity Technology Center
5-34-3, Shimbashi, Minato-ku, Tokyo 105-0004, Japan
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Top of Superconductivity Web21: http://www.istec.or.jp/Web21/index-E.html

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This work was subsidized by the Japan Keirin Association using promotion funds from the KEIRIN RACE

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The 10th International Superconductivity Industry Summit (ISIS-10)

Follow-up: Focusing on Trends Outside Japan

The 10th International Superconductivity Industry Summit was held in Santa Fe, New Mexico in the United States from March 14 through 16, 2002. 55 participants from Japan, Europe, and the United States attended the summit.

The summit proceeded with the following agenda.

(Speech on Overview)

Retrospective and Outlook for Superconductivity in the 21st Century

Dr.Carl H. Rosner, CardioMag Imaging, Inc.

Overview of U.S. Program

Dr. James Daley, Department of Energy

(Panel Discussion)

From Developer to User: Electric Power Applications for Superconductors

Dr.Gregory Yurek, American Superconductor Corp.

Dr.Juan Farre, Nordic Superconductor Technologies A/S

Dr. Hans-Werner Neumuller, Siemens AG

Dr.Tsuneo Nakahara, Sumitomo Electric Industries, Ltd.

Prof.Eisuke Masada, Science University of Tokyo

Commercial Applications for Superconducting Electronics

Dr.Robert Hammond, Superconductor Technologies, Inc.

Dr.Randy Simmon, Conductus

Dr. Michael Sander, Conectus

Dr. Shoji Tanaka, ISTEC/SRL

Meeting the Needs of the 21st Century High Energy Physics Community

Dr. Ronald M. Scanlan, Lawrence Berkeley National Lab

Dr. Hans-Udo Klein, ACCEL Instruments GmbH

Prof.Takakazu Shintomi, High Energy Accelerator Research Organization

The Outlook for Superconducting Medical Applications

Dr. David Andrews, Oxford Instruments, Superconducting Technology

Dr. Hans-Werner Neumuller, Siemens AG

Dr. Keiji Tsukada, Central Laboratory, Hitachi, Ltd.

The Bush Administration in the United States is putting much emphasis on energy policy. The policy seems quite reasonable from the standpoint of national security because the nation's imported oil accounts for more than 50% of the oil consumed in the United States and two-thirds of the imported oil comes from the Middle East. The Bush Administration seems to be also more aggressive about superconductivity than the former administration. Under these circumstances, the United States appears to put more stress on practical applications in her energy policy. For example, the electric power industry is likely to upgrade the nation's obsolete power infrastructure with the adoption and introduction of new technologies. The government is also putting considerable emphasis on the next generation wire development facilities at Los Alamos National Laboratory, where we visited this time. As for the superconducting filter, US corporations are very powerful in the world market. One thousand and several

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hundred superconducting filters have been applied to practical applications in the United States, and the market continues to expand rapidly. At least, US telecommunications carriers have begun to recognize the benefit. It seems that the United States is about to take the next step to expand practical applications of superconductivity technologies.

The 10th summit has agreed to hold the 11th International Superconductivity Industry Summit in Tokyo from November 17 to 19, 2003.

(Akihiko Tsutai, Director, International Affairs Dept., ISTEC)

Top of Superconductivity Web21

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2002 ISTEC Forum on Superconductivity Technology Trends

International Superconductivity Technology Center (ISTEC) held its Forum on Superconductivity Technology Trends on Wednesday, May 15, 2002 at Toshi Center Hotel in Tokyo. The Forum, subtitled 'Towards Energy-Saving, Environment, & Industrial Application: Launching Superconductivity Technology', focuses on recent achievements of research and developments on superconductivity for commercialization. Two hundred thirty participants attended the forum, involving the academic, bureaucratic and industrial communities together with journalists. They discussed challenging issues and future trends intensely.

At the beginning, the Forum received congratulatory addresses from Research and Development Division Manager Shigeo Tani of the Industrial Science and Technology Policy and Environment Bureau, Ministry of Economy, Trade and Industry, and General Manager Haruo Suzuki of the New Power Technology Development Office, New Energy and Industrial Technology Development Organization. They expressed hopes for early commercialization of superconductivity technology based on R&D achievements and industrial needs. Director General Shoji Tanaka of ISTEC noted in his keynote speech that the evolving highly sophisticated information society is expected to be in addition an energy-consuming society where superconductivity technologies, including superconducting devices, superconducting electric power transmission lines, SMES, and flywheel power storage will play the ultimate role in energy-saving and innovations. Director General Tanaka of ISTEC expressed his firm determination to pursue further research and development.

Director Tajima of SRL emphasized the significance of analyzing the mechanism of MgB_2, a new superconductor. According to an evaluation result, MgB_2 is s-wave superconductor and its superconductivity at 4.2K could exceed metal superconductors. She also stressed the necessities of controlling the dope condition, constituents, and orientation based on research achievements of physical properties of high temperature superconductors(HTS) in order to develop wires and devices.

Director Tanabe of SRL reported on the progress that has been made in the development of substrates, thin film layering, joint formation, prototypes of small-scale demonstrative circuitry for HTS devices, achievement of 270 GHz operation with a flip-flap circuit, and a roadmap for early demonstration of medium-scale circuit prototypes including AD converters and measurement instruments. Professor Hayakawa of Nagoya University reported on the progress in the technological development of an LTS superconducting circuit for integration and presented a roadmap of its practical applications towards 2010, including field testing for AD converters and its demonstration and systematization for high-end routers and servers.

Director Murakami of SRL reported on a remarkable improvement in the features of a trapped magnetic field due to successful developments in process technology for bulk superconductors and an improvement in the mechanical strength due to resin impregnation, and introduced industrial applications, such as magnetic separation and current lead. Dr. Oka of the Iwate Industrial Promotion Center and Aishin Seiki reported on the development and commercialization of a superconducting permanent magnet system with a Sm HTS bulk that can generate a 3T magnetic field, and proposed a joint development project that aims to apply the HTS bulk to magnetic systems and magnetic separation systems.

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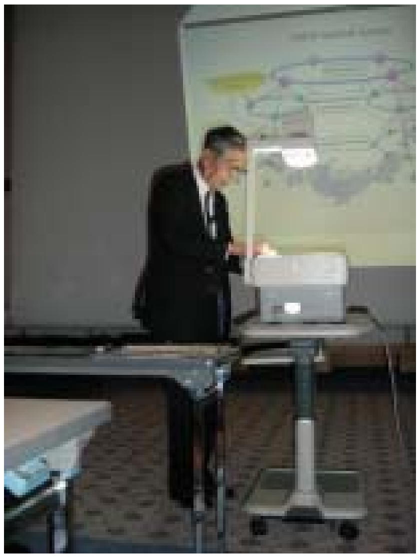
Director Shiohara of SRL reported achievements on a 30-meter long next generation HTS wire with a Jc of almost 1 MA/cm^2. His topics covered progress in the technological development of long length wire manufacturing processes, technological trends in the United States, the practical targets of wire performance, including a wire cost and challenging issues.
Mr. Hirose of Sumitomo Electrical Industries introduced a joint development project with Tokyo Electric Power Company, where a verification test for practical use is successfully on the way using a 100-meter long HTS power cable of three-core non-segregated type.

Managing Director Tatsuta of ISTEC, reported on a magnificent development of SMES cost reduction technology that enables us to set a target cost and to estimate the feasibility of the application, including decisions on the optimal conductor structure and the coil system of the metal superconductor, and the possibility for further cost reduction by applying a HTS. Dr. Koshizuka, Acting Director General of the SRL Morioka Branch Office, reported on an improvement in the loading capacity of superconducting bearings for flywheel power storage. His report also covered the development of an essential technology for rotation loss reduction and for axis fall reduction, superconducting bearing operation testing, results of application technology developments including flywheel axis damping, and challenging issues.

In the end, Professor Masada of Science University of Tokyo gave a keynote speech titled 'Industrial Application of Superconductivity Technology: Possibilities and Impacts.' In particular, Professor Masada mentioned that based on the technological progress of superconductivity in the energy and electrical power areas we are requested to cope with circumstantial changes. Industrial application becomes very important and meaningful because there can be markets that allow existing superconductivity technology to break in and because commercialization at the each steps of development levels will be possible. Great effects will be brought about on energy-saving when we use superconductors into fixed energy utilization sources, such as motors accounting for 60 to 70% of the electric power for industrial use, transformers and cables. In closing Professor Masada emphasized the significance of preparing a roadmap, contributing to Japan's international competitiveness, and developing technologies in consideration of costs.

This forum has renewed our understanding of the meaning and significance that Japan's superconductivity technology is leading the world and that both the national government and private sectors should continue research and development on superconductivity, which will eventually reinforce the competitiveness of industries in Japan.

(Yoshinobu Ueba, Director, Research & Planning Dept., ISTEC)



Director General Tanaka of SRL,ISTEC giving a keynote speech

Top of Superconductivity Web21

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Long-Range Current-Voltage Tests of World's First Three-Core in a Cryostat High Temperature Superconducting Cable System Completed

Tokyo Electric Power Company, Sumitomo Electric Industries, Ltd., and the Central Research Institute of Electric Power Industry (CRIEPI) completed the verification tests for the practical application of a bismuth oxide superconducting cable (current-voltage test) in June 2002 as initially scheduled. The test had begun at the Yokosuka Research Laboratory of CRIEPI in June 2001.

The bismuth oxide superconducting cable is characterized as having a three-core in a cryostat, cold electrical insulation, and having completed 100-meter long cable testing for the first time in the world. A series of verification tests for practical application covered (1) first cooling test, (2) nominal current-voltage tests, (3) load fluctuation tests, (4) over-loading test, and (5) four-times cooling cycle tests. An overview of the verification tests is described below.

At first, in (1) first cooling test, it took approx. 35 hours to cool the entire cable down to the liquid nitrogen temperature (77.3K) from the ambient temperature; the thermal contraction stress, caused by cooling, reduced to one-fifth; a critical current indicated 2,760 A (equivalent to 223 MVA) in the liquid nitrogen temperature; superconducting shielding current was confirmed in the adverse phase of the conductor; thermal insulation loss and alternating current loss in 1 kArms-50 Hz stood at approx. 2.5 W/m and approx. 2 W/m respectively. In (2) nominal current-voltage tests, 40 kV of voltage to ground (equivalent to 66 kV phase to phase) and rated loading and conducting of 1 kA three-phase current continued for one month, during which the static capacitance tan δ kept fine; and occurrence of partial discharge was lower than the detection level. In (3) load fluctuation tests, two loading patterns were tested at 40 kV of voltage to ground (fixed). After maintaining 8 hours at 1 kA, the current was lowered to 0.4 kA to continue the operation for 16 hours. The other loading pattern was to lower the current down to 0.2 kA to maintain the current for 8 hours after maintaining the current at 1 kA for 16 hours. The currents were stable under the both loading patterns. In (4) over-loading test, the current kept stable under a conducting test that exceeded 1 kA. In (5) three-times cooling cycle tests, the heat-mechanical influence on a system and the influence on a cable performance did not observe in critical current measurement, heat loss measurement, shielding current measurement, current-voltage test, etc. The system characteristics were verified as good. The last fourth cooling cycle test is scheduled in the future.

Moreover, they are planning to conduct the disassembly and investigation of the cable and others in fiscal 2002 to investigate the superconductivity characteristics, insulation characteristics, and other physical properties of the bismuth oxide superconducting cable.

(Mitsuhiro Anju, General Affairs Dept., ISTEC)

Top of Superconductivity Web21

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Present Situation of SQUID Related Markets

Sales of SQUID high-function sensor systems, where low temperature superconductivity (LTS) and high temperature superconductivity (HTS) technologies are incorporated, have amounted to ¥5,500 million/year to ¥6,000 million/year in recent years. SQUID involves applications of medical science and biotechnology, material assessment, current measurement, geophysics, and other sciences.

Since the 1990s, LTS-SQUID related markets have exhibited a remarkable growth in medical science-applied areas, especially brain magnetic field measurement systems (magnetoencephalograph, called 'MEG' for short) with SQUID and cardiac magnetic field measurement instruments (magnetocardiograph, called 'MCG' for short). MEG costs ¥400 million or more and requires ¥25 million/year in maintenance costs. However, its space resolution and time resolution are superior to other competing products. Worldwide, 75 MEG systems with dozens of channels have already been installed (38 MEG systems in Japan) and more than 60 MEG systems are working. Some 10 MEG systems are installed every year, forming a market size of ¥5,000 million/year. Major MEG system makers include 4D-Neuroimaging Inc. (a merger company of Neuromag Ltd. and BTi Corp.) and CTF Co., Ltd. New comers are also trying to break into the market, including Yakogawa Electric Corporation and Shimadzu Corporation. Meanwhile, some 50 MCG systems have been installed worldwide (5 MCG systems in Japan). MCG systems are about to form a market with annual sales of ¥500 million. The reason, for such a small number of MCG system installations seems attributable to differentiation from other measurement systems. Embryonic MCG systems have come into the spotlight in recent years.

Meanwhile, the development of HTS-SQUID applied systems is underway, where hundreds of millions of yen have been spent so far. Promising areas include applications of medical science and biotechnologies, material assessment by non-destructive inspection and SQUID microscopes, X-ray detectors, applications of current measurement such as wiring inspection of integrated circuits, applications of geophysics such as structural probe of oceans and underearth, and environmental magnet measurement. It will take five to ten years before the HTS-SQUID system becomes stable in operation, available at a low price, and useful for clinical application.

Sources: Shin Iryo (May, 1999 issue); Roadmap of Superconducting Electronics (May, 2002 issue) by the 146th Committee, Japan Society for the Promotion of Science

(Yasuzo Tanaka, Editor)

Top of Superconductivity Web21

超電導 Web21
Superconductivity

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Superconductivity Web21

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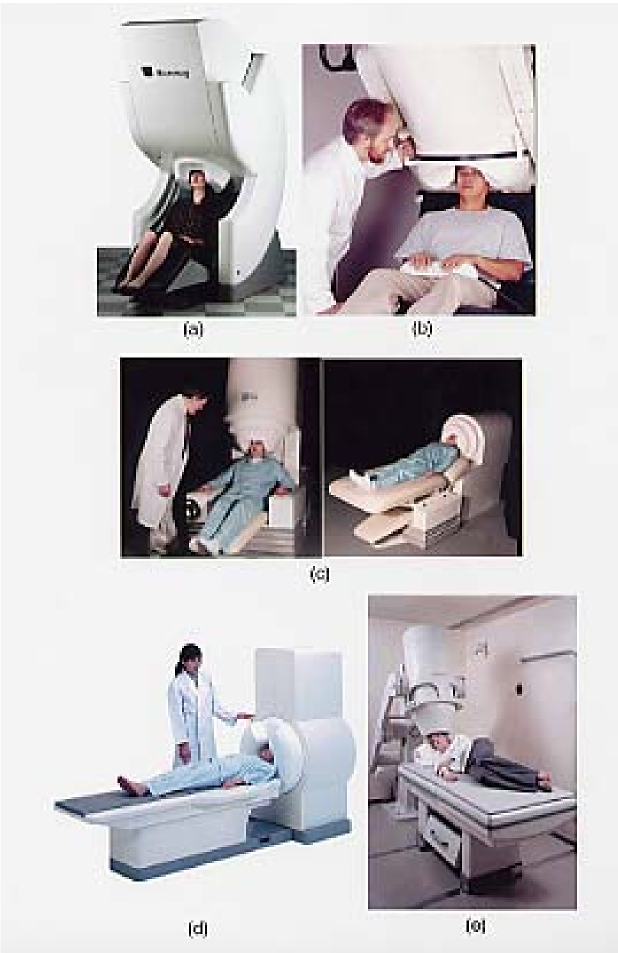
MEG Market and Present Situation of the Technology

Norio Fujimaki
Senior Researcher, Brain Function Group
Communications Research Laboratory

In MEG (Magnetoencephalography) experiments, we measure weak magnetic fields (hundreds of fT) produced by human brains in sufficient time resolution (millisecond) to detect the brain activities. Commercially available MEG systems use LTS SQUIDs having the sensitivity of 10 fT/Hz $^{-1/2}$ or less at a frequency of 1 or 2 Hz. To reduce external noise, the MEG systems adopt gradiometer coils that detect spatial changes of the magnetic fields, i.e., being more sensitive to neighboring sources in the brain than far noise sources, noise cancellation algorithms, and magnetically shielded room. The MEG systems have been manufactured and marketed by overseas corporations (4-D Neuroimaging (merger of former BTi and Neuromag), CTF, etc.) and Japanese corporations (Yakogawa Electric, Shimadzu, Hitachi, Daikin, Seiko Instruments). The latest systems have up to 150 measurement points and 300 SQUIDs (number of channels), and cost several hundred million yen. Over 80 systems with more than dozens of channels have been installed worldwide (half of which are installed in Japan), in universities, national and public institutions, corporate laboratories, hospitals, and medical institutions. Clinical applications of MEG systems include localization of epileptic foci and functional test before and after brain surgery operations. Some of the hospitals have been approved to use MEG as the highly advanced medical treatment system. It is hoped that health insurance will cover the use of MEG systems in the near future. In basic research, MEG systems are used to measure brain activities related to the visual acoustic, somatosensory, gustatory, and olfactory stimulations. In addition, research is underway to estimate locations of multiple active sources from the brain magnetic fields by solving the inverse problems. Concerning the hardware of MEG systems, although there are unsatisfactory points such as transfer of liquid helium, required tuning, and shielding technology, most users are satisfied with basic



Latest MEG systems: (a) Neuromag, (b) BTi, (c) CTF, (d) Yokogawa Electric, and (e) Shimadzu.
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performance. Meanwhile, demands for improvements in software are quite strong, especially for stable solutions of the inverse problems, shortening of analysis time, automated analysis, displaying method of analytical results, and user-friendliness. Although the MEG market grows slowly but steadily, its further growth will depend on improvements in software, low pricing, completeness of the system, after-sales support, and other services.

Reference: This article was written by referring to Superconductivity Roadmap, published by the 146th Committee of Superconductivity Electronics, Japan Society for the Promotion of Science (http://www.okabe.rcast.u-tokyo.ac.jp/jsps/index-j.html)

Top of Superconductivity Web21

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MCG Technology of Hitachi, Ltd.

Keiji Tsukada, Senior Researcher
Medical System Department
Central Research Center, Hitachi, Ltd.

Hitachi, Ltd. is conducting R&D on the magnetocardiograph(MCG), which measures the weak magnetic field emitted from the heart and diagnoses heart diseases. The 64-channel MCG using Nb SQUIDs, which are LTS, was developed by Hitachi High Technologies corporation, a Hitachi subsidiary company. (It became a separate spin-off company in October 2001.) The compact system was realized by fastening the sensor unit and adopting a freely movable bed mechanism. Since many instruments including the electrocardiograph and the ultrasonic echo and scintigraph equipment are already available as heart disease diagnosing equipment, validity and superiority have been required of the MCG. Hitachi has been verifying clinical effectiveness in joint research with medical institutions. Our company has clarified new findings concerning the ischemic heart disease and arrhythmia in particular. It has become possible to capture images of myocardial repolarization abnormality and inhomogeneous current distribution of ischemic heart disease and quantify them (Fig. 1). As for arrhythmia, it has also become possible to estimate the anatomical position of an arrhythmia-generating source and capture images of the propagation process. Heart disease in the fetus can also be identified. The WPW syndrome and the long QT syndrome have been reported for the first time. Interest in MCG has increased in recent years and a growing number of medical institutions are conducting research on MCG in the United States as well as in Germany. Under these circumstances, the diffusion of the MCG and the establishment of heart disease diagnosing criteria are accelerating. Hitachi is also carrying out research on the SQUID of the HTS and its system as next-generation technology. The company developed and reported on the MCG in combination with a gradiometer-type SQUID and a small magnetic shield using nanocrystalline soft magnetic alloy (FINEMET manufactured by Hitachi Metals, Ltd.) (Fig. 2). Hitachi will aim to further improve the sensitivity and reliability of the SQUID and realize a simple, small HTS magnetocardiograph.

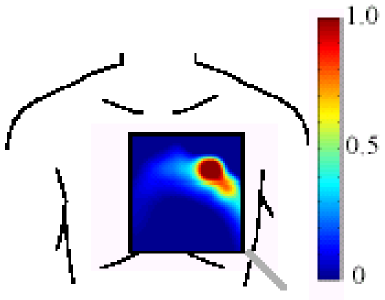

Fig. 1 The current ratio map, which shows a change (the red area is abnormal) in cardiac current before and after exercise stress in an ischemic heart disease patient.

Fig. 2 HTS magnetocardiograph

Top of Superconductivity Web21

FALL, 2002 Date of Issue: October 15, 2002

Superconductivity Web21

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Prospects for High-Temperature Superconducting Bulk and Wire

- Steady Progress in Element Technology for Putting Bulk to Practical Use and Making Wire Longer -

The International Superconductivity Technology Center (ISTEC) is conducting R&D to realize high-temperature superconducting bulk and a superconducting wire as part of the "Project on Research and Development on Basic Technologies Required for Superconductivity Applications," which has been carried out since the 1998 fiscal year. ISTEC has prospects of achieving an original goal in the 2002 fiscal year with respect to the development of element technology.

ISTEC's original goals in the development of the element technology for superconducting bulk are shown below by making a large superconducting bulk magnet.
(1) To obtain a trapped magnetic field of 3T at 77K and
(2) To achieve a critical current density of 100,000 A/cm^2 at 77K and 3T.
As for goal (1), ISTEC achieved a surface magnetic field of 2.7T, using a gadolinium-based bulk superconductor. As for goal (2), ISTEC achieved a critical current density of 700,000 A/cm^2 in neodymium, europium, and gadolinium bulk superconductors at 77K and 3T. The advance in these element technologies was made possible by introducing a magnetic field induction type pinning center, miniaturizing RE-211 precipitates, improving mechanical characteristics owing to epoxy resin impregnation technology, making bulk large due to crystal bonding technology, etc. The achievement of the original goal in the 2002 fiscal year is considered to be within the realm of possibility. In this context, these superconducting bulk element technologies are making steady progress toward the commercialization of the superconducting motor, magnetic separator, magnetic bearing, and other devices.

On the other hand, ISTEC set the following two original goals for the development of the element technology for superconducting wire.
(1) To achieve a critical current density of 300,000 A/cm^2 at 77K and 5T for a next-generation short wire (L = 20 cm) and a critical current density of 10,000 A/cm^2 at 77K and 0T for a next-generation long wire (L = 50 cm), and
(2) To obtain a critical current of 1,000 A or more at 77K and 3T in a next-generation large-current short (L= 20 cm) conductor with a diameter of 2 mm.
As for goal (1), ISTEC achieved a critical current density of 170,000 A/cm^2 ($\perp$c) at 77K and 5T and that of 100,000 A/cm^2 (//c) at 77K and 3T in a short wire, with a YBCO film laminated and the TFA-MOD film-making method, using a metallic substrate as a YSZ intermediate layer with the IBAD method. It also achieved a critical current density of 780,000 A/cm^2 and a critical current of 39A at 77K and 0T in the PLD film-making method using a 30-meter-long IBAD-method metallic substrate. As for goal (2), ISTEC succeeded in manufacturing a 20-centimeter-long unidirectional solidified crystal(a critical current of 2000 A at 77K and 0T and a diameter of 2.8 mm) made of yttrium material. As seen above, since ISTEC is studying the optimization of each element process and speeding up the process of making a long superconducting wire, it will be able to achieve the original goals by the end of the 2002 fiscal year.

As described above, the commercialization of the element technology for superconducting bulk material can be expected. We think it necessary to spend enough time to determine whether a process of combining each element technology is possible or not and to conduct a demonstration test of the long superconducting wire.

(Yasuzo Tanaka, Editor)

Top of Superconductivity Web21

FALL, 2002 Date of Issue: October 15, 2002

超電導 Web21
Superconductivity

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Prospects for Superconducting SFQ Element Technology

- Should the SFQ Device of HTS Be Commercialized on a Medium Scale? -

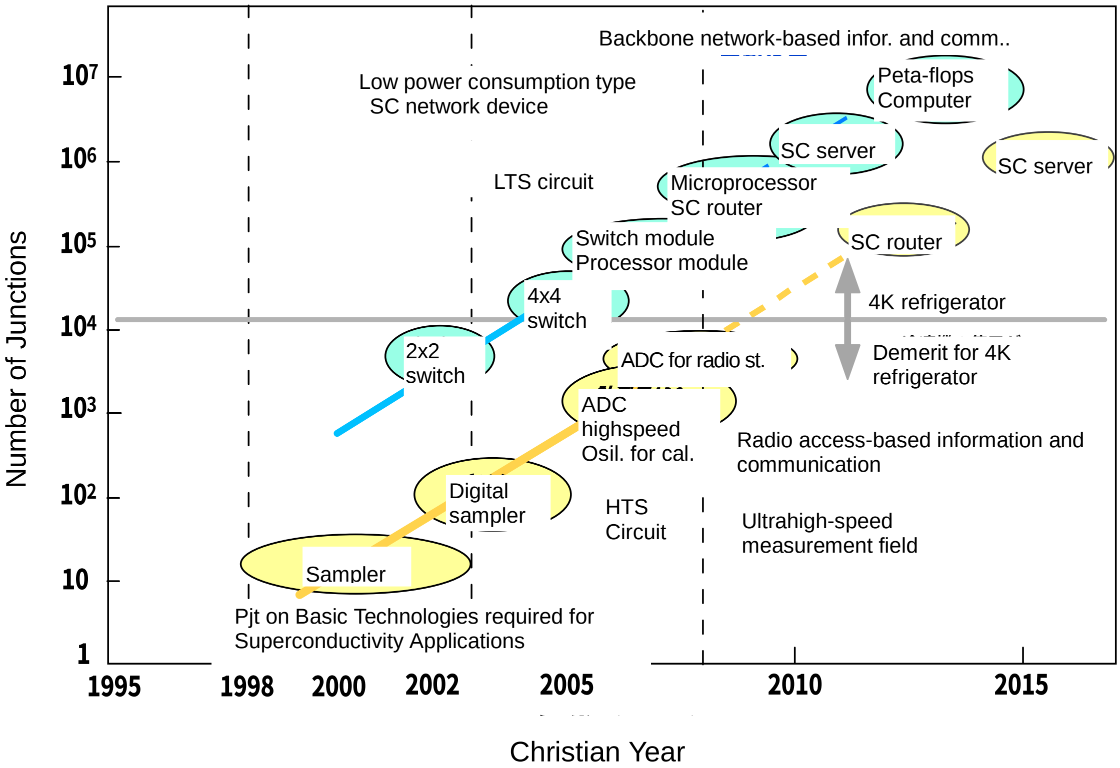
The development of superconducting device technology using the superconducting Single Flux Quantum (SFQ) instead of Si-CMOS as a digital device element is making progress, forming two main currents.

The target of one (A) of the main currents is to put to practical use medium- and small-scale stand-alone type systems such as the analog-to-digital converter and the receiver for radio stations in the field of access-based information and communications, the ultrahigh-speed oscilloscope in the field of measurement, and the waveform generator. The target of the other current (B) is to conduct R&D on a large-scale practical system such as the digital signal processor, superconducting router, and superconducting server in view of the application to the field of backbone network-based information and communications. The former current (A) includes the R&D handled in the "Project on Research and Development on Basic Technologies Required for Superconductivity Applications," which was started in the 1998 fiscal year. The latter current (B) will be handled in the "Project for Development of a Low Power Consumption Type Superconducting Network Device," which is scheduled to start in the 2002 fiscal year.

It is said that the superconducting SFQ device will realize a 100 GHz-class ultrahigh-speed clock characteristic at a scale of integration as high as the LSI level with a power consumption as low as 1/100 of Si-CMOS. In other words, the superconducting SFQ device is expected to play an important role as a next-generation Si-based digital device. The realization of a device using this SFQ element depends greatly on the development of low-temperature, high-speed packaging technology including integration technology such as junction and thin film process, circuit design technology, and cooling technology. For the high-temperature-superconductor-using SFQ device that belongs to current (A), medium-scale integration (thousands of junctions or less) technology and low-cost 20K-40K operating temperature technology will be adopted for the time being. On the other hand, for the low-temperature-superconductor-using device that belongs to current (B), ISTEC is aiming to demonstrate a large-scale integration device of 10,000 junctions or more. This figure is said to be a break-even point in 4K cooling technology. It also plans to demonstrate a prototype such as a switch module for routers through the development of niobium high-integration process technology, circuit design technology at a scale of 100,000 junctions, and low-temperature high-speed packaging technology.

The interim evaluation of the "Project on Research and Development on Basic Technologies Required for Superconductivity Applications" has been finished recently. The evaluation has revealed steady progress of junction technology and prototype circuit manufacturing technology related to a digital device using a high-temperature superconductor. First, as for junction technology, ISTEC achieved the IcRn product of 1.1 mV @ 40K on the LPE film ground plane of YBCO by means of surface reforming barrier ramp-edge junction and the standard deviation σ=8.1% of Ic variation at 100 junctions for Ic uniformity.

On the other hand, in the high-speed prototype circuit manufacturing technology, ISTEC verified a 270-GHz operation (@4.2K) in a toggle flip flop circuit with nine junctions of which the IcRn product is 1.7 mV and a 100-GHz operation (@20K) in a $\Sigma-\Delta$AD converter front-end circuit with 13 junctions. ISTEC also verified a 30-GHz oscillation (@30K) in a ring oscillator circuit using 21 junctions on a ground plane. These achievements show continued progress toward the superconducting three-layer thin film lamination technology, Ic variation standard deviation σ<8% (1000 junctions with @GP), operation of several tens of GHz in a small-scale circuit, low power consumption of 100 nW/junction, which are immediate targets of this project. There is a very good prospect of the achievement of these immediate targets, and ISTEC is making steady progress toward medium-scale commercialization of several thousand junctions described in current (A).



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May 15, 2002 (Wednesday), International Superconductivity Technology Center

(Yasuzo Tanaka, Editor)

Top of Superconductivity Web21

FALL, 2002 Date of Issue: October 15, 2002

Superconductivity Web21

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Outlook of Base Technology for Improvements in Superconducting Characteristics

- Proposing Guidelines for Practical Applications Including RE-123, Bi-2223, and MgB_2 -

The International Superconductivity Technology Center (ISTEC) has proposed guidelines for the 'Development of Base Technology for Superconductivity Application' project implemented in fiscal 1998. In particular, ISTEC has proposed guidelines for the (1) high temperature superconductivity occurrence mechanism, (2) critical current mechanism, (3) new material research, and (4) improvement in characteristics of practical materials. Such superconducting materials include RE-123, Bi-2223, and MgB_2. This report describes steady results on superconducting materials.

For the development of high temperature superconductivity, optical spectrums of superconductor La214 observed superconducting responses that suggest special pairing. Raman scattering spectroscopy on Bi-2223 also observed resonance effects derived from three CuO surfaces in unit cells. A single crystal of new superconducting material MgB_2 was found to be a BCS superconductor from structural analysis, transportation characteristics analysis, Raman spectroscopy, and photoelectron spectroscopic measurement.

For critical current mechanism, Nd-123 crystal of neodymium, 2% of which was replaced with calcium, improved its irreversible magnetic fields to 12T at 77K in the anisotropy lowered by the introduction of carriers. It was found that polycrystal MgB_2, to which titanium was added, improved the critical current density in the self magnetic field to 2 million A/cm^2 at 5 K. The anisotropy of single crystal MgB_2 was indicated to be 3 to 4.5 when the critical magnetic field, irreversible magnetic field, and electrical resistivity were measured. It was also revealed that the irreversible magnetic field of single crystal Bi-2212 improved dramatically as the constituent ratios of 2:2:1 of Bi, Sr, and Ca were slightly changed.

For new material research, Japan succeeded in producing quality single crystals of MgB_2 ahead of other nations in the world, contributing to the analysis of its physical properties. Moreover, growth conditions of Bi-2223 single crystals were optimized to examine the effects of zinc replacement.

For improvements in characteristics of practical materials, emphasis was placed on (1) controlling anisotropy (to lower anisotropy and to enhance pinning with carrier dope and impurity replacement), (2) controlling crystallographic axis orientation (to draw maximum capacity from anisotropic superconductors), (3) controlling carrier density (to enhance pinning of high carrier density constituents), and (4) controlling copper-site impurities and crystal distortion (removing instability unique to the d wave symmetry).

(Yasuzo Tanaka, Editor)

Top of Superconductivity Web21

FALL, 2002 Date of Issue: October 15, 2002

超電導 Web21
Superconductivity

Superconductivity Web21

Published by International Superconductivity Technology Center
5-34-3, Shimbashi, Minato-ku, Tokyo 105-0004, Japan Tel: 03-3431-4002, Fax: 03-3431-4044

Progress in Super-ACE (R&D on Base Technology for Alternating Current Superconducting Power Equipment)

Tohru Nakatsuka (Cable Engineering Section), Katsuji Iwadate (Static Equipment Engineering Section), Alternating Current Equipment Engineering Dept., Engineering Research Association for Superconductive Generation Equipment and Materials (Super-GM)

NEDO commissioned the project of 'Research and Development of fundamental technologies for superconducting AC power equipments (Super-ACE)' to Super-GM in 2000. The five-year project is a part of the innovative technology program to prevent global warming initiated by the Ministry of Economy, Trade and Industry, which aims to make an early introduction of AC superconductivity technology into power transmission and transformation.

This project aims to realize energy-saving by making AC superconducting transmission and transformation power equipment, which can reduce energy loss and realize compact and light-weighted power equipment unlike existing power equipment. The core of this project lies in the development of a superconducting cable, an SN transition type superconducting fault current limiter (SN type FCL), and a superconducting magnet for power applications. The following report describes the progress made so far in these areas.

In the development of a superconducting cable, we set goals of more than 3 kA of maximum conducting capacity, 1 W/m or less of AC losses, and the establishment of a liquid nitrogen technology that can cool a 500-meter long cable. These goals will be achieved when the following relevant element technologies are developed, namely 1) technology that can fabricate HTS conductor of large capacity and low loss, 2) technology that can form barrier layers, 3) technology that can cool the long cable. For the technology in 1) above, we developed equipment that can measure AC losses by heat from a cable conductor and examined a 3 kA-class short Bi twisted-wire conductor whose winding pitches have been adjusted. The result gave us a prospect for attaining AC losses of 1 W/m or less. We also found the possibility of making a Y system tape wire conductor by examining a model conductor of a few Y system tapes. For the technology in 2) above, we made a Bi barrier tape wire of 19-filaments in honeycomb structure to demonstrate the reduction of AC losses. We also measured the growth speed of forming a bridge between superconducting filaments, a cause of AC losses. For the technology in 3) above, we made a 30 m-class long model cable to carry out cooling tests. Our tests found no reduction of Ic in cable laying and heat contraction. The heat invasion of the cable stood at 1 W/m (straight part) and 2 W/m (bending part). We optimized the heat insulating pipe to reduce heat invasion. Based on the data obtained from these experiments, we optimized the cable specification and testing methods. Verification test of cooling a 500-meter long cable will be started in the second half of fiscal 2003.

For an SN type FCL, we are working on the developments of a technology that can form a 10 cm x 30 cm superconducting thin film with 1 MA/cm^2 or more of critical current density (Jc); a technology that can realize 6.6 kV of high voltage in series-parallel connection of devices; and a technology that can achieve 1 kA of large current. We succeeded in developing equipment that can produce superconducting films (PLD method) and making HoBCO superconducting thin film on a 3 x 10 cm single crystal substrate. The superconducting thin film gave us the results of Ic = 76 to 148 A/cm and Jc $\leqq$ 3.3 MA/cm^2 (transport method). For a technology of making large current FCL, we examined the leveling of currents, temperature rise in current limiting, and heat stress in relation to element structures and arrangements, and decided the specification and element arrangement configuration (8 parallel connection, 2 serial connections in polygonal arrangement) for 1 kA-class FCL. Now we are trying to optimize the 1 kA-class FCL. For making a high voltage FCL, we succeeded in enhancing the heat characteristics of elements and achieved applying 900 V peak to element of 12 cm long (applicable stress : 75 V/cm). These led to a successful current limiting test of 12 current limiting modules in series (Ic = 90A) with 5.4 kV of peak voltage.

For magnets, we are focusing on the technological developments of an iron core magnet for 66-77 kV/10 MVA-class transformers and coreless magnet with 66kV, 500A, and 500A/5ms of responsiveness for rectified FCL. The element technologies include producing high voltages and large currents and cooling. For producing high voltages, we carried out insulation tests of a model coil and bushing in sub-cooled liquid nitrogen and in a gas-liquid mixed condition to obtain basic characteristics of their insulations, which are necessary for designing 66 to 77 kV-class equipment. For producing large currents, we optimized the conductor constituents (to reduce loss), assessed current carrying characteristics and current distribution characteristics of coils, and obtained characteristics of transient responsiveness on overcurrent conduction, all of which aims to produce a kA-class current. For cooling, we made a cooling system to obtain data for initial cooling time and cooling characteristics. Based on this data, we are trying to establish a magnet technology for power applications.

In addition, from the results of analyzing effects of introducing a superconducting cable into a power system, we found that superconducting cables can improve the stability of the voltage and increase the maximum transmittable power, compared with existing power cables. We have also confirmed conditions in which installing and extending superconducting cables can cost less than existing power cables.

Super-GM has mobilized extensive knowledge and technology representing business, government and academics and achieved considerable results. We hope that our activities will lead the world to make AC superconducting power equipment practicable and to encourage younger engineers involved in AC superconductivity projects.

Top of Superconductivity Web21

FALL, 2002 Date of Issue: October 15, 2002

Superconductivity Web21

Published by International Superconductivity Technology Center
5-34-3, Shimbashi, Minato-ku, Tokyo 105-0004, Japan Tel: 03-3431-4002, Fax: 03-3431-4044

Nanostructure Control Made Dramatic Improvement in Characteristics of Magnetic Fields of High Temperature Superconductors

(World's highest characteristic 14 T or more of irreversibility field at 77 K)
- Great hopes for application of high magnetic fields with high temperature superconductors -

The Superconductivity Research Laboratory (SRL), in cooperation with the Industrial Technology Center of Iwate Prefecture, succeeded in developing a technology that makes a dramatic improvement in the magnetic field dependency of critical current density by controlling the nanostructure of an RE-Ba-Cu-O bulk superconductor (RE: rare earth element) in nano-meter order.

At present, the development of high temperature superconducting materials is actively running towards practical applications. Among them, RE-Ba-Cu-O bulk drawing attention on the marketplace because the superconductor allows you to make a powerful superconducting bulk magnet which magnet is several times more powerful than permanent magnets. A superconducting bulk magnet contains a lots of microscopic non-superconducting particles dispersed in the superconducting phase. It uses the strong pinning force of non-superconducting materials to trap large magnetic fields. In addition, it is also important to make a material larger and to enhance the magnetic fields dependency of the critical current density to make a more powerful magnet. Here, it is useful to add a lot of microscopic non-superconducting particles to the superconductor to enhance the actual critical current density.

At present, Y-Ba-Cu-O bulk superconductors are most popular materials in the research and development of RE-Ba-Cu-O bulk superconductors. In the liquid nitrogen temperature (77 K), the critical current density will decrease as a magnetic field is added to the Y-Ba-Cu-O superconductor, and at around 5 T, the critical current density will fall to zero (refer to Figure 1). However, an LRE-Ba-Cu-O bulk superconductor (LRE includes La, Nd, Sm, Eu, Gd among rare earth elements) made in the OCMG method developed by SRL increased characteristics of the critical current density in strong magnetic fields, improving magnetic field characteristics up to around 8 T. This is because microscopic pinning centers have been formed in the RE123 superconductor as crystal grows in a low oxygen atmosphere.

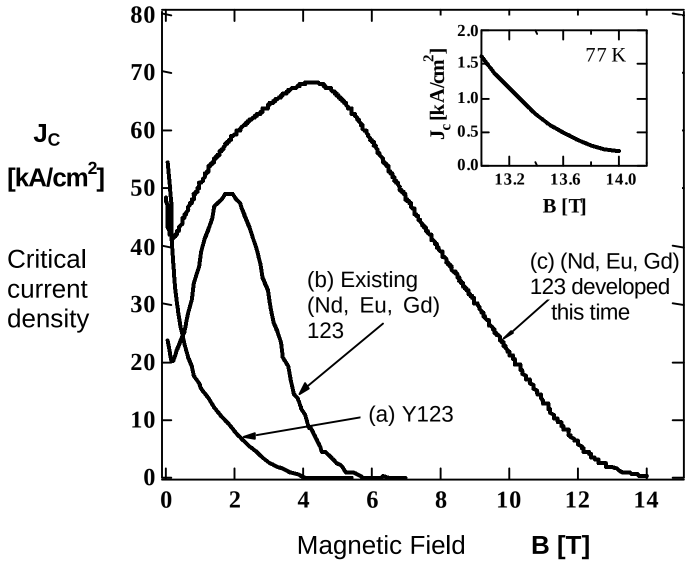

Figure 1
Existing Y123 bulk superconductor (a), (Nd, Eu, Gd)123 (ratios of Nd:Eu:Gd are 1:1:1) bulk superconductor (b) and (Nd, Eu, Gd) 123 developed this time (ratios of Nd: Eu: Gd are 33:38:28, and 5% of (Nd, Eu, Gd)211 are added) Dependency of external magnetic fields, B, of the critical current density, Jc, of bulk superconductor (c) (The dependency was measured by applying magnetic fields along the c-axis of specimen at 77 K). Jc did not fall to zero even at 14 T (suggesting that the bulk could be used as a superconductor up to 14 T).

The superconducting material, developed this time, was produced in the improved OCMG method technology where Nd, Eu, and Gd were mixed and the constituent and the production method were optimized. As Figure 1 shows, we succeeded in reaching the world's highest 20,000 A/cm^2 of critical current density under a high magnetic field at 10 T and 77 K, and in increasing the irreversibility field up to 14 T or more. When we observed the microscopic structure of the bulk material with a transmission electron microscope (TEM), we found stripe structures in less than 20 nm in width. When we observed some of the bulk materials with a scanning tunneling microscope (STM), we also found structures of a few nanometer granular materials are arranged in stripes. The structures, separated out in stripes, seem to have contributed to a dramatic improvement in the magnetic field dependency of the critical current density.

For Y-Ba-Cu-O bulk superconductors, approx. 1 T of superconducting magnets are made at the liquid nitrogen temperature (77 K).

Since the bulk material, developed this time, has made a dramatic improvement in the critical current density under a strong magnetic field, it could make a 10 T or stronger magnet in the liquid nitrogen temperature (77 K). This will promote applications of high magnetic fields to powerful bulk magnets, etc. in the high temperature range, such as the liquid nitrogen temperature. Applications of powerful bulk magnets include water purification systems, magnetic tomographs, magnetic separation systems for recycling resources, magnetic excitation equipment, powerful magnetic levitated systems, and others.

Our research achievements were presented at the Applied Superconductivity Conference (ASC) held in the United States from August 4, 2002.

This work was supported by the New Energy and Industrial Technology Development Organization (NEDO) as Collaborative Research and Development of Fundamental Technologies for Superconductivity Applications.

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Telephone: +81-19-635-9015

Top of Superconductivity Web21

Superconductivity Related Products Guide

[Corporations are listed in Japanese alphabetical order.]

- Superconducting Quantum Interference Device (SQUID) Related Products -

Shimadzu Corporation
SQUID magnetometer, Biomagnetic measurement system (vector type: 129 channels, SBI-100: magnetoencephalogram (MEG))
Tel: 075-823-1271 Fax: 075-811-8185
E-mail: medical@shimadzu.co.jp

Sumitomo Electric Hightecs Co., Ltd.
High temperature superconducting magnetic sensor 'SQUID Introductory Kit'; high temperature superconducting magnet sensor 'SQUID Experiment Kit'; high temperature superconducting SQUID high-sensitive magnetic sensor 'SEIQUID II'; high temperature superconducting SQUID applied 'Biomagnetic measurement system,' 'antigen antibody reaction inspection system,' 'Geological survey system', 'Foreign object inspection system,' 'Semiconductor inspection system', etc.
Tel: 03-3423-5921 Fax: 03-3423-5924
Person in charge: Ohashi and Ishikawa of the Sales Dept.

Seiko Instruments, Inc.
Scientific Equipment Division
Nb low temperature scanning type SQUID microscope, etc.
Tel: 043-211-1345 Fax: 043-211-8067
E-mail: yukiya.watanabe@sii.co.jp
Person in charge: Yukiya Watanabe, Measurement Sales Section I

Yokogawa Electric Corporation
MEG Center, Aerospace and Specialty Equipment Division
Magnetoencephalogram (MEG), Compact and weak magnetic field measurement system
Tel: 0422-52-5662 Fax: 0422-52-5946
E-mail: meg@csv.yokogawa.co.jp
Person in charge: Toshihide Miyabe

- Nuclear Magnetic Resonance Related Products (MRI, NMR) -

MRI

Oxford Instruments Corporation
Superconductivity Division
MRI Magnets
Tel: 03-5245-3261 Fax: 03-5245-4472/4466
E-mail: michio.shimizu@oxinst.co.jp
Person in charge: Michio Shimizu

Shimadzu Corporation
MRI system (MAGNEX ECLIPSE/POLARIS, MAGNEX EPIOS)
Tel: 075-823-1271 Fax: 075-811-8185
E-mail: medical@Shimadzu.co.jp

GE Yokogawa Medical Systems Corporation
MR Sales & Marketing Dept., Sales Division
MRI system for medical treatment (magnetic resonance imaging system for medical treatment)
Tel: 042-585-9360 Fax: 042-585-3601
http://www.gemedical.co.jp/

Toshiba Medical Systems Co., Ltd.
MR Sales Department
MRI systems (EXCELART Series: XG, AG, VG, OPART Paragon Version)
Tel: 03-3818-2091 Fax: 03-3813-7625

Hitachi Medical Corporation
MRI system (Alitaire)
Tel: 03-3800-8864 Fax: 03-3800-8258

Bruker BioSpin Corporation
MRI system for small animals
Tel: 0298-52-1234 Fax: 0298-58-0322
E-mail: info@bruker-biospin.jp
Person in charge: Takeo Dohmoto (e-mail: td@bruker.co.jp)

NMR

Oxford Instruments Corporation
Superconductivity Division
NMR Magnets
Tel: 03-5245-3261 Fax: 03-5245-4472/4466
E-mail: michio.shimizu@oxinst.co.jp
Person in charge: Michio Shimizu

Japan Superconductor Technology Inc.
Sales Group
Superconducting magnet for NMR
Tel: 03-5739-5210 Fax: 03-5739-5211
E-mail: shibutani-jastec@kobelco.jp
Person in charge: Kazuyuki Shibutani

JOEL, Ltd.
Analytical Equipment Sales Division
Nuclear magnetic resonance systems (JNM-ECA300, 400,500, 600, 700,800)

Tel: 042-528-3340 Fax: 042-528-3385
Person in charge: Norio Shimada

Bruker BioSpin Corporation
Nuclear magnetic resonance systems, Electronic paramagnetic resonance systems, QC/QA desktop nuclear magnetic resonance systems
Tel: 0298-52-1234 Fax: 0298-58-0322
E-mail: info@bruker-biospin.jp
Person in charge: Takeo Dohmoto (e-mail: td@bruker.co.jp)

Varian Technologies Japan, Limited.
NMR Sales Dept.
NMR analysis systems
Tel: 03-5232-1236 Fax: 03-5232-1264
E-mail: mitsuo.seki@varianinc.com
Person in charge: Mitsuo Seki

- Power Equipment Under Development -

Power Cables

-Joint Development by Tokyo Electric Power Company, Inc. and Sumitomo Electric Industries, Ltd.
Target product:100-meter long triple-core type, 66 kV-class 114 MVA high temperature superconducting cable system
Development stage: Verification tests for practical application completed
Test site: Central Research Institute of Electric Power Industry

- 'Research and Development of Base Technology for Alternating Current Superconducting Power Equipment' project
Target: Development of a 500-meter long, high temperature superconducting cable system
Development stage: Creation of a 30-meter long high temperature superconducting model cable
Project leader: Kiyotaka Ueda, Director, Alternating Current Equipment Technology Division, Engineering Research Association for Superconducting Generation Equipment and Materials (Super-GM)
Tel: 06-6361-1051

Transformers

- Joint development by Fuji Electric Co. Ltd., Kyushu University, and Kyushu Institute of Technology
Target product: 1000 A-class small oxide superconducting transformer
Development stage: Prototype operation tests

Fault Current Limiters

- 'Research and Development on Base Technology for Alternating Current Superconducting Power Equipment' project

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Targets:
1) Research and development on base technology for superconducting fault current limiters (S/N transition type)
2) Research and development on superconducting reactor for fault current limiters
Development stage:
1) Succeeded in testing a fault current limiter on 5.4 kV of peak voltage in the technological development of making a large space superconducting film and in the development of a 6.6 kV-class superconducting fault current limiter module
2) Insulation test of a coil for 66 kV-class reactor type fault current limiters, over current conducting test and insulation test of bushing
Project leader: Kiyotaka Ueda, Director, Alternating Current Equipment Technology Division, Engineering Research Association for Superconductive Generation Equipment and Materials (Super-GM)
Tel: 06-6361-1051

SMES

- 'Technological Development of a Superconducting Power Storage System' project
Target: Technological development of element technologies on SMES for power system stabilization and load fluctuation compensation and frequency adjustment
Development stage: Technological developments of LTS100 MW-class 15 kWh and 500 kWh SMESs, and HTS devices
Project manager: Yoshinori Tatsuta, Managing Director, International Superconductivity Technology Center
Tel: 03-3431-4002

(Yasuzo Tanaka, Editor)

Top of Superconductivity Web21

FALL, 2002 Date of Issue: October 15, 2002

Superconductivity Web21

Published by International Superconductivity Technology Center
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What's New in the World of Superconductivity (August)

Material

Superconductive Components, Inc. (August 16, 2002)

Superconductive Components, Inc. (SCCI) has reported a US $38,305 loss applicable to common shares for the three-month period ending June 30, 2002, compared with a loss of $5,720 for the same period last year. Total revenues declined 20.8% to $716,747 for the second quarter of 2002 (from $905,071 for the same period in 2001). Sales revenues were $642,445 for the second quarter, versus $801,366 for the previous year. The decrease in sales is attributed to the weak national economy and lower sales and contract research revenues. Their second quarter results benefited from a $39,083 insurance claim.

Dan Rooney, President and Chief Executive Officer, remained optimistic; he explained that SCCI recently established SCI Engineered Materials as its sole operating unit. This restructuring is expected to enhance SCCI's utilization of their internal manufacturing and research capabilities and to strengthen their position in their targeted markets. In addition, SCCI was awarded a $100,000 Phase I SBIR grant from the U.S. Department of Energy that will begin in the third quarter of 2002.

Source:
"Superconductive Components, Inc. Reports Second Quarter Results"
Superconductive Components, Inc. Press Release (August 16, 2002)
http://www.investquest.com/iq/s/scci/ne/earnings/scci22.htm

Telecommunication

Conductus, Inc. (August 6, 2002)

Conductus Inc. has announced their financial results for the second quarter and 6-month period ending June 30, 2002. Overall, second quarter revenues decreased by 7% to $1,594,000, compared to the same period in 2001. However, product revenues increased by 27% to $955,000 compared to their second quarter earnings of $752,000 in 2001. This increase in revenue was mainly the result of an increase in the shipment of ClearSite® products. Contract revenues decreased by 33% to $639,000, down from earnings of $1,684,000 for a comparable period in 2001. The company's net loss for the second quarter or 2002 amounted to $5.4 million, compared to a net loss of $4.8 million for the second quarter of 2001. This net loss includes the impact of approximately $560,000 in excess and obsolete inventory recorded during the second quarter of 2002 and ongoing costs associated with the ISCO International litigation. The company has been affected by delays in the purchasing decisions of customers as a result of the weak economy; consequently, they have imposed several cost reduction measures, including specific expense reductions as well as a 15% reduction in their workforce.

Source:
"CONDUCTUS REPORTS SECOND-QUARTER RESULTS"
Conductus, Inc. Press Release (August 6, 2002)
http://www.conductus.com/pressReleases/press96.html

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Conductus, Inc. (August 8, 2002)

Conductus has received an order for two prototype HTS filter systems from a major OEM customer in Japan. The prototype system uses highly selective HTS filters in a new configuration and is intended for use in fourth-generation wireless networks. The systems are scheduled to be delivered later this year and in early 2003. Conductus has received over US $ 1 million in orders from Japanese customers in the last 18 months and expects to continue to receive orders as Japanese companies begin to deploy HTS systems in 2003 and 2004.

Source:
"Conductus Receives Order to Provide Prototype 4G Systems to a Major Japanese Supplier"
Conductus, Inc. Press Release (August 8, 2002)
http://www.conductus.com/pressReleases/press97.html

ISCO International, Inc. (August 14, 2002)

ISCO International, Inc. (ISCO) has released their financial results for the second quarter of 2002. Consolidated net revenues totaled US $134,000 and $1,697,000 for the three-month and six-month periods ending June 30, 2002, respectively, versus $1,374,000 and $1,886,000 for comparable periods in 2001. Their consolidated net losses totaled $4,009,000 and $7,789,000 for three-month and six-month periods, respectively, versus $5,529,000 and $10,276,000 for the same periods in 2001. The reduction in net losses was caused by the implementation of cost reductions in 2001, including the consolidation of ISCO's facilities. ISCO cites the challenging market conditions as the main reason for their decrease in sales and has taken several steps to realistically adapt to the new market conditions. These steps include further reductions in overhead, resisting competitive pressure to make sales below cost or issue warrants to induce sales, and continuing to invest in their patent infringement action against Superconductor Technologies Inc. and Conductus Inc. (scheduled to go to trial before a jury on January 13, 2003).

Source:
"ISCO International Reports Quarterly Results"
ISCO International, Inc. Press Release (August 14, 2002)
http://www.prnewswire.com/news/index.shtml

Basic

US Department of Energy/Lawrence Berkeley National Laboratory (August 14, 2002)

A team of theorists at Lawrence Berkeley National Laboratory and the University of California at Berkeley, led by professors Marvin Cohen and Steven Louie, have calculated the properties of magnesium diboride (MgB_2) from first principles, explaining several of the superconductor's anomalous properties. Using the Bardeen-Cooper-Schrieffer (BCS) theory and a technique developed by one of the group, Dr. HyougJoon Choi, which enabled the BCS equations to be solved for materials with complex electronic structures, the group discovered that the conflicting results obtained by various labs around the world were, in fact, consistent. Their findings have been published in the August 15 issue of Nature. MgB_2 exhibits several unusual characteristics, including a transition temperature of 39 degrees Kelvin and more than one superconducting energy gap, a state of affairs that has been theoretically anticipated but never observed experimentally. These unusual characteristics appear to arise from two electron populations, nicknamed "red" and "blue", that form different kinds of bonds among the superconductor's atoms. The group's calculations have led to predictions that have been experimentally confirmed, such as the fact that MgB_2 contains two superconducting gaps – a feature that has not been seen in any other material. Their findings also suggest the possibility of creating radically new materials with

similar electronic structures.
Source:
"A most unusual superconductor and how it works"
US Department of Energy/Lawrence Berkeley National Laboratory Press Release (August 14, 2002)
http://www.lbl.gov/Science-Articles/Archive/MSD-superconductor-Cohen-Louie.html

University of Illinois at Urbana-Champaign (August 26, 2002)

Researchers at the University of Illinois at Urbana-Champaign have used a low-temperature scanning tunneling microscope to obtain the first images of the copper-oxide plane in a cuprate superconductor. Their findings, which were published in the August 19 issue of Physical Review Letters, show that a single copper-oxide plane can form a stable layer on the surface of a superconductor; the behavior of this surface layer differs from that of layers within the superconductor crystal. "In contrast to previous studies, we found that this copper-oxide layer exhibits an unusual suppression of tunneling conductance at low energies," commented Professor Ali Yazdani. "We think the orbital symmetry of the plane's electronic states may be influencing the tunneling process and is responsible for the strange behavior we observed at the surface." Imaging at an atomic scale enables a much higher level of precision to be obtained. The researchers used scanning tunneling microscopy (STM) to observe large areas of the sample crystal and then correlated the STM topographic images with X-ray crystallographic data to identify individual copper-oxide layers and measure their electronic properties. Now that researchers have a method of directly observing the surface of superconducting crystals, they can begin to manipulate the properties of the crystal by changing what lies beneath the surface.
Source:
"Copper-oxide plane at surface of superconductor has surprising properties"
University of Illinois at Urbana-Champaign Press Release (August 26, 2002)
http://www.news.uiuc.edu/scitips/02/0826copper.html

(Akihiko Tsutai, International Affairs Department, ISTEC)

Top of Superconductivity Web21

FALL, 2002 Date of Issue: October 15, 2002

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Patent Information

List of Japanese Patents Approved for Fiscal 2001

Stated below is a list of ISTEC-applied Japanese patents approved in 2001. For more information, access the Patent Electronic Library of the Patent Office of Japan and other relevant databases. You may make inquiries concerning the licensing of these inventions from us.

1) Patent No. 3144675, 'Oxide Superconductor and Its Production':
A bulky oxide superconductor of melt-growth method is impregnated with resin to reduce drastically the deterioration caused by the trapped magnetic field and other internal or external forces.

2) Patent No. 3149996, 'Josephson Junction and Manufacture thereof':
To form Josephson junction, oxide superconductive film is covered a region where the crystallinity of a substrate is destroyed by a fine ion beam irradiation.

3) Patent No. 3155333, 'Production of Oxide Superconductor having High Critical Current Density':
A method of producing REBaCuO oxide superconductors in the melt-growth method, where platinum, rhodium, and cerium are applied as auxiliary elements.

4) Patent No. 3155334, 'Oxide Superconductor having Large Magnetic Floating Power and its Production':
A RE123 oxide superconductor with platinum and/or rhodium element and dispersed micro particles of the RE211 phase and its production method.

5) Patent No. 3157667, 'Oxide Superconductor and its Production Method':
An oxide superconductor with a critical temperature of over 100K, which consists of alkaline earth metals (Ba, Sr, Ca), copper and oxygen.

6) Patent No. 3157895, 'Method for Forming Oxide Superconductor Film and Oxide Superconductor Member':
After the thin film formation of YBCO oxide superconductor with the chemical vapor crystalline growth method, the laser beam irradiation is introduced on the film so that an excellent smoothing surface is reformed with the c-axis in parallel with the substrate.

7) Patent No. 3160420, 'Production of Multilayered Film Laminate of Y123 Type Crystalline Film':
In the liquid phase epitaxial growth method for the thin film with Y123 type crystalline structure, contents of the solute are featured.

8) Patent No. 3165615, 'Surface Element Analyzing and Device':
A procedure for analyzing surface elements using the surface element analyzing method especially the reflecting high-speed electron diffraction (RHEED) method.

9) Patent No. 3165770, 'Production of Oxide Superconductor':
A method of producing $HgBa_2Ca_2Cu_3$ oxide superconductors with additive element, Pb, Bi, Ti, Au, Pt, etc.

10) Patent No. 3188358, 'Production of Oxide Superconductor Thin Film and Oxide Superconductor Thin Film Laminate':
A production method of an a-axis-oriented 123-type superconductor thin film on a c-axis-oriented 123-type superconductor thin film.

11) Patent No. 3205646, 'Production of Sm123 Crystal':
A crystal pulling method for Sm123 single crystals wherein the solid phase Sm211 on the bottom of a crucible is gradually melted into the solution of Ba and Cu oxide powder.

12) Patent No. 3207058, 'Thin film and Its Production':
This is related to Nd123 superconductor thin film with Tc of 77-96K and its production method for the PLD and the spattering, where Ba elements of the film are substituted by Nd elements.

13) Patent No. 3207066, 'Production of Oxide Crystal and Apparatus for Producing the same':
A method of producing single crystal superconductor wherein the ascending speed of the crystal pull-up axis is controlled in accordance with the moving speed of the solution surface, estimated from time-sequential measurement of the height position of the surface of a raw material melt.

14) Patent No. 3208849, 'Bi-Sr-Ca-Cu-O Superconducting Thin Film and Its Production Method':
Bi-Sr-Ca-Cu-O superconducting thin film with (110) face is selectively formed on MgO [110] single crystals substrate by CVD and its production method.

15) Patent No. 3222353, 'Method for Controlling Crystal Orientation of Oxide Superconducting Film':
A superconducting thin film of the c-axis orientation in a parallel with the substrate surface is prepared by MOCVD and two kind of heat treatment are introduced to the thin film to alternate the crystal orientation to a-axis or b-axis, the first in a non-oxidation atmosphere and the second in an oxidation atmosphere.

16) Patent No. 3234711, 'Method for Holding Melt of Oxide and Production of Oxide Crystal':
In the production of RE123 (RE: yttrium and lanthanoid elements) single crystal by crystal pulling method, two crucibles are stacked to avoid contamination with solution impurities, where the inner crucible is composed of RE, Ba, and Cu oxides and the outer crucible is composed of magnesium oxide, etc.

17) Patent No. 3244391, 'Composite Substrate and Production of Single Crystal Substrate with the same':
To obtain the clean surface single crystal substrate, restored such substrate defects as polishing flaws, etc., the composite substrate is formed by epitaxial growth of an amorphous layer, whose chemical composition is same as that of the single crystal substrate, onto the substrate (for example, STO).

18) Patent No. 3245506, 'Surface Treatment of $LnBa_2Cu_3O_{7-x}$ Single Crystal Substrate':
A heat-treatment for copper oxide superconductor wherein oxygen atmosphere of 50 to 200 mTorr partial pressure is applied to remove the surface damage of the superconductor.

19) Patent No. 3257000, 'Copper Oxide Superconductor and Its Production':
This invention is related to wire-shape or tape-shape Y124 and Y123 oxide superconductors, especially concerning to chemical composition of superconductors and production method where calcination process is applied after forming dried gel, obtained by hydrolyzing alcoxide mixed solution of raw.

Superconductivity

FALL, 2002 Date of Issue: October 15, 2002

Superconductivity Web21

Published by International Superconductivity Technology Center
5-34-3, Shimbashi, Minato-ku, Tokyo 105-0004, Japan Tel: 03-3431-4002, Fax: 03-3431-4044

Published Unexamined Patents for the 1st Quarter of Fiscal 2002

Stated below is a list of ISTEC's published unexamined application from April to June 2002. For detailed information, visit the homepage of the Patent Office of Japan and check the patent database of IPDL (Intellectual Property Digital Library).

1) Publication No. 2002-104900, 'Method of Manufacturing Oxide Superconductive Structure':
On the substrate, 123-structured oxide layer, whose copper elements are replaced by other metal elements, is prepared for the seed crystal layer, and 123-structured oxide superconductive film is easily formed by liquid phase epitaxial method.

2) Publication No. 2002-111273, 'Magnetic Shield Transformer':
This magnetic shield transformer reduces problems of energy loss and declining efficiency due to leakage flux and iron loss by housing the magnetic paths with high temperature superconductor bulks.

3) Publication No. 2002-124711, 'Barrier Layer Estimating Method of Josephson Element':
This presents a method of assessing the barrier layer in the interface-modified barrier Josephson junctions and is useful to establish high uniformity of the characteristics of Josephson junctions.

4) Publication No. 2002-136144, 'Superconducting Power Circuit':
This presents a superconductive power supply circuit with high conversion efficiency that enables the distribution of large DC current at very low voltage, which is especially necessary for integrated superconductor circuits.

5) Publication No. 2002-150854, 'Oxide Superconductor and Manufacturing Method of the same':
This is related to method of producing a multi-layered structure superconductor that consists of a metal substrate, an oxide interlayer, a seed crystal layer, and a liquid phase epitaxial layer for oxide superconductive film. The new chemical compositions for the seed crystal layer and the superconductive layer lead a substantial improvement of yield rate and quality of the superconductive layers.

6) Publication No. 2002-150855, 'Oxide Superconductor Wire Material and Manufacturing Method':
This presents a new structure for the multi-layered superconductor wire that consists of a polycrystalline metal substrate, a buffer layer, and a superconductor layer, where the buffer layer is constructed with the surface oxide of the substrate and the second oxide buffer layer.

(Katsuo Nakazato, Director, Development Promotion Div., SRL/ISTEC)

Top of Superconductivity Web21

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Standardization Activities

This Month's Topics (June)

Maintenance of Established Standards Started

As stated below, IEC/TC90 Superconductivity and IEC/TC90 Superconductivity Committee have already issued eight international IEC standards and five national JIS standards for superconductivity related standards, respectively. It is also formulating or discussing six international standards and nine national standards.

The standards already issued must be reviewed to correct errors found late and to supplement or revise or discontinue standard requirements along with technological development. IEC calls these activities 'maintenance' and accordingly maintenance teams are supposed to carry out maintenance according to their maintenance cycle as specified in respective standards.

For IEC/TC90 Superconductivity, the standard subject to maintenance is (2) 'IEC61788-1: 1998 Direct Critical Current Ic Testing Method of NbTi Composite Superconducting Wires.' IEC/TC90 has already confirmed the maintenance cycle of the standard in September 2001, which is supposed to be completed by 2008.

Under the circumstances, a maintenance team (MT2) has been set up since fiscal 2002 to carry out maintenance activities. The following standards subject to maintenance include (3) through (7), whose maintenance cycles will be confirmed at the IEC/TC90 international conference to be held in Vienna, Austria in February, 2003.

(1) IEC60050-IEV815: 2000 Superconductivity Related Terms; JIS H 7005:1999
(2) IEC61788-1: 1998 Method of Testing Direct Critical Current Ic of NbTi Composite Superconducting Wires; JIS H 7301:1997
(3) IEC61788-2: 1999 Method of Testing Direct Critical Current Ic of Nb_3Sn Composite Superconducting Wires; JIS H 7302: 2000
(4) IEC61788-3: 2000 Method of Testing Direct Critical Current Ic of Bi Oxide Superconducting Wires; JIS H 7305: Under deliberation
(5) IEC61788-4: 2001 Method of Testing the Residual Resistance Ratio of NbTi Composite Superconducting Wires; JIS is formulating a draft plan
(6) IEC61788-5: 2000 Method of Testing the Copper Ratio of NbTi Composite Superconducting Wires: JIS H 7304: 2001
(7) IEC61788-6: 2000 Tensile Testing Method of NbTi Composite Superconducting Wires in Ambient Temperature; JIS H 7303:2001
(8) IEC61788-7: 2002 Method of Testing the Surface Resistance of Superconductors Microwave Band; JIS is formulating a draft plan
(9) IEC61788-8: Method of Testing Alternating Current Loss in the Pickup Coil Method of NbTi Composite Superconducting Wires; Under deliberation
(10) IEC61788-9 Method of Testing the Trapped Flux Density of Bulk Superconductors; Under deliberation
(11) IEC61788-10 Method of Testing the Critical Temperature of Superconducting Wires; Under deliberation
(12) IEC61788-11 Method of Testing the Residual Resistance Ratio of Nb_3Sn Composite Superconducting

Wires: Under deliberation

(13) IEC61788-12 Method of Testing the Copper Ratio of Nb_3Sn Composite Superconducting Wires; Under deliberation

(14) IEC61788-13 Method of Testing Alternating Current Loss of NbTi Composite Superconducting Wires by a Magnetometer Method; Under deliberation

This Month's Topics(July)

The 15th IEC/TC90 Superconductivity Committee Steering Committee Meets

The 15th Steering Committee of the IEC/TC90* Superconductivity Committee (Chairperson Shigeki Saito, Senior Managing Director of ISTEC) was held on June 3, 2002 at a conference room in the Shimbashi Annex of the Mori Bldg.

*: IEC/TC90: International Electrotechnical Commission / 90th Technical Committee (Superconductivity)

In his opening speech, Sadaharu Akiyama, General Manager, Standard Section, Standard Certification Unit, Industrial Science and Technology Policy and Environment Bureau, Ministry of Economy, Trade and Industry expressed his hopes for the reinforcement of Japan's industrial competitiveness by conforming to the 'Standardization Strategy' and deploying standardization activities in the future. The session deliberated the following agenda.

- The business report for fiscal 2001 (draft) and the settlement statement of balance for fiscal 2001 (draft) were proposed to the committee. Both of them were approved as proposed. The total business expenditure for fiscal 2001 stood at ¥22.7 million. The major business for fiscal 2001 included (1) the IEC/TC90 Superconductivity International Conference and the meeting of the working group held in Seoul, South Korea, in September, 2001 as part of international projects; and (2) a meeting of the basic issue examination committee to deliberate superconductivity standardization activities and their steering, formulating a JIS draft plan, and working on two new JIS draft plans as national projects.

- The business plan for fiscal 2002 (draft) and the budget document of income and expenditure for fiscal 2002 (draft) were proposed to the committee. Both of them were approved as proposed. The major business for fiscal 2002 includes (1) to propose the maintenance of the existing standards and to propose product standard concepts at the Vienna conference to be held in February 2003 as part of international projects; and (2) to review the roadmap of superconductivity standardization, to extract product standardization task items, to start product standardization tasks, to extract supplementary standardization items of product standards such as testing methods and implement the supplementary standardization tasks, to start activities integrated with national projects, to formulate two JIS draft plans, and to start the preparation of two JIS draft plans as national projects. The total business budget for fiscal 2002 stands at ¥15.6 million.

- A superconductivity standardization strategy and a superconductivity standardization roadmap based on a market forecast for the coming 20 years (draft) were introduced by the committee secretariat, and also deliberated by the committee members.

FALL, 2002 Date of Issue: October 15, 2002

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This Month's Topics(August)

Revision Started on the Superconductivity Standardization Roadmap

IEC/TC90 Superconductivity Committee (Chairperson: Shigeki Saito, Senior Managing Director of ISTEC) announced that the steering committee will work on drastic revisions of the superconductivity standardization roadmap according to the superconductivity standardization strategy in conformity with Japan's standardization strategy to which the steering committee had agreed.

The superconductivity standardization roadmap so far is based on the roadmap confirmed by the IEC/TC90 Superconductivity Committee in 1990 when the committee was just formed. Major standardization activities have been centered on the standardizations of superconductivity related terms and of testing methods. A total of nine international standards, consisting of one superconductivity related terminology and eight standards of testing methods, have been approved. Japan has issued five accompanying JIS standards. At present, six proposed standards are being deliberated. The superconductivity market in the world has annual sales of around ¥300 billion and fortunately is growing steadily. However, it is important to note that Japan should reinforce public relations for global superconductivity industries because many of Japan's superconductivity related technologies are world-class. Meanwhile, Japan's standardization strategy is timely along with the nation's industrial policy, including the reinforcement of Japan's industrial competitiveness. It is hoped that Japan should continues to carry out the superconductivity standardization strategy.

A superconductivity standardization strategy includes superconductivity standardization activities and implementation of (1) market-adjustment, (2) internationality, and (3) integrated promotion with research and development. In particular, it is urgent to revise the superconductivity standardization roadmap for (1) market adjustment and (3) integrated promotion with research and development because this responds to the demands of this age and society. The IEC/TC90 Superconductivity Committee has deliberated and revised superconductivity standardization guidelines for the past 13 years to meet demands. The product standard preparation committee, under the technical committee of the IEC/TC90 Superconductivity Committee, deliberated on the superconductivity standardization roadmap for the past two years and decided to complete the roadmap this fiscal year (hopefully by March, 2003).

The superconductivity standardization roadmap to be revised has two characteristics. One is to classify superconducting products, to be released onto the existing market or a near-future market, into biotechnological and medical areas, large-scale research and development areas, and power equipment and cryoelectronics areas; to arrange them in chronological order; and to integrate them into standardization activities. These tasks will contribute to the definition of (1) market adjustment mentioned in the above paragraph. The other characteristic is to prepare documents leading to final standards, such as publicly available specifications (PAS) and technical specifications (TS), in cooperation with the existing and near-future superconductivity related national projects, and to integrate them into standardization activities, too. These tasks will contribute to the (3) integrated promotion with research and development mentioned in the above paragraph. Accordingly, the superconductivity standardization roadmap to be revised is to include these two characteristics for chronological and visual presentations.

(Yasuzo Tanaka, Editor)

Top of Superconductivity Web21

