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Superconductivity Web21

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ISTEC's Outline of Activity Plans for Fiscal 2003

International Superconductivity Technology Center (ISTEC) has announced that Hiroshi Araki, President of ISTEC, held the general board of directors in the 31st time and the board of councilors in the 21st at the Keidanren Kaikan on March 12, and deliberated ISTEC's Activity Plans for fiscal 2003 and a revision of the organization rules.

The activity plans feature active promotion of research on superconductivity by conducting surveys and investigations on pertinent topics, performing research and development required for specific superconductivity applications, and promotion of international exchanges. Consequently, these activities will provide significant contributions to the expansion of the superconductivity industry.

In addition, fiscal budget of about 5,900 million yen including the income from commissioned business, supporting membership fees, etc. is expected for the following activities.

ISTEC will be reorganized and simplified to meet the progress of R&D projects that have been promoted by the Superconductivity Research Laboratory (SRL). Specifically, the current seven research departments and three laboratories will be reorganized into three research departments and one laboratory. (See the diagram on the next page.)

1. Promotional and Educational Activities, and International Exchanges

(1) The 16th International Symposium on Superconductivity (ISS 2003)
  Period: October 27 to 29, 2003
  Venue: Tsukuba International Congress Center (Epochal Tsukuba), Tsukuba City

(2) Workshop on research results
  Date: June 3, 2003
  Venue: Toshi Center Hotel, Tokyo

(3) The 12th International Superconductivity Industrial Summit (ISIS2003)
  Period: September 21 to 23, 2003
  Place: Germany

(4) Superconductivity Web 21
  Information on the development and practical applications of superconductivity technology will be distributed through the Internet to ISTEC members via E-mail (monthly Japanese version, quarterly English version) and a public website.

(5) Publication of SRL Technical Reports fiscal

(6) Collection and distribution of information on superconductivity activities in Japan and abroad (ISTEC Overseas News, etc.)

2. Research and Development Activities

(1) R&D of fundamental technologies for superconductivity applications (FY2003 - FY2007)

(2) Development of Superconductors Network Device (FY2002 - FY2006)

(3) R&D of superconducting magnetic energy storage system(SMES) (FY1999 - FY2003)

(4) Development of superconducting magnetic bearing for flywheel electric power storage systems (FY2000 - FY2004)

(5) The U.S. - Japan Joint Study of AC Losses in High Temperature Superconductivity (FY2002 - FY2004)

(6) Development of Superconductor Manufacturing Technology Utilizing a Microgravity Environment (FY1995 - FY2003)

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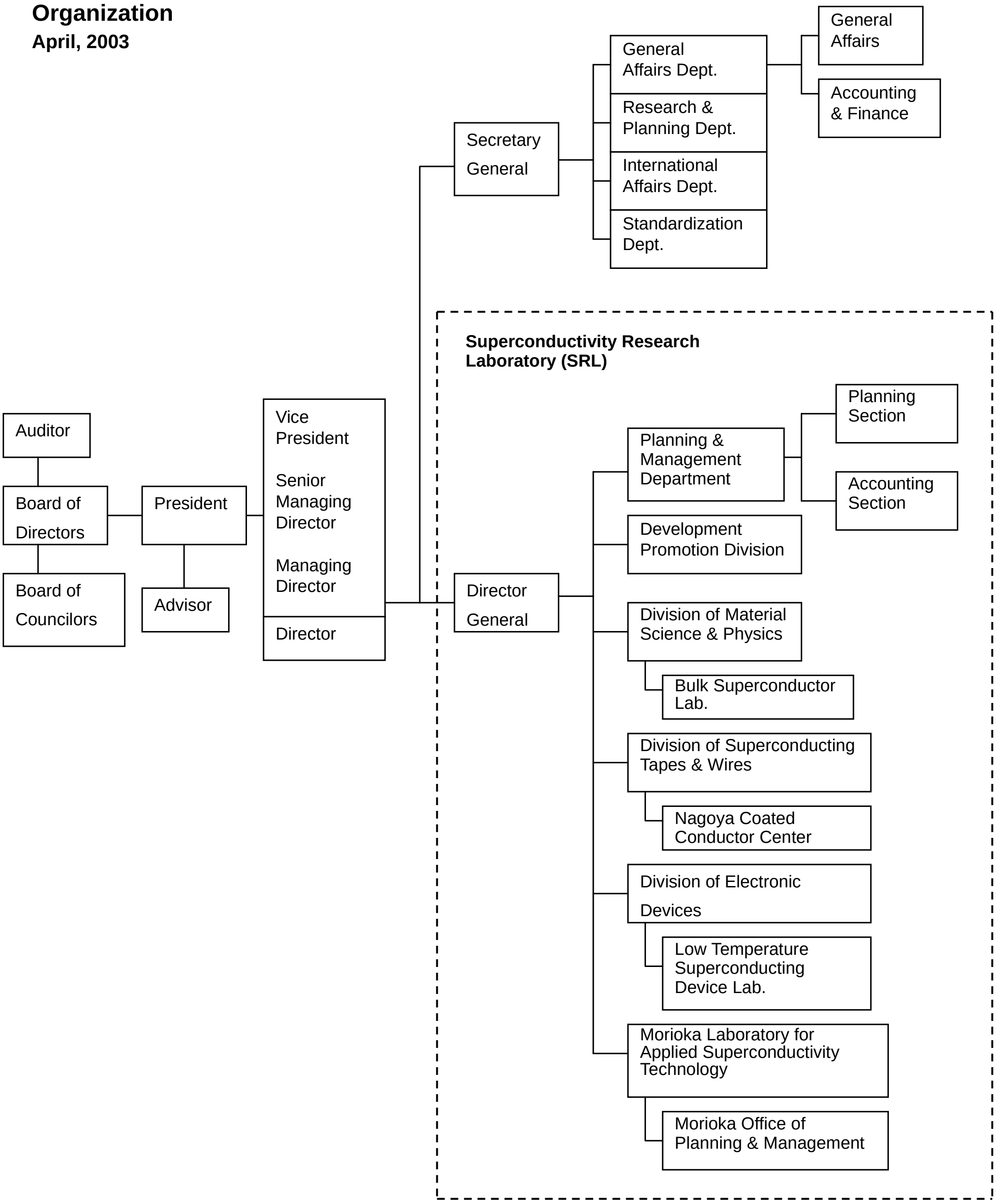
3. International Standardization
(1) IEC/TC 90 superconductivity
(2) Preparation of JIS Drafts

ISTEC/SRL
Organization
April, 2003



(Mitsuhiro Anju, General Affairs Dept., ISTEC)

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Director General Shoji Tanaka of SRL receives JSAP Outstanding Achievement Award

The Japan Society of Applied Physics (JSAP) awarded its third Outstanding Achievement Award to Director General Shoji Tanaka of SRL, which is under ISTEC, on March 27, 2003. The award has been awarded to member researchers who have made remarkable achievements in developing applied physics and/or remarkable contributions to academic and industrial circles. The third Outstanding Achievement Award was also awarded to Professor Iijima at Nagoya University who is well-known for his work on carbon nano tubes. Director General Tanaka of SRL presented an award commemoration lecture titled "Road to High Temperature Superconductivity" at the Yokohama Campus of Kanagawa University on March 28, 2003.

“Outstanding Achievement Award” Plaque

Following a congratulatory address by JSAP President Goto at the award commemoration lecture, Professor Sakaki of the University of Tokyo, who prepared and managed the award commemoration lecture, introduced Director General Tanaka of SRL to the audience. At the beginning of his talk, Director General Tanaka told us an old story from when he started his research on semiconductors at the University of Tokyo. While projecting an OHP image titled "Away From Shoals of Researchers," he looked at back his steady efforts for making high quality samples, emphasizing the importance of making high quality samples to the audience. In the latter half of the 1970s, he began to have a strong interest in two dimensional material MX_2, and dreamed of causing a two dimensional superconductivity phenomenon, while he was stimulated by stories on CDW and Frohlich superconductivity. Meanwhile, he was also attracted to superconducting phenomena such as the low-concentrated carrier of oxide superconductor Ba (Pb, Bi)O_3 changing its superconductivity in the carrier concentration. Although the research budget was limited then, he and his fellow researchers managed to set up a SQUID susceptometer. This instrument later played a decisive role in confirming the existence of high temperature superconductivity. In the fall and winter of 1986, he happened to read Bednorz and Muller's article, and he succeeded in confirming the existence of high temperature superconductivity, ahead of other researchers around the world. It was November 1986. That month was a miracle for him. When he observed a clear phenomenon of high temperature superconductivity caused by a two-dimensional oxide material, he was very impressed. He couldn't resist contributing an article, with his name alone, to JJAP. In the second half of his lecture, Director General Tanaka of SRL briefed us on the progress of high temperature conductivity research, especially the application areas. Using a number of keywords such as complicated crystal structure, two-dimensional superconductivity, d-wave symmetry, short coherence length, and soliton propagation of flux quantum, he emphasized and pointed out some characteristics for possible application as well as challenging subjects before indicating the outlook for the future.

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At the end of his award commemoration lecture, Director General Tanaka introduced a poem titled Red Light written by the late Mokichi Saito, a famous Japanese poet.
The poem means something like this:
A road clearly straightens out in front of me.
It is my life to follow the road, even if I have no idea where it will go.

In closing, Professor Sakaki asked Director General Tanaka: "What would you like to comment on this remarkable development of a small seed--superconductivity which started in a research room?" Director General Tanaka answered, with an air of embarrassment, "I didn't particularly mean for it to happen." All the audience clapped in a thunder of applause, and the lecture ended.

(Seiji Adachi, Keiichi Tanabe, SRL/ISTEC)

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Trends in Needs for Superconducting Microwave Devices

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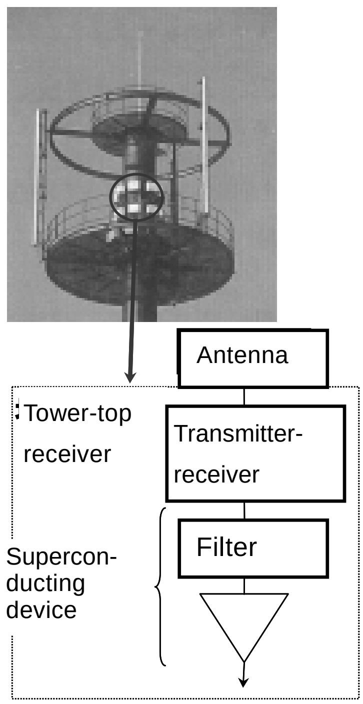
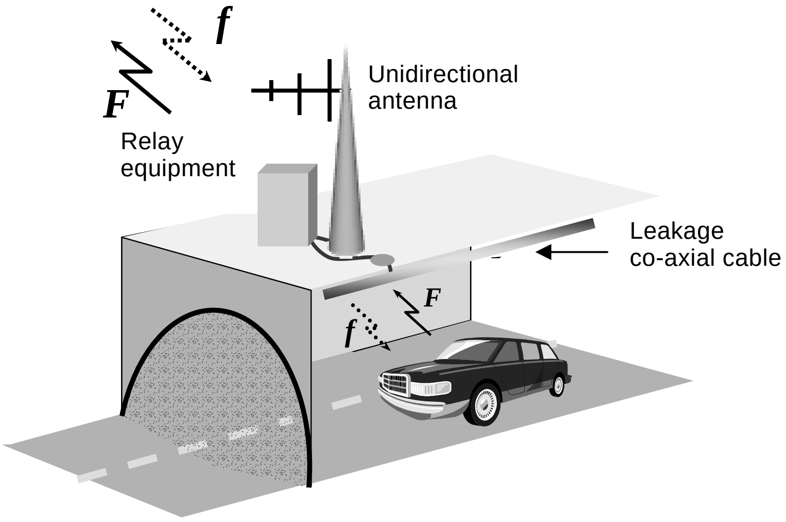
A high temperature superconducting microwave filter is characterized as having an extremely excellent performance, unlike existing microwave filters. Since the research and development of the first basic device was proposed in the United States, almost a decade year has passed. Research deployment in advanced nations, including Japan, are now capable of manufacturing such devices at the practical application level. Compared with existing devices, a high temperature superconducting microwave filter is characterized as having low-loss high selectivity with over a double-digit Q value. What is more, the filter is advantageous in that integration is possible by using a planar circuit. It has high potential for developing into a highly functional IC integrated with an amplifier or another active devices. A high-selectivity filter can be applied to telecommunications, broadcasting, and other diverse areas. Growing demand is seen for base stations for cellular phones, which are enjoying explosive popularity in many parts of the world. Since such base stations handle radio waves from many terminals collectively, they must be able to remove unrequired radio waves from other frequencies, which are transmitted from terminals of other carriers and other systems as well as illegal radio waves in order to eliminate the effects of these waves. The application of superconducting filters and cooled receiver amplifiers to base stations enables telecommunications of high quality, high reliability (no disruption), and high sensitivity (longer usage time and larger transmission capacity). Trial introduction of high temperature superconducting microwave filters for commercial base stations has just begun in the United Sates. The channel disruption during telecommunication has been reduced by dozens of percentage points. Meanwhile, successful application of such filters to third generation mobile communication such as W-CDMA has been confirmed, but commercial introduction has not yet begun to base stations in Japan. This is partly because the device is costly and partly because the number of subscribers to the third generation cellular phones has not increased as much as expected. Yet mobile communication will continue to expand, and exploiting new frequencies and the effective use of existing frequencies will become increasingly



Wireless System Antenna for Cellular Phones and Tower-Top Receiver important. Thus, demand for superconducting filters will continue to grow. In addition, there is a strong possibility for introducing superconducting filters into commercial booster relay equipment that relays and amplifies radio waves in hard-to-transmit tunnels because high selectivity is required. This demand is expected to trigger substantial demand in mobile communications.



Booster Relay Equipment for Blind Zone

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Trends in Superconducting Microwave Device Technologies in Japan

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It is most likely at the practical level to apply superconducting microwave devices to superconducting band-pass filter systems and superconducting antenna systems for wireless communication stations. This article focuses on technological trends in this area in Japan.

- Superconducting Band-Pass Filter Systems

Compared with existing filter systems, superconducting filter systems have extremely high performance. Superconducting filters are attracting attention because they are ideal for wireless stations that realize high speed and high quality telecommunications. In the United States, STI Corporation has merged with Conductus, Inc. and has been exclusively manufacturing and marketing band-pass filters for wireless stations for second-generation mobile communication. Already, more than 2000 units of superconducting filter systems have been installed, and there is news that the company is going to market filter systems in Brazil. Superconducting band-pass filter systems have been attracting attention in Japan because of their potential for a different application, the third generation mobile communication IMT-2000 system, which is concerned with PHS interference. The field-testing for the IMT-2000 system has been completed, indicating fairly good results. The third generation cellular phones, however, have not become as popular as expected as shown in Figure 1. Thus, we are disappointed to report that adopting superconducting band-pass filter systems for IMT-2000 stations is not increasing. Considering improvement in the quality of telephone calls and a possible solution for environmental electromagnetic wave issues, superconducting hand path filter technology is extremely important. There is no doubt that the technology will be applied to wireless stations in the near future. In Japan, Fujitsu Laboratories, Toshiba, and Denso, which have succeeded with cryo device technology, have been making prototypes of superconducting band-pass filter systems and presenting them. Compared with STI Corporation, which is also planning to market such filter systems in Japan, the three Japanese corporations need to further improve their technology for practical application, although the number of personnel engaged in this area is small. STI Corporation (Mr. Iwawaki, phone: 03-5798-2396) is appointing sales agents to market superconducting filter systems in Japan. It seems difficult for the Japanese companies to compete with STI Corporation without substantial investment in this area for new technological development. Specifically, projects must urgently be initiated and promoted for the design, prototyping, and thin-film manufacturing technology of a small filter and for developing a small and low-cost refrigerator.

- Superconducting Antennas

Superconducting antennas are attractive microwave devices. Compared with existing antennas, superconducting antennas can realize small and high-performance array antennas. Thus, strong hopes are held for their practical application. Reflecting the deteriorating Japanese economy, however, most Japanese corporations concerned are not engaging in new projects for early application at a practical level. Under these adverse environments, Yamagata University and Kyushu University have been investigating a unique hybrid device where an antenna is integrated with a mixer and a light guide, and it is expected that this unique device will be realized.

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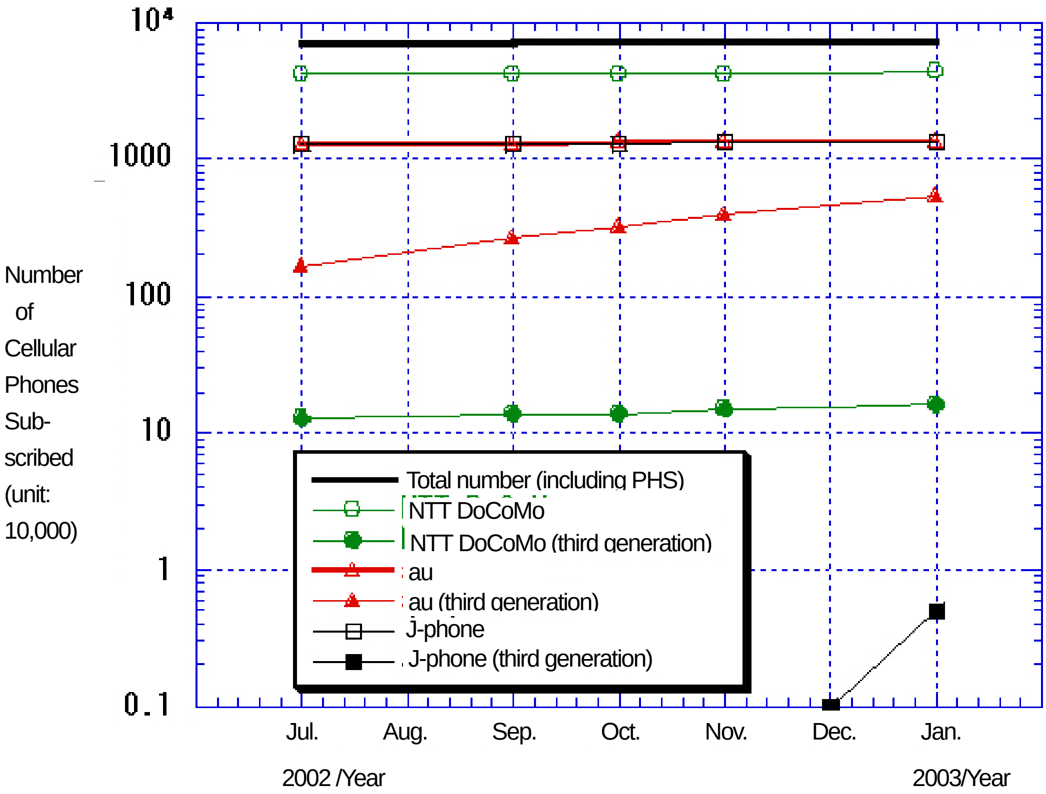

Fig. 1 Changes in the Number of Cellular Phone Subscribers (July 2002 through January 2003)

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Superconductivity Related Product Guide

-- Large Area Superconducting Thin Films and Applied Products --

1. Large Area Superconducting Thin Films
- Superconductivity Research Dept., Energy and Environment Technology Laboratory, Sumitomo Electric Industries, Ltd.
- 3-inch disk, round, HoBCO laser abrasion film
- Contact: Masaya Konishi
Tel: +81-6-6466-5639 Fax: +81-6-6466-5705

2. Superconducting Antennas (under trial development)
- Department of Electrical Engineering, Faculty of Engineering, Yamagata University
- HTS antennas
- Contact: Shigetoshi Oshima
Tel: +81-238-26-3286 Fax: +81-238-26-3293

3. Superconducting Transmitter-receiver, Duplexers (under trial development)
- Department of Electrical Engineering, Faculty of Engineering, Yamagata University
- Superconducting Transmitter-receiver
- Contact: Shigetoshi Oshima, Tel: +81-238-26-3286 Fax: +81-238-26-3293

4. Superconducting Filters (under trial development)
- Denso Research Laboratories
- HTS filters for mobile communication stations
- Contact: Nobuyoshi Sakakibara
Tel: +81-5617-5-1050 Fax: +81-5617-5-1185

- Fujitsu Laboratories, Ltd.
- High temperature superconducting filters
Tel: +81-46-250-8261

- Department of Electrical Engineering, Faculty of Engineering, Yamagata University
- HTS cross couple filters
- Contact: Shigetoshi Oshima
Tel: +81-238-26-3286 Fax: +81-238-26-3293

(Yasuzo Tanaka, Editor)

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Trends in Practical Superconducting Wire Materials

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There are now two types of superconducting wires that are manufactured on an industrial basis, namely Nb-Ti wire metals and Nb_3Sn wire composites.

Since Nb-Ti wire is relatively inexpensive and easy to manufacture, it is used in great quantities for MRI (Magnetic Resonance Imaging). Demand for Nb-Ti wire has been growing in past years. Nb-Ti wire for MRI has a high copper ratio and dozens of filaments in its simple structure. The market is now seeking cost reduction rather than improvement. Another demand for Nb-Ti wire is the construction of a giant particle accelerator (LHC) being constructed in Europe. The demand is huge and accompanies difficulties in terms of technology. Specifically, 1200 tons of Nb-Ti-molded cable will be used and the conductor requirements are very strict to stabilize the beaming. The I_c, copper ratio, magnetization width, and other items, for example, must pass strict specifications. The contents of the manufacturing technology are expected to become the standard for superconducting compacted cable for particle accelerators. The technology of mass manufacturing for this advanced conductor in a short time will also be applied to large projects including the construction of nuclear fusion reactors. Nb-Ti wire is also used for semiconductor lifting equipment, circumferential coils for NMR (Nuclear Magnetic Resonance), and other practical systems.

Nb_3-Sn wire is complicated to manufacture, and it requires diffusion heat treatment at around 700℃ for many hours during the final stage. These difficult manufacturing processes limit the demand for applications when compared with Nb-Ti wire. Nb_3Sn wire, however, is widely used for equipment and systems that require a high magnetic field of 10T or more, which cannot be generated by Nb-Ti wire. The Nb_3Sn wire market now focuses primarily on NMR systems. NMR system performance is indicated with a resonant proton frequency. A higher resonant frequency indicates a higher resolution. Since NMR systems are indispensable for protein analysis and medicinal development, manufacturers are emphasizing the development of a high-performance NMR system. Currently, 700 to 800 MHz NMR systems are sold in the commercial market in the private sector. A national project that seeks a higher frequency (1GHz) is being promoted. As moves continue toward higher-performance and larger NMR systems, demand for Nb_3-Sn wire has been increasing for the past several years. There is another demand for Nb_3-Sn wire in ITER (International Thermonuclear Experimental Reactor). ITER has set a goal of igniting the first plasma in 2013 and will use several hundred tons of Nb_3Sn wire. Thus, once ITER construction starts, a huge amount of Nb_3Sn wire must be mass-manufactured in a short period, which is unprecedented. Looking back at the past history of superconducting wire, many such large projects have contributed to epoch-making development in the manufacturing processes of superconducting wire and improvements. Thus, the ITER project will do the same for technological development.

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Nb_3Al Wires Approaching to Practical Applications

Takao Takeuchi
Associated Director
Superconducting Material Center
National Institute for Material Science

Nb_3Al has been developed as a next generation superconducting wire for high magnetic field applications because Nb_3Al shows better tolerance to strain than Nb_3Sn. An important feature of the rapid heating, quenching, and transformation (RHQT) processed Nb_3Al wire is an utilization of metastable bcc supersaturated-solid-solution state that eventually causes a remarkable J_c improvement in a field higher than 20 T. Thus, Nb_3Al is promising as a candidate conductor for high field NMR application.

The key to the practical use of RHQT Nb_3Al conductors lies in a long-length of rapid Heating and quenching (RHQ) operation of a multifilamentary Nb/Al precursor wire to produce a supersaturated solid solution, because it has been quite difficult to adjust the maximum joule heating temperature (T_{max}) of a reel-to-reel moving wire to the destined one with accuracy of a few degrees.

After examining RHQ conditions in detail, it was however, found that the solid solution limit of Al into Nb in the bcc phase expanded to 25at% or more when T_{max} was set to the vicinity of 1900℃. As shown in Fig. 1, at least for the Nb-25at%Al composition, the extended bcc solid solution exists in a temperature range of about 150℃ (green region). As long as a wire is quenched from such a temperature region, a single-phase of supersaturated solid solution gets formed. As a result, it was found that the J_c, T_c, and B_{c2} after transformation are insensitive to T_{max} in such a RHQ condition. Therefore, when performing a long-length of RHQ operation, the T_{max} (I_{RHQ}) should be set in the middle of such a plateau region, so that the J_c characteristic will be homogeneous over the long-length of wire. The issue of incorporation of stabilizer inevitable

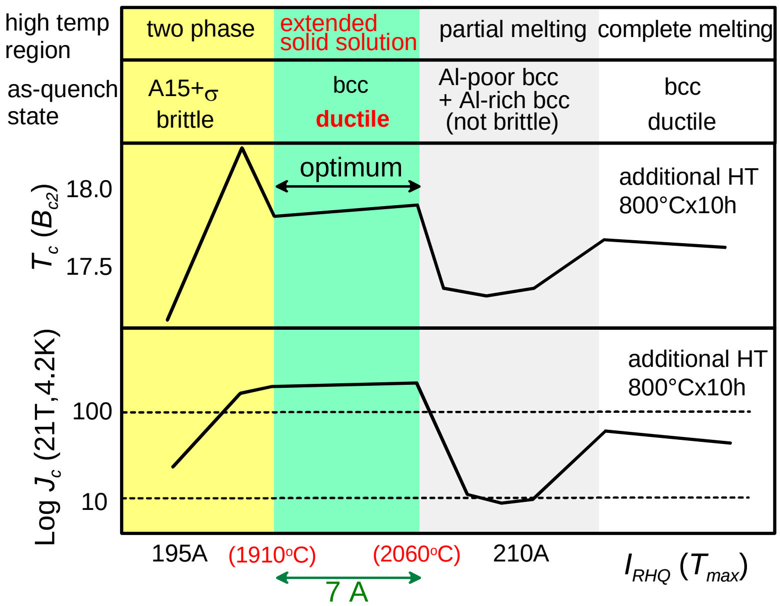

Figure 1
Variations of T_c (B_{c2}) and the logarithm of the J_c as a function of joule heating current that is a parameter of T_{max}. The phases identified with x-ray diffraction and mechanical properties for the as-quenched state, and the speculated high-temperature state from which the wire is quenched are given above the figure. Long-length of wires are processed by setting I_{RHQ} in the middle of the plateau region (green).

for a commercial superconducting wire was settled by adoption of the mechanical cladding method that put a Cu stabilizer on the surface of the wire after the RHQ operation, based on excellent ductility of supersaturated-solid solution. Using a 250-meter length of Cu-clad RHQ wire, we have made a small prototype coil by the so-called 'wind and react' technique and then succeeded in generating additional 3.2 T in a bias field of 14 T at 4.2 K by increasing a coil current up to almost the I_c of short samples that are cut out from point and tail of a long-length of Cu-clad JR Nb_3Al conductor used for a winding. This clearly indicates that a long-length of RHQ processing over several hundred meters and subsequent Cu-cladding were uniformly performed. Thus, the RHQT JR Nb_3Al conductor has taken a major step for developing a practical conductor that can exceed a unit length of 1 km.

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Outlooks on MgB_2 Wire

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National Institute for Material Science

Two years have passed since MgB_2 superconductor was discovered.[1]
Research and development is underway for making the material into tape and wire with the Power-In-Tube (PIT) method. The J_c values of the tape and wire are also improving.[2] There are two methods available for making MgB_2 tape and wire in the PIT method. One is the ex-situ method where MgB_2 composite powder is filled into a metal tube for processing. The other is the in-situ method where mixed Mg and B powder is used. Figure 1 indicates J_c-B characteristics of recent MgB_2 tapes at 4.2K in comparison with characteristics of existing Nb-Ti practical wire and $Bi_2Sr_2Ca_2Cu_3O_x$ (Bi-2223) oxide wire. The ex-situ method allows a fairly high J_c value without heat treatment. This is very advantageous for reducing the wire manufacturing cost.[3] What is drawing attention is how far the ex-situ method can improve the J_c without heat treatment. Meanwhile, the in-situ method allows attaining J_c more than one order of magnitude higher than the J_c attained in the ex-situ method. Thus, it is difficult to determine which method is superior. It is noteworthy that the in-situ method has recently attained a high J_c value with tape where pinning centers were introduced by adding SiC nano particles.[4]

Along with the ongoing progress in tape and wire fabrication so far, 10-meter long tape has been manufactured, and coils using this tape have also been made.[5] For example, tape produced with the ex-situ method enables experimentally making small solenoid coils without heat treatment, and such solenoids can attain magnetic fields of 0.5 tesla. The I_c of a coil stands at some 80% of a short tape's I_c, indicating that the 10-meter long tape has fairly low I_c dispersion, which is encouraging for practical

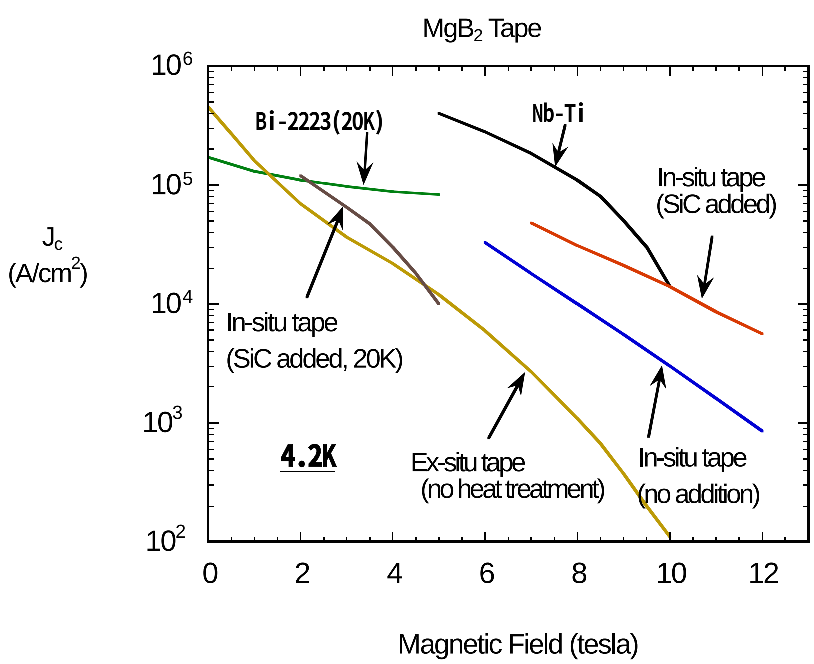

Figure 1 Critical Current Characteristics of Different MgB_2 Wires

application. Research in making longer tape/wire and larger coils is expected to continue in the future and produce substantial advancement.

As shown in Figure 1, however, the J_c of the present MgB_2 tape and wire has not yet reached the practical application level, suggesting the need for further improvement. To improve the J_c, it will be important to optimize many parameters on tape/wire manufacturing in order to raise the MgB_2 core filling density. Introduction of magnetic flux pinning centers are also very important. The crystal grain boundary is suggested for effective pinning center of MgB_2, like A15 composites such as Nb_3Sn. It seems effective for making MgB_2 crystal grains finer. In addition, as mentioned above, introduction of pinning centers using nano-particles is expected to enhance J_c further in the future. A proposal is being made where MgB_2 is applied to a refrigerator cooled magnet at 20K or the vicinity. Since the B_{c2} upper critical magnetic field of MgB_2 tape/wire remains at low levels of ~5T or so at 20K, B_{c2} will need to be improved in order to use MgB_2 wire at 20K or the vicinity. Compared with bulk materials, a fairly high B_{c2} of MgB_2 thin film has already been reported, which is worthy of attention.[6, 7]

Research on MgB_2 tape and wire fabrication has recently started. Many challenging subjects remain unsolved. As seen in past developments of practical superconducting wire, steady and unabated efforts will open the door to further breakthroughs.

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For High Production Rate of YBCO Wire: PLD-CeO_2 (*Self-Epitaxy*) Enhanced Production Speed and Orientation, Raising J_c to $4MA/cm^2$ or More

- Nagoya Coated Conductor Center, Superconductivity Research Laboratory -

Nagoya Coated Conductor Center (**NCCC**, newly established in April 2003), headed by Director General Shoji Tanaka of the Superconductivity Research Laboratory (SRL), has applied PLD-CeO_2 to the buffer layer and succeeded in speeding up YBCO wire production rate. Yamada (ISS2002, WS-4) and Muroga (ISS2002, WSP-4) presented at ISS 2002 (held at Pacifico Yokohama in November 11 through 13, 2002) that when CeO_2 film was deposited by the PLD (Pulsed Laser Deposition) method onto an IBAD (Ion Beam Assisted Deposition)-$Gd_2Zr_2O_7$ (GZO) substrate, the crystal orientation degree of the buffer layer was found to be improved remarkably in a short time.

Last year, Fujikura Ltd. has fabricated a 46-meter long wire using the IBAD and PLD methods, and the groups in the USA and European nations have also succeeded in making wire of several meters to ten meters. These indicate that the (PLD+IBAD) method is now the most promising method. The problem remained now is the slow manufacturing speed of 0.5 to 1m/h. However, the above newly method found by Nagoya Coated Conductor Center has given a solution and enables the wire production much faster by depositing CeO_2 film by the PLD method onto a thin IBAD substrate with a highly orientated microstructure. Since the final orientation degree of the wire is close to a single crystal, the J_c of the wire has been improved much. Unlike the conventional IBAD method, this new method does not require any assistance with Ar ion during deposition. The researchers concerned call this phenomenon by the PLD-CeO_2 film as ***Self-Epitaxy***.

—Faster and Higher Orientation: 10 degrees of Orientation in a minute

SRL-NCCC has deposited a CeO_2 film on IBAD-GZO ($Gd_2Zr_2O_7$) substrates in different thicknesses using the PLD method. Figure 1 shows a typical result compared with the normal IBAD method. The figure shows the relationship between the orientation degree of the buffer layer ($\Delta\phi$) and the deposition time. Less than 10 degrees of orientation is said to be necessary in order to attain a J_c of $1MA/cm^2$ or more. Accordingly, the IBAD

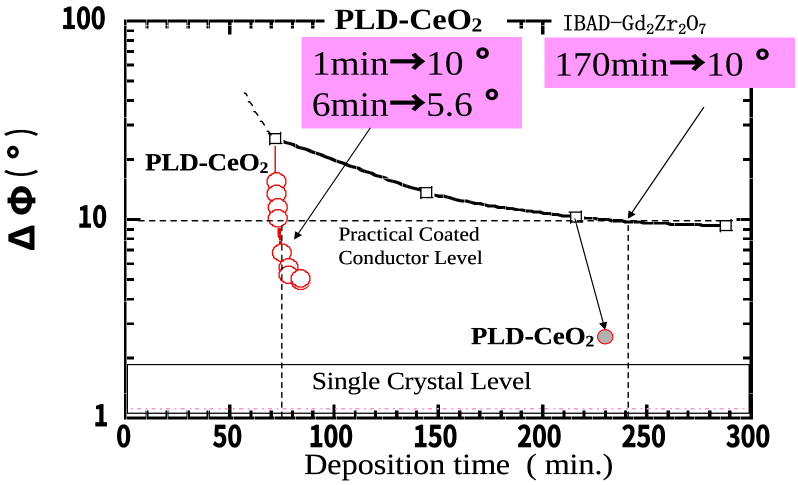
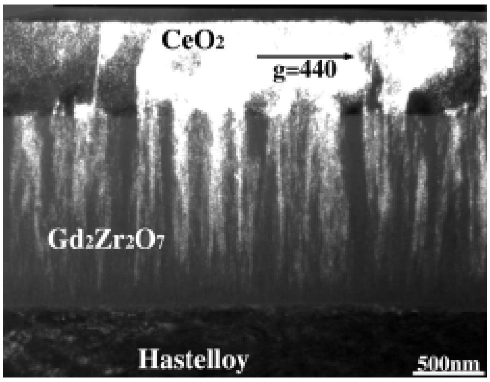


Figure 1 Change in the Orientation of Self-Epitaxy PLD-CeO_2 Film.
It takes one minute to attain 10 degrees of orientation and six minutes to attain 5.6 degrees of orientation. 2.4 degrees of orientation are also obtained, which is close to a single crystal.

method alone takes four hours to obtain this degree of orientation. Meanwhile, as the white circles show in Figure 1, the new PLD-CeO_2 film onto an IBAD substrate takes only one minute to obtain 10 degrees of orientation from 25 degrees of the initial orientation (GZO seed film). A six-minute deposition resulted in 5.6 degrees of orientation. This suggests an improvement in the manufacturing speed. Applying IBAD-GZO film of 10 to 13 degrees of orientation as a seed can reach a final orientation of 2.4 degrees, which is equal to a single crystal substrate level (gray circle in the figure).

Takemi Muroga, SRL-NCCC chief researcher, has been engaged in developing intermediate layers, said, "Many researchers are studying ceria films. Our ceria film is very sensitive to PLD condition. This made it difficult to find the optimal. The newly obtained fast orientation will contribute to an efficient long wire manufacturing process. " Figure 2 was taken by Kato, chief researcher of JFCC. CeO_2 film deposited on an IBAD-GZO substrate using the PLD method is fine in the grain size till 100 nm in thickness. Subsequently, the grains grew as large as 1-2 μm in diameter. Kato said, "The diffraction pattern indicates this area above 100nm in thickness of PLD-CeO_2 seems almost a single crystal."



IBAD-GZO film/PLD-CeO_2 film interface

Figure 2 TEM of typical PLD-CeO_2 film on an IBAD-GZO. CeO_2 film was deposited onto an IBAD-GZO film with orientation $\Delta\phi$ = 13 degrees using the PLD method for 18 minutes. The CeO_2 film attained $\Delta\phi$=4.1degrees of orientation and the grains were large above 100nm in thickness from the interface.
(Photo by JFCC chief researcher Kato.)

—High J_c, attaining 4.4MA/cm^2

SRL-NCCC Researcher, Iwai, who fabricated YBCO film using the PLD method and measured the J_c, said, "CeO_2 film of high orientation can easily brought about a J_c that is 2 to 3 times higher than that of the conventional film. We have already obtained 4.4MA/cm^2, which has been difficult for the conventional YBCO coated conductors. " Such a high J_c will give a operation margin for the performance of an application device.

—Self-Epitaxy: Is It a New Phenomenon?

SRL-NCCC Director, Yutaka Yamada, who has led this research at NCCC , said, "I have been engaged in CeO_2 film intermediate layer research also with colleagues for three years. Since the beginning, I had a question on the conclusion drawn by others that thick CeO_2 film would deteriorate orientation. The question triggered our research on the orientation of thick CeO_2 film. It is well known that when Gd, Y, or other rare earth are involved in CeO_2, the CeO_2 have oxygen deficiency and abnormal conductivity phenomena. I thought that the above self-epitaxy might be related to these phenomena of *Self-Epitaxy*. The phenomenon that the orientation of a deposited film is better than that of the substrate is beyond the traditional epitaxial growth framework. We would like to explain the phenomenon." SRL-NCCC is now developing long PLD-CeO_2 and YBCO wire.

Director of SRL-Division of Superconducting Tapes & Wires Yuh Shiohara, who has led the National Program of YBCO Coated Conductor Development, says, "I think this is the greatest practical achievement in the history of SRL. Furthermore, this CeO_2 film has not brought about cracks, which is very advantageous in terms of long wire production. Japan is now leading research in this area. The SRL will continue to support the newly established NCCC."

This research was conducted jointly by SRL, Fujikura Ltd., and Japan Fine Ceramics Center (JFCC).

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Superconductivity Related Product Guide

-- Superconducting Wire --

[Nb-Ti Alloy Composite Superconducting Wires]

Material Department, Tsuchiura Plant, Hitachi Cable, Ltd.
- Conductors for nuclear fusion and accelerators, conductors for pulse magnetic fields
Contact: Shuji Sakai
Tel: 029-826-7400 Fax: 029-823-2442

Superconducting Product Sales Section, Traffic and Public Sales Department,
The Furukawa Electric Co., Ltd.
- Contact: Mr. Yoshikawa, Mr. Shimizu
Tel: 03-3286-3161 Fax: 03-3286-3686
Superconductivity Development Department, Nikko Copper Elongation Factory, Metal Company
- Contact: Kazutomi Miyoshi
Tel: 0288-54-0504 Fax: 0288-54-2216
- Conductors for high energy accelerators, conductors for changing magnetic fields, Nb-Ti conductors for copper stabilization

Superconducting Wire Manufacturing Project Group, Nuclear Power Department, Power and Industrial System Office, Mitsubishi Electric Corporation
- PVF insulated superconducting wires, polyimide insulated rectangular wires, etc.
- Contact: Hidetoshi Kitakoga (project group manager)
Tel: 0427-79-5564 Fax: 0427-79-5673
E-mail: hidetoshi.kitakoga@sj.sow.melco.co.jp

[Nb_3Sn Composite Superconducting Wires]

Japan Superconductor Technology Inc. (JASTEC)
- Wires for NMR analysis, conductors for high magnetic field magnets
- Contact: Yukinobu Murakami
Tel: 093-391-2836 Fax: 093-391-2847

Material Department, Tsuchiura Plant, Hitachi Cable, Ltd.
- Conductors for high magnetic field magnets, conductors for nuclear fusion
- Contact: Shuji Sakai
Tel: 029-826-7400 Fax: 029-823-2442

Superconducting Product Sales Section, Traffic and Public Sales Department,
The Furukawa Electric Co., Ltd.
- Contact: Mr. Yoshikawa, Mr. Shimizu
Tel: 03-3286-3161 Fax: 03-3286-3686
Superconductivity Development Department, Nikko Copper Elongation Factory, Metal Company
- Contact: Kazutomi Miyoshi
Tel: 0288-54-0504 Fax: 0288-54-2216
- Wires for NMR analysis, conductors for high magnetic field magnets, CICC strands for nuclear fusion reactors

Superconducting Wire Manufacturing Project Group, Nuclear Power Department, Power and Industrial System Office, Mitsubishi Electric Corporation
- Low hysteresis loss strands for nuclear fusion reactors, direct current high critical current density strands
- Contact: Hidetoshi Kitakoga (project group manager)
Tel: 0427-79-5564 Fax: 0427-79-5673
E-mail: hidetoshi.kitakoga@sj.sow.melco.co.jp

[Nb_3Al Composite Superconducting Wires]

Material Department, Tsuchiura Plant, Hitachi Cable, Ltd.
- Conductors for high magnetic field magnets, conductors for nuclear fusion
- Contact: Shuji Sakai
Tel: 029-826-7400 Fax: 029-823-2442

[Silver-Sheathed Bismuth Oxide Superconducting Wires]

Superconductivity Project, Technical Development Center, Showa Electric Wire & Cable Co., Ltd.
- Silver-sheathed Bi-2212 wire, silver-sheathed Bi-2223 wire, current lead
- Contact: Takayo Hasegawa
Tel: 042-773-7163 Fax: 042-773-7291

Superconductivity Research Department, Energy and Environment Technology Laboratory,
Sumitomo Electric Industries, Ltd.
- Silver-sheathed Bi-2223 tapes
- Contact: Kazuhiko Hayashi
Tel: 06-6466-5634 Fax: 06-6466-5705

(Yasuzo Tanaka, Editor)

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Summary, 2003 Date of Issue: July 15, 2003

Superconductivity Web21

Superconductivity

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5-34-3, Shimbashi, Minato-ku, Tokyo 105-0004, Japan Tel: 03-3431-4002, Fax: 03-3431-4044

2K Refrigerator Cooling-Type Magnet

Tsutomu Shimonosono
Specialist
Machinery and Equipment Department, Keihin Product Operations
Toshiba Corporation

Most of the refrigerator cooling-type magnets, except for those with some 20K refrigerators for cooling high temperature superconducting magnets, come with 4K-class refrigerators. Researchers have been trying to improve the cooling capacity of 4K refrigerators in order to develop a magnet with a larger bore in a high magnetic field. Recent moves have also seen growing demand for higher magnetic fields, such as for NMR systems. Using a high temperature superconductor is now inevitable, however, for attaining 15 tesla or a high magnetic field with a 4K refrigerator. This also implies that the manufacturing costs will increase remarkably.

In a joint development project with the National Institute for Materials Science in Japan, Toshiba successfully developed a small GM/JT refrigerator with 1W or higher cooling capacity at 1.8K. In order to demonstrate that the small refrigerator could be applied to a high magnetic field magnet, Toshiba has made a superconducting magnet consisting of Nb_3Sn and NbTi, considering 2K-class conductor cooling (see the photo below). Since most existing 2K-class cooling magnets use super-fluid helium for the refrigerant, they have some problems. Handling them is very complicated, and the cooling equipment itself is bulky. With a simple switching operation, the magnet that we developed and manufactured attains up to 2K-level cooling and generates a high magnetic field. Compared with 4K cooling magnets, our magnet is also small. These advantages are the same with a refrigerator cooling-type magnet.

Applications of 2K refrigerators go beyond high magnetic fields. When a 10-tesla class NbTi magnet can be cooled down to 2K, the production cost will be inexpensive. The magnet can also be applied to cooling samples for physical property testing. Thus, applications of 2K refrigerators are expected to increase in diverse areas in the future.

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Refrigerator Cooling-Type Magnet with a Magnet-Shield

Tsuneaki Minato
ENERGY & INDUSTRIAL SYSTEMS CENTER
MITSUBISHI ELECTRIC CORPORATION

Introduction

The first refrigerator cooling-type magnet was developed some ten years ago. This type of magnet is increasing the possibilities for application. At the beginning, only small magnets with some 100kJ storage energy were considered for possible application. Now, magnets exceeding 1MJ and magnets 2-meters or longer are in the practical application range. Mitsubishi Electric has successfully developed a refrigerator cooling-type magnet with the magnetic shield in response to the demand for a small magnetic field outside the magnet, although the magnetic field is used in the bore in the room temperature. This type of magnet has already been delivered to customers.

This article introduces magnets in which multiple coils are built in, instead of single solenoids.

Figure 1 Superconducting Magnet for Crystal

Superconducting Magnet for Crystal

This magnet generates a cusped magnetic field in a bore of over a one-meter diameter at room temperature (Figure 1). Since workers pass by outside the magnet, a magnetic shield is installed to reduce leaks from the magnetic field to insure worker safety. As the crystal is enlarged, a super magnet of 1.5 meters in diameter is under development.

Figure 2. Superconducting Magnet for ECR Ion Source

Magnet for ECR Ion Source

This magnet generates high-temperature plasma inside a bore to generate highly charged ion beams (Figure 2). A magnetic shield is required to prevent negative effects on the orbit of the beam being generated. Four built-in coils consist of three circuits to adjust the parameters of the plasma to be generated. These three circuits can be electrified independently from each other. Of the four coils, the central coil can be electrified in the reverse direction.

Magnet for Klystrons

This magnet controls the behavior of electron beams to generate X-band microwave (Figure 3). A magnetic shield is equipped with the magnet to prevent negative effects on electronic beams outside the magnet. Three coils are serially connected.

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Points of Development

The magnetic shield naturally generates electromagnetic force between the coils. When multiple coils are fixed inside the magnet, due consideration must be given, in both designing and manufacturing, to the electromagnetic force among the coils besides electromagnetic force between the coils and the magnetic shield. For the magnet for ECR ion sources, the conducting conditions of individual coils can be changed. Thus, the magnet must be designed so that it can function under any conducting conditions. There are a number of devices in the magnet for fixing the coils, ensuring positioning accuracy, and supporting the magnet.

Figure 3 Magnet for Klystrons

Conclusion

Refrigerator cooling-type magnets are expected to continue to advance while expanding their applications. We are ready to meet market demand by offering easy-to-handle magnets to customers.

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2. Arai, H. *et al*. , "Effect of minimum strength of mirror magnet field(B_{min}) on production of highly charged heavy ions from RIKEN liquid-He-free superconducting electron-cyclotron resonance ion source (RAMSES)", Nuclear Instruments and Methods in Physics Research A 491(2002)9-14

3. Yokoyama *et al*., "Conduction cooled Superconducting Magnet for Klystrons without Liquid Helium," T IEE Japan, 115-D, No. 10 (1995).

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Larger-Diameter Refrigerator Cooling-type Magnet

Kazuyuki Shibutani
Manager
Tokyo Office
Japan Superconductor Technology Inc.

The scope of applications for the refrigerator cooling-type magnets is steadily expanding. Our company has so far delivered over 100 units of refrigerator cooling-type magnets to our customers. One recent trend is enlarging the diameter of the bores. The following is a delivery record of our company.

Example 1 is for the enlargement of existing mineral electromagnetic separation processes. The magnet is operated in a manufacturing plant in Europe. Major applications of other magnets include magnetic separation, magnetic orientation, and magnetizing, all of which are processes close to practical application. An increasing number of inquiries from these areas concern the capacity of the refrigerator cooling-type magnets for the combination of generating magnetic field and bore size. From the technical perspective, all sizes of liquid-helium-soaked magnets available can be used. A liquid helium-soaked 8T-800mm magnet for experiments, which is the largest size for MRI application, could serve as a guideline of size. Practical application of magnets with refrigerators will increase once process conditions, such as field ramp speed, and economic conditions are met.

Table Examples of Large-Diameter Bore Refrigerator cooling magnets

Example	Maximum central magnetic field	Room temperature-penetrated bore diameter
1	0.7T	1015mm
2	3T	400mm
3	5.5T	400mm
4	10T	180mm

Photo 1 3T-400mm Solenoid Type

Photo 2 5.5T-400mm solenoid Type

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Superconductivity Related Product Guide

-- Small Refrigerators --

[Stirling Small Refrigerators]

E&E Group, Energy System Marketing Dept., Aisin Seiki Co., Ltd.
- Pulse tube refrigerator
- Stirling refrigerator
- Contact: Hitoshi Kondo
Tel: 0566-24-8805 Fax: 0566-24-8859

Semiconductor Equipment Dept., Daikin Industries, Ltd.
- Pulse tube refrigerator
- Contact: Masahiro Oyama
Tel: 072-243-2412 Fax: 072-243-2652
E-mail: masahiro.ohyama@daikin.co.jp

Fuji Electric Co., Ltd.
- Stirling refrigerator, pulse tube refrigerator
- Contact: Takayuki Takeuchi
Tel: 03-5435-7086 Fax: 03-5435-7440

[Gifford-McMahon (GM) Small Refrigerators]

E&E Group, Energy System Marketing Dept., Aisin Seiki Co., Ltd.
- Pulse tube refrigerator, GM refrigerator
- Contact: Hitoshi Kondo
Tel: 0566-24-8805 Fax: 0566-24-8859

Marketing Dept., Cryo Unit Business Center, Precision Instrument Division, Sumitomo Heavy Industries, Ltd.
- 4KGM refrigerator, 10KGM refrigerator, 20KGM refrigerator, 80K single-stage GM refrigerator, 80K pulse tube refrigerator, 4K pulse tube refrigerator
- Contact: Mr. Sakajima, Mr. Ishikawa, Mr. Kanno, Mr. Watanabe
Tel: 0424-68-4094 Fax: 0424-68-4254
E-mail: cryo@shi.co.jp

Semiconductor Equipment Dept., Daikin Industries, Ltd.
- GM-/J/T tube refrigerator
- Contact: Masahiro Oyama
 Tel: 072-243-2412 Fax: 072-243-2652
 E-mail: masahiro.ohyama@daikin.co.jp

Super-Cryogenic Section, Super-Cryogenic Dept., Industrial Gas Operation Dept., Gas Business Division, Taiyo Toyo Sanso Co., Ltd.
Tel: 03-3231-9845 Fax: 03-3272-3270

Magnetic Application Advanced System Dept., Power and Industrial System Office, Mitsubishi Electric Corporation
- 4KGM refrigerator (2 and 3-stages)
- Contact: Takahiro Matsumoto
 Tel: 0791-46-2140 Fax: 0791-46-2222
 E-mail: matumoto@ako.melco.co.jp

[Modified-Solvay Small Refrigerators]

Cryogenic Equipment Dept., Iwatani Industrial Gases Corporation
- Contact: Yasuji Ochi
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Semiconductor Equipment Dept., Daikin Industries, Ltd.
- Contact: Masahiro Oyama
 Tel: 072-243-2412 Fax: 072-243-2652
 E-mail: masahiro.ohyama@daikin.co.jp

[Liquid-Helium: Dilution Refrigerators]

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What's New in the World of Superconductivity (May)

Power

American Superconductor Corporation (May 14, 2003)

American Superconductor Corporation (AMSC) reported record net revenue of US $21.0 million for fiscal 2003, compared to the $11.7 million earned in fiscal 2002. The net loss for the year amounted to $ 87.6 million, including $45.3 million in non-cash charges recorded in the fourth quarter. This net loss was higher than the $ 57.0 million recorded in fiscal 2002. In the fourth quarter alone, net revenues reached a record $10.9 million, compared with the $3.2 million earned in the fourth quarter of fiscal 2002. The company ended the year with cash, cash equivalents, and long-term investments amounting to $ 20 million and no long-term debt. As of April, the company had $ 92 million in backlog orders, providing a strong base for revenue growth. AMSC is continuing to explore several options of raising cash for working capital and to enable the scale-up of its second-generation HTS wire manufacturing technology.

Source:
"American Superconductor Reports Fiscal 2003 Fourth Quarter and Year End Results"
American Superconductor Corporation press release (May 14, 2003)
http://www.amsuper.com/html/newsEvents/news/105290973471.html

Intermagnetics General Corporation (May 14, 2003)

Intermagnetics General Corporation (IMGC) has reached an agreement with Philips Medical Systems to extend and expand their exclusive supply agreement for the superconducting-based actively shielded magnets used in Philips' commercial MRI systems. The new agreement could result in additional revenue of US $ 20 million annually for IMGC. The previous initial contract between the two companies has been extended by two years, making it a seven-year pact. Thereafter, the agreement will return to a rolling five-year contract. The two companies plan to actively explore additional MRI product opportunities.

Source:
"INTERMAGNETICS ANNOUNCES EXPANDED STRATEGIC AGREEMENT WITH PHILIPS MEDICAL SYSTEMS"
Intermagnetics General Corporation press release (May 14, 2003)
http://www.igc.com/news_events/news_story.asp?id=86

Intermagnetics General Corporation (May 14, 2003)

Intermagnetics General Corporation (IMGC) reaffirmed their expected earnings (of between US $ 0.25 – $0.26 per diluted share) for the fourth quarter of the current fiscal year, ending May 25, 2003. Overall FY04 growth is still anticipated, despite a probable drop in first-quarter deliveries arising from the realignment of an agreement between Intermagnetics and Philips Medical Systems (see previous report). The new contract is expected to improve long-term revenues for several years. Glenn Epstein, chairman and chief executive officer, commented " . . . the initial net effect of our decision to enter into this enhanced strategic agreement is that we expect the upcoming quarter to result in minimal profitability followed quickly by run-rates that are expected to be in line with our long-term goals. We expect the anticipated abnormally low first quarter will result in the upcoming 2004 fiscal year being below our stated long-term targets, but will position the company for above-average growth rates in subsequent years." Industry experts expect the overall global MRI market to grow by 9 - 10% annually for the

foreseeable future. This growth rate could increase if newly configured MRI systems or new applications involving neurological and cardiology diagnostic procedures are introduced.
Source:
"INTERMAGNETICS REAFFIRMS 2003 EXPECTATIONS, PROVIDES INITIAL GUIDANCE FOR FISCAL 2004"
Intermagnetics General Corporation press release (May 14, 2003)
http://www.igc.com/news_events/news_story.asp?id=85

American Superconductor Corporation (May 19, 2003)

American Superconductor Corporation (AMSC) has launched a new PM1000 PowerModule(TM) power converter line. This device can be used to regulate voltage and current in high-power applications, such as variable speed motors, motor-generator sets, wind turbines, fuel cells, and power quality solutions. The PM1000 is based on AMSC's Power Electronic Building Block (PEBB) technology, which enables a highly flexible, programmable, and scalable design architecture that can be adapted to suit a variety of applications. For a given application, the volume of a PowerModule-based solution is usually one-third the volume of other converter solutions. AMSC's first customer will be Calnetix, a high-speed motor and generator manufacturer, who will use the PM1000 to construct a 2 MW ship generator for the Royal Navy. Calnetix has ordered four 2 MW systems, with each system comprising six PM1000s, as well as filters, transformers, inductors, and related equipment. Delivery of the four systems will occur between January 2004 and mid-2005.
Source:
"American Superconductor's PowerModule(TM) Power Converters To Be Used in Royal Navy Application"
American Superconductor Corporation press release (May 19, 2003)
http://www.amsuper.com/html/newsEvents/news/105309461641.html

American Superconductor Corporation (May 28, 2003)

American Superconductor Corporation (AMSC) has announced the first delivery of its second-generation HTS wire to Ultera(TM), a joint venture between Southwire Company (USA) and nkt cables (Denmark). Ultera is collaborating with Oak Ridge National Laboratory (ORNL) to fabricate and test a multi-wire HTS cable conductor - the central current-carrying component in power transmission cables. The Ultera-ORNL team ordered thirty 1.5-meter long wires with a rating of at least 110 A when immersed in liquid nitrogen. AMSC subsequently manufactured the wires in lengths of 10 meters and then cut them to size. The performance level for this production run reached 180 A for the 10-meter lengths, a new industry standard. The average performance of the shipped wires was 150 A. The Ultera-ORNL team expects to present the results of tests on the HTS cable conductor at the U.S. Department of Energy Superconductivity Peer Review meeting, which will be held at the end of July.
Source:
"American Superconductor's Delivery of Second Generation High Temperature Superconductor Wire Sets Stage for Future Market Expansion, New Applications"
American Superconductor Corporation press release (May 28, 2003)
http://www.amsuper.com/html/newsEvents/news/105405711691.html

Material

Superconductive Components, Inc. (May 16, 2003)

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

Superconductive Components, Inc. reported a 16% decrease in total revenue for the first quarter in 2003 (from US $ 783,379 in 2002 to $ 657,879 in 2003). Net cash from operating activities improved to $ 109,087, compared to $ 50,489 for the same period in 2002. Product revenues decreased from $714,148 for the first quarter in 2002 to $624,546 for the first quarter in 2003. Contract research revenue also decreased following the expiration of a Phase II SBIR grant from the National Science Foundation. Overall, the gross profit for the first quarter of 2003 was $149,218 (22.7% of the total revenue), compared to $186,370 (23.8%) for the same period in 2002.

Source:
"Superconductive Components, Inc. Announces First Quarter Results"
Superconductive Components, Inc. press release (May 16, 2003)
http://www.targetmaterials.com/ne/earnings/scci13.htm

Communication

ISCO International, Inc. (May 15, 2003)

ISCO International, Inc. has reported consolidated net revenues of US $1.235 million for the quarter ending March 31, 2003, compared to $1.563 million (including a single $1.1 million order) for the same period in 2002. However, the gross margin for these two periods increased from 2% to 49%. The consolidated net loss for the quarter ending March 31, 2003, was $3.151 million, compared to $3.780 million for the same period in 2002. The largest cost increase was an increase in legal expenses associated with a patent litigation; this item accounted for the majority of the net loss incurred during the first quarter of 2003.

Source:
"ISCO International Reports Financial Results for the First Quarter 2003"
ISCO International, Inc. press release (May 15, 2003)
http://www.iscointl.com/

(Akihiko Tsutai, Director, International Affairs Department, ISTEC)

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Patent Information

Published Unexamined Patents for the Third Quarter of Fiscal 2002

Introduced below are ISTEC's patents published for October through December 2002. For more information, access the homepage of the Patent Office of Japan and visit the Industrial Property Digital Library (IPDL).

1. Publication No. 2002-326817: " Oxide Superconductor and Its Production Method"
This invention relates to improving Bi2212 whose magnetic characteristics is superior to Bi2223, which is close to practical application. An appropriate configuration of elements (Bi, Sr, Ca, Cu, O) can improve a critical current density by ten times and an irreverse magnetic field by three times.

2. Publication No. 2002-338392: "Methods of Producing Oxide Crystal Film/Substrate Composite Material"
When making a Y123 superconducting oxide crystal film on a substrate using a liquid phase method such as the LPE method, introducing low-oxygen concentration atmosphere can lower the liquid temperature down to 850℃ or less, enabling the formation of a superconducting crystal film on a metal substrate composite

3. Publication No. 2002-338393: " Solution for Producing Oxide Crystal"
When forming a Y123 superconducting oxide crystal film using a liquid phase method such as the LPE method, adopting BaO-CuO-BaF_2 solvent with an optimized Ba/Cu ratio can lower the crystal growth temperature.

4. Publication No. 2002-344307: "Single Flux Quantum Logic Circuit and Single Flux Quantum Output Converter Circuit"
To connect a single flux quantum (SFQ) circuit that uses high-speed pulse signals to an external circuit such as the semiconductor circuits, the pulse signals must be converted into a pulse width and voltage level that the eternal circuits can operate with. In a well-known art, these signals were converted by using SFQ/DC and SQUID circuits. When new SFQ/DC circuits with a magnetically combined circuit are used, the SFQ/DC circuits can be serially connected, easily converting pulse width and voltage level .

5. Publication No. 2002-359408: "Permanent Current Switch and Method for Using the Same"
Superconducting current is detected in the contact surface of two bulk RE superconductors whose mechanical strength were extremely improved by resin impregnation. This mechanism acts as a mechanical permanent current switch. When the contact surface is set vertically against the ab-plane, greater effects can be realized.

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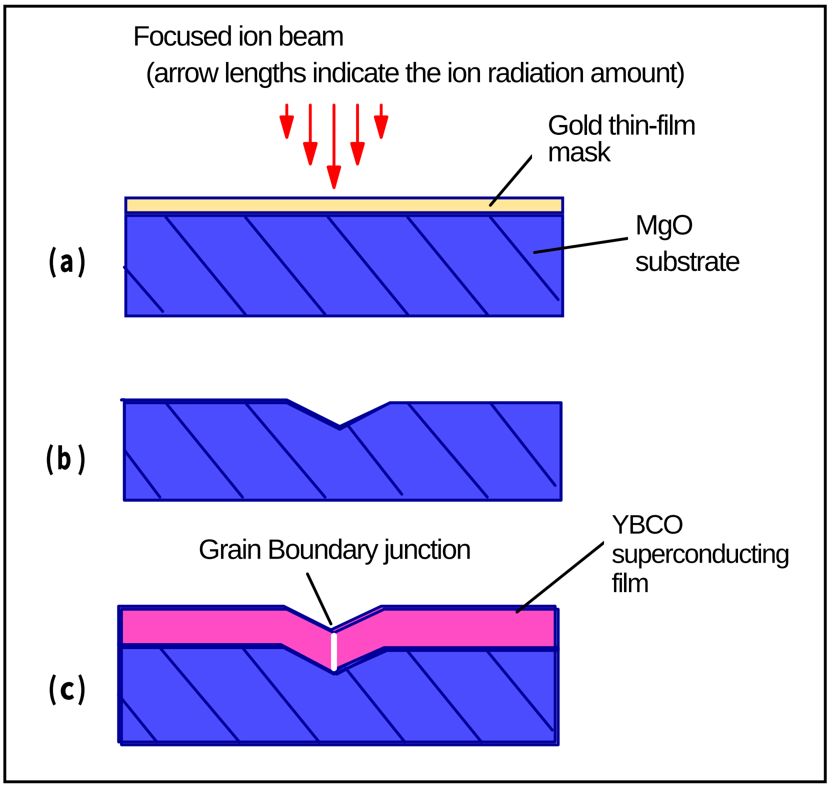
Introducing of Approved Patents

A recently approved patent is described below. For more information, access the homepage of the Patent Office of Japan and visit the Intellectual Property Digital Library (IPDL).

Patent No. 3367878: "A Method for Making an Oxide Superconductor Element," Publication No. 1999-112044 (Applied for in 1997)

A technology that forms a V-shaped groove with a focused ion beam is useful for superconductor junction fabrication from the perspectives of miniaturization and junction arrangement. Since shapes of grooves are up to the ion beam strength distributions, however, instability of machining results in un-uniformity of the groove shapes and the critical current in junctions.

In this invention, varying the ion radiation amounts enables optimizing groove shape in these junctions on the substrate As a result, critical current distribution in the junctions is remarkably improved, leading to application to fabricating oxide superconducting integrated circuits.



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Patent No. 3384919
"A Method for Making an Oxide Crystal," Publication No. 1999-124396 (Applied for in 1995)

When a mixture of some oxides such as $YBa_2Cu_3O_6$, BaO, or CuO, which contain elements forming a superconductor oxide crystal, is furthermore mixed with some halides such as BaF_2 or CuF_2, which contains elements forming a superconductor, the crystal growth temperature can be maintained at lower temperature in a liquid phase method such as the LPE method. In making Y123 crystal, the crystal growth temperature of a solvent without any mixed halide stood at 968 to 1007℃ while the crystal growth temperature of a solvent with some mixed halide stood at 945 to 989℃. The latter crystal growth temperature taking place below the fusion point of metallic silver (960℃) indicates that some orientated metals could be used for a substrate for superconductor tape. This method is also applicable to rare-earth oxide superconductors such as Nd. Moreover, keeping the crystal growth temperature in the low temperature range could minimize a mixture of redundant elements other than the superconductor elements, improving the superconductivity properties.

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

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Standardization Activities

-- Publishing International Standard IEC 61788-11: "Method of Testing the RRR of Niobium 3-Tin Composite Superconductors" --

The international IEC 61788-11 standard, "Method of Testing the RRR of Niobium 3-Tin(Nb_3Sn) Composite Superconductors (abbreviation) was published on January 21, 2003. This falls into the 11th superconductivity related standard approved by the IEC (International Electrotechnical Commission). The standard is effective until January 30, 2007.

The official title of this standard is described in English and French as follows:
Title (English):
Superconductivity – Part 11: Residual resistance ratio measurement – Residual resistance ratio of Nb_3Sn composite superconductors
Title (Français):
Supraconductivité – Mesure du rapport de résistance résiduelle – Rapport de résistance résiduelle des supraconducteurs composites de Nb_3Sn

This standard defines a testing method in the 4-terminal method in order to decide the residual resistance ratio (RRR) of Nb_3Sn composite superconductors. The testing method is applied to straight rectangle and circular (section surface; less 3 mm^2) superconductors under 350 of RRR and whose reactive heat-treatment was completed. The standard prohibits measurements in magnetized environments.

This standard was proposed on March 29, 2000, by working group WG4 and officially approved as a proposed new work (PNW) on May 19, 2000. WG4 prepared a working draft (WD) under Professor C. Hua at Beijing Non-ferrous Metal Laboratory in China as the combiner and Professor Teruo Matsushita at Kyushu Institute of Technology as the co-combiner. The WD was submitted to the IEC as the first CD on February 2, 2001 and was followed by CD voting on July 29, 2001, before the FDIS was submitted to the IEC on October 11, 2002. The IEC announced the voting results for the international standard on December 18, 2002 (100% ratification of 13 P member nations with voting rights), and published the draft as the IEC 61788-11 international standard on January 21, 2003.

Technical issues in the course of examining the draft included how to define the initial state of testing samples, how to calculate the COV (coefficient of variation), which was obtained by dividing the standard deviation by the average value, how to round off the COV value, whether to define the COV in the regulations, and how to forward the round robin test RRT. The international discussions resulted in all issues being agreed on and settled. These include solutions that the initial state of testing samples must be straightened after reactive heat-treatment and that the COV should be rounded off within 5% by examining past RRT samples.

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-- International Electrotechnical Commission 90th Technical Committee (IEC/TC90) 8th General Meeting Report --

The 8th Conference of the International Electrotechnical Commission 90th Technical Committee (IEC/TC90), also referred to as the Vienna Conference, and a working group meeting were held at the Vienna University of Technology from February 24 through 26, 2003. Twenty-three participants from eight nations, including eight participants from Japan, discussed the agenda, which included pending subjects, maintenance of present standards, and proposed new work for the future. These meetings were arranged and managed by IEC and the Austrian Electrotechnical Committee (OEK).

Following Chairman L. Goodrich's declaration opening the conference, the subjects to be discussed were adopted. Afterwards, the minutes from the last Seoul Conference, which was held in September 2001, were confirmed, and the extension of the chairmanship of Chairman L. Goodrich (until March 30, 2006) was approved.

Then, the four international standards of the Testing Method of Surface Resistance IEC61788-7, Testing Method of Critical Temperature IEC61788-10, Testing Method of Composite Ratio of Nb_3Sn IEC61788-12, and Testing Method of Residual Resistance Ratio of Nb_3Sn IEC61788-11, which were issued after the Seoul Conference, were presented at this conference, along with their progress during examinations by the working committee.

The following three international standard proposals were presented at the conference for discussion and confirmation.

- Concerning the " Testing Method for Alternative Current Loss with the Pickup Coil Method," which had been discussed by a working group (WG9), the conference approved replacing Figure C.1b in the Final Draft of the International Standard (FDIS) and decided to put it on the ballot for FDIS on the regulation schedule (Deadline: March 21, 2003).
- Concerning the " Testing Method for Alternative Current Loss with Magnetometry," which had been discussed by WG9, the conference decided to put it on the ballot for FDIS on the regulation schedule (Deadline: April 18, 2003).
- Concerning the " Testing Method for the Trapped Flux Density of Bulk Superconductors," which had been discussed by WG10, the conference approved the inclusion of the RRT (round robin testing) results into the Committee Draft of Vote (CDV). That means the conference approved the temporary cancellation of the CDV now circulating and re-circulating a revised CDV, preferably by November 2003.

Concerning the revision of the IEC/TC90 Strategic Policy Statement, the conference approved the inclusion of the following subjects.

- The conference confirmed that the existing working groups enforce the maintenance of the current standards IEC61788-1, -2, -3, -4, -5, -6, -7, -10, and -12 as part of their tasks; that opinions on comments being proposed be collected within three months to prepare for a circulatory maintenance report; and requests that standardization activities of the P-member nations be vitalized and new experts be registered.
- As parts of the standardization activity reports in participating nations and VAMAS, the adjustment

situations of the IEC-coordinated domestic standards in these countries were presented as well as the need for standardization activities in cooperation with VAMAS. In addition, the USA reported a method for testing the residual resistance ratio (RRR) of niobium; Korea reported a method for testing microwave band surface resistance; and Japan reported new work proposals such as product standardization that meets the superconductivity market.

- Concerning ongoing standardization activities including product standardization, the conference confirmed the need for broad cooperation with IEEE, ICMC, CIGRE, and other organizations, and cooperation with R&D projects in issuing publicly available specifications (PAS) and technical specifications (TS).

The conference reached a broad agreement for holding the 9th IEC/TC90 Conference in the United States, preferably at Argonne National Laboratory or Wisconsin University in September or October 2004.

-- Superconductivity Standardization Service at Turning Point --

Japan's standardization activities, which started in 1986, have reached a turning point after 16 years. The New Material Center (NMC), attached to the Osaka Science Technology Center, and the Japan Fine Ceramics Association (JFCA) decided to discontinue their activities at the end of fiscal 2002. These bodies had played a leading role in Japan's superconductivity standardization services in cooperation with IEC/TC90 Superconductivity Committee. The standardization activities for fiscal 2003 and onward will be promoted chiefly by the IEC/TC90 Superconductivity Committee and the National Institute of Advanced Industrial Science and Technology (AIST) of the Ministry of Economy, Trade and Industry of Japan.

The basic standardization system of Japan, which acts as a managing nation of IEC/TC90 (superconductivity) under the IEC/TC90 Superconductivity Committee of International Electrotechnical Commission (IEC), will remain unchanged. In addition, liaison relations will remain as before between IEC/TC90 and VAMAS (Chaired by the National Institute for Materials Science, Japan). Thus, what has changed are the objects for standardization and the enforcement system.

Japan's past 16 years of standardization services centered on standardizing superconductivity related terms and methods for testing, which are essential for superconductivity. Superconductivity related terms and ten methods for testing were already issued as international standards. Five standards were also issued as JIS standards. Three testing methods, which are now under discussion, are also expected to be produced in a preliminary agreement within a year. Meanwhile, under basic standards, superconductivity related research, development activities, and technological development projects saw remarkable progress over the past 16 years. Sales of superconducting products have now increased to over 300 billion yen market. The objects of superconductivity standardization services have also been broadened to pre-standardization and superconducting product standardization that reflect the results of research and development.

In particular, diverse standardization services for the future will come to include the following five points:

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A. Establishing product standardization groups that target superconducting products in the market and those that are greatly needed

B. Extracting maintenance standards and enforcement from existing working groups

C. Recruiting for product standards as well as extracting and proposing complementary standards and new standard items

D. Pre-standardization including PAS and TS, in cooperation with research and development projects

E. Maintenance, new recruiting, complementary standardization, pre-standardization, and preparing a roadmap that covers product standardization

In order to promote these standardization items, Japan needs to first formulate its own standardization strategy centering on IEC/TC90. Next, Japan is urged to rebuild an enforcement system for the above five points. Third, Japan needs to promote continuous and efficient policy-project-budget allocations, in addition to cooperating closely with the IEC/TC90 Superconductivity Committee and their member nations. These activities will contribute to smooth standardization and timely and need-oriented standardization results.

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