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# Superconductivity Web21

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# SRL Recorded World's Highest Critical Current Value of Long High-Temperature Superconducting Wires (YBCO)
## - Achieved by a new manufacturing process using multi-plume and multi-turn method -

At Superconductivity Research Laboratory (SRL, Director General: Shoji Tanaka) of International Superconductivity Technology Center (President: Hiroshi Araki), the next-generation high-temperature superconducting wires ($Y_1Ba_2Cu_3O_y$, called "YBCO" for short) have been developed as part of "Fundamental Superconducting Application Technologies Project" (Project Leader: Director Yuh Shiohara at SRL) commissioned by New Energy and Industrial Technology Development Organization (NEDO).

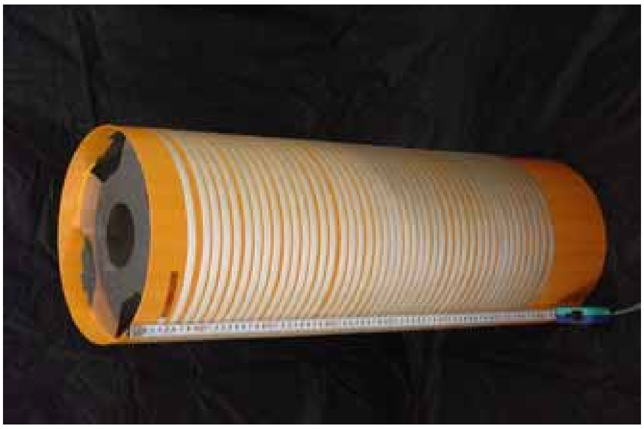

Fig. 1 World's-highest-characteristic YBCO wire

The achievement this time was the success in developing long wires that allow a superconducting current flow of 182A throughout the length of trial-manufactured 45.8m at liquid nitrogen temperature (77K). (Fig. 1) This broke the previous critical current value (Ic) record for several dozen to 100 meters class long wires significantly.

Until last year, the development of long YBCO wires that would allow a large current flow had been desired. For this reason, developments related to longer wires/higher Ic have been advanced actively as national projects or by venture companies in Japan, U.S., Europe and Korea. In August this year, IGC (Intermagnetics General Corporation) reported 70A with 100m-long wires and Fujikura Ltd. reported 104A with 65m-long wires in succession. The achievement this time is a significant progress that nearly doubles such current values with long wires, and YBCO wire applications, which have been desired for a long time, can be expected at an early date. As for the first generation Bi-system wires of which applications are advanced, the wires of several hundred meters in length and have 100A-class Ic are already being used. Regarding the achievement this time, although the length did not reached to several hundred meters, the Ic of 50m-class wire is much higher than that of Bi wires. When the development of this wire will be advanced in the future, the applications to equipments such as SMES and MRI will become available. The current targets of NEDO-METI project are 200A for 200m-long wires by the end of FY2005, and 300A for 500m-long wires by the end of FY2007.

This wire was realized by adopting a new manufacturing process called "multi-plume and multi-turn method" based on Pulsed Laser Deposition (PLD) method for longer wires which have been developed at Nagoya Coated Conductor Center (Director: Yutaka Yamada) of SRL, together with the following two technologies.

The first one being applied to this manufacturing process is, unlike the conventional PLD, is the technology to make multiple laser plumes and deposit YBCO to multiple tapes effectively. In addition, as this technology allows the temperature variation according to film thickness, the higher-speed and

  

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higher-characteristic manufacturing of YBCO films than the conventional manufacturing process will become available. The wire that recorded Ic of 182A this time was manufactured at 3m/h—this speed was higher than that of conventional process. Furthermore, the wires of 100A-class Ic can be manufactured at 7.5m/h. A manufacturing speed several times higher than that of conventional PLD method (1-2m/h) is now available. This high-speed manufacturing technology can be a great advantage for future industrialization.

The second technology established and applied was the ion-assisted sputtering (IBAD)/ceria ($CeO_2$) substrate manufacturing process that can manufacture 100-200m-class substrates stably. To obtain high-characteristic YBCO wires, substrates with fine crystalline orientation (high orientation) are required. Since last year, the substrate manufacturing process has been modified and reached to a technological level to stably manufacture 100-200m-long highly oriented substrates, which are very close to single-crystal substrates. This was an important element of development success this time. While the orientation of conventional substrates which had been used in another place was approx. 10 degrees, the orientation of this substrate has been improved to 3-5 degrees currently by using a special ceria film that is effective for self-texturing (1-2 degrees for single-crystal substrates).

The development of this wire is now being advanced at Nagoya Coated Conductor Center where the large integrated wire manufacturing facility using IBAD and PLD methods is installed. With our eyes set on its applications, we are planning to focus on the development of 200m-long wires that will allow a current flow of 200A at the first setout.

The achievement this time was presented at a "Applied Superconductivity Conference 2004" held from October 4, 2004 in Jacksonville, Florida, USA.

This R&D has been advanced as part of R&D of Fundamental Superconducting Application Technologies Project commissioned by New Energy and Industrial Technology Development Organization (NEDO). In this project, Nagoya Coated Conductor Center has advanced this R&D with IBAD method cooperatively with Fujikura Ltd. The above-mentioned IBAD machine to manufacture substrates was introduced in 2002 by cooperation of Fujikura Ltd.

(Osamu Horigami, Director, SRL/ISTEC)

(Published in a Japanese version in the October 2004 issue of *Superconductivity Web 21*)

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## The 13th International Superconductivity Industry Summit was Held

The 13th International Superconductivity Industry Summit (ISIS-13) was held in Jacksonville, Florida, USA, on October 8, 2004. Some 50 people from Japan, USA, and Europe attended the meeting this year. Although the landfalls of several big hurricanes had been reported, the Florida summit ended successfully after all.

The 1st summit was held in U.S. in 1992, and this year's summit is the 13th. The theme of the summit was "Infrastructure—Challenges and Solutions". At the beginning, national reports were presented by respective leading representatives from Japan, USA and Europe including S. Tanaka, Vice President of ISTEC. Though Japan, USA and Europe have their own problems, steady progress toward the goals have been made in all the regions. Consecutively, reports on governmental funding to superconductivity-related research and development in the past decade were presented. One of the differences between Japan and USA is that such as SPI, USA focuses their R&D investment more on the electric power applications than Japan. The SPI is typically focusing on the high-temperature superconductivity. In Europe, as superconductivity development programs of each country are financed mainly by each national budget, the proportion of the EU programs seems to be less than that of national projects in superconductivity-related R&D activities. For this reason, the overall image on superconductivity-related R&D activities in Europe was a little bit less visible than those in Japan and in USA.

At the meeting, USA reported on the cable demonstration programs to be carried out under SPI as one of the topics. One of them was a project in Albany, New York, in which a Japanese company, Sumitomo Electric Industries, Ltd., is participating. The project in Columbus, Ohio and that in Long Island, New York were also reported. In the SPI, about half of each project cost burden has been borne by private participating companies. In Japan, only the demonstration project of 500m superconducting cable by Super-GM, Furukawa Electric Co., Ltd. and Central Research Institute of Electric Power Industry is in progress. In USA, as was seen, three projects are going on simultaneously and therefore, R&D in power transmission cable field is more active than in Japan.

Although the present status and circumstances in superconductivity-related R&D activities in USA, Europe and Japan are different, their advancements have been steady, and their achievements will be brought to the market one by one upon becoming available in the future. In some cases, it may take some time for such superconductor products to be accepted in the marketplace. Patience must be required to some extent. What product shall be planned is important as well. Whatever the case may be, R&Ds of superconductors, especially high-temperature superconductors, may be entering a crucial stage.

The next ISIS-14 is tentatively scheduled for October 27 and 28, 2005 in Tokyo, Japan.

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

(Published in a Japanese version in the November 2004 issue of *Superconductivity Web 21*)

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# Shoji Tanaka, Director General of SRL Won the IEEE Max Swerdlow Award

Shoji Tanaka, Director General of Superconductivity Research Laboratory (SRL) won the Max Swerdlow Award from the superconductivity department of IEEE (Institute of Electrical and Electronics Engineers). The award ceremony was held at the beginning of the first day of Applied Superconductivity Conference (ASC) 2004 held on October 4 through 8, 2004, in Jacksonville, Florida, USA.

At the award ceremony, Director General Shoji Tanaka was awarded a plaque, on which the contents of his achievements were engraved, together with an extra prize. (Photos)

The moment of winning award


Awarded plaque

The reasons for the award were his continuous outstanding leadership in the applications of superconductivity, unmatched and sustained efforts for development, establishment and management of distinctive research organization, and so on.

The Max Swerdlow Award was established by Mr. Max Swerdlow, who had been a program manager at a science laboratory of US Air Force from 1960s to 1980s, to honor people who had made great achievements for development of the applications of superconductivity devotedly with a never-give-up attitude.

Award winners and committee members

Award ceremony

(Osamu Horigami, Director, SRL/ISTEC)

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# What's New in the World of Superconductivity (November)

## Power

**American Superconductor Corporation (November 2, 2004)**

American Superconductor Corporation (AMSC) has announced an order for two D-VAR voltage regulation systems and ancillary equipment to be used in a 150-MW wind farm in Saskatchewan, Canada. The two D-VAR systems are each rated at 8 MVAR of reactive compensation with a 24-MVAR-overload capability. The wind farm, which should be completed in December 2005, will generate enough emission-free energy to meet the electrical demands of about 64,000 homes. VestasAmericas, a division of Vestas Wind Systems A/S, placed the order for the D-VAR systems; Vestas is the world's largest supplier of wind turbines. The wind farm will be the second to combine Vestas' wind turbines and AMSC's D-VAR voltage regulation systems.

Source:
"American Superconductor Receives Order for Two D-VAR(R) Voltage Regulation Systems for Saskatchewan Wind Farm"
American Superconductor Corporation press release (November 2, 2004)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=639062&highlight

**American Superconductor Corporation (November 4, 2005)**

American Superconductor Corporation (AMSC) has reported its financial results for the second quarter, ending September 30, 2004. Total revenues dropped by 1% to US $9.5 million, compared to $9.6 million for the same quarter in the previous fiscal year. The reduction was mainly due to an expected delay in funding from the U.S. Navy for the development of a 36.5-MW superconductor motor. The net loss for the quarter decreased by 44% to $4.1 million, compared to $7.3 million for the same quarter in the previous fiscal year. Greg Yurek, Chief Executive Officer of AMSC, commented that the company remains on track to achieve its targeted revenue range of $55 - $60 million for the fiscal year ending March 31, 2005. Furthermore, the anticipated commissioning of five PQ-IVR and D-VAR power electronic systems in the third quarter is expected to result in record quarterly revenues for the company. Overall, AMSC received $3 million in new orders and contracts during the second quarter, bringing its total backlog of orders and contracts to $57.1 million, of which $36 million should be recognized as revenue in the remainder of fiscal 2005. Higher revenues for the company's SuperMachines business are also expected as funding from the U.S. Navy returns to its normal level. The company's 36.5-MW superconductor motor program passed the U.S. Navy's "Detailed Design Review" in October, authorizing the completion of the motor's manufacture.

Regarding the shipment of HTS wire, Dave Paratore, President and Chief Operating Officer of AMSC, stated, "In the first half of our fiscal year, we manufactured 253,000 meters of first generation HTS wire ... We remain on track to meet our goals for wire shipments in the second half of our fiscal year, which we expect to bring us to a total of about 550,000 meters of wire shipped for the full fiscal year -- an increase of almost four times last year's shipments." The company is also making progress in its attempts to develop second-generation HTS wire, increasing wire performance and scaling up to 4-cm widths over longer lengths.

Source:
"American Superconductor Reports Fiscal 2005 Second Quarter and Six-Month Results"

Published by International Superconductivity Technology Center
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American Superconductor Corporation press release (November 4, 2005)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=640258&highlight

**Intermagnetics General Corporation (November 15, 2004)**

Intermagnetics General Corporation has announced that its SuperPower, Inc., subsidiary has agreed to collaborate with AEP EmTech, LLC, a subsidiary of American Electric Power Company, Inc., to develop, install, and demonstrate a Beta Prototype HTS Matrix Fault Current Limiter (MFCL) device to protect utility grids from damaging current surges. Glenn H. Epstein, Chairman and CEO of Intermagnetics, commented, "This is a significant move forward in the program as it will allow for the installation and demonstration of a 138 kV, three-phase, Beta prototype MFCL device at an AEP transmission substation." SuperPower successfully completed a proof-of-concept prototype MFCL device in July 2004 and is presently working on a single phase, 138-kV Alpha prototype device. Richard Verret, Senior Vice President of Transmission at American Electric Power, further added, "… AEP is building on its early membership on SuperPower's MFCL Technical Advisory Board. We look forward to hosting the world's first demonstration of a transmission level superconducting fault current limiter. Our commitment to the development of this device is evidence of the need we have seen for this technology for at least 20 years. That need will increase as the demand for reliable electricity continues to grow." The US $12.2 million program, which has been underway at SuperPower since June 2002, has received funding from the Electric Power Research Institute and the U.S Department of Energy. Nexans SuperConductors GmbH is a strategic partner and is supplying the "melt cast" superconductors for the device as well as sharing the uncovered costs with SuperPower. AEP's contribution as the host utility adds the final critical component to the project team.
Source:
"INTERMAGNETICS ANNOUNCES AGREEMENT BETWEEN SUPERPOWER SUBSIDIARY AND AMERICAN ELECTRIC POWER ON MFCL PROJECT"
Intermagnetics General Corporation press release (November 15, 2004)
http://www.igc.com/news_events/news_story.asp?id=144

**Rockwell Automation, Inc. (November 16, 2004)**

Rockwell Automation, Inc., has signed an exclusive agreement with SuperPower, Inc., to cooperate in the design, development, building, and installation of HTS motors and generators for high-horsepower industrial and military applications. Under the terms of the agreement, Rockwell will incorporate SuperPower's second-generation (2G) coated conductor technology in its Reliance ™ industrial, commercial, and marine motors and generators. In 2001, Rockwell Automation engineers demonstrated a 1600 horsepower superconducting motor using first-generation wire. The use of SuperPower's 2G wire will further assist in the development of lightweight, cost-effective, and highly efficient generators and motors for multiple industrial applications. Joseph D. Swann, President of Rockwell Automation Power Systems, commented, "The results of our future efforts under this joint agreement will make a significant impact on the successful commercialization of second-generation HTS rotating machinery, leading to cost-effective electric motors and generators that are ultra-efficient, lighter, and substantially more power dense than those that are available today."
Source:
"Rockwell Automation Signs Cooperative Agreement with SuperPower, Inc."
Rockwell Automation, Inc. press release (November 16, 2004)
http://www.shareholder.com/rockwellauto/ReleaseDetail.cfm?ReleaseID=148373&ReleaseType=Company

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## Medical

**CardioMag Imaging, Inc. (November 1, 2004)**

CardioMag Imaging has been awarded a US $100,000 Phase I Small Business Technology Transfer (STTR) award from the National Institutes of Health (NIH) National Heart, Lung, and Blood Institute (NHLBI). The award and possible follow-on NIH funding will be used to develop a magnetocardiograph (MCG) system for small animals, like mice. Molecular biologists and pharmaceutical scientists would use such a system to perform research using animal models, ultimately leading to improved drug development and safety testing. CardioMag will collaborate on the project with the Baylor College of Medicine.

Source:
"CARDIOMAG IMAGING IS AWARDED NATIONAL INSTITUTES of HEALTH GRANT"
CardioMag Imaging, Inc. press release (November 1, 2004)
http://www.cardiomag.com/

## Magnet

**Varian, Inc. (November 3, 2004)**

Varian, Inc. has completed its previously announced acquisition of Magnex Scientific Limited (Oxford, U.K.). Magnex designs and manufactures MRI magnets and is also a major supplier of vertical high-resolution NMR magnets, superconducting magnets for Fourier Transform mass spectroscopy (FT-MS), and MR microscopy gradients. The acquisition of Magnex is expected to help Varian's further advance into the field of MR imaging and to encourage Varian's growth in the areas of pharmaceutical and medical research. Magnex will be operated as a wholly owned subsidiary of Varian, Inc.

Source:
"Varian, Inc. Finalizes Magnex Scientific Ltd. Acquisition"
Varian, Inc. press release (November 3, 2004)
http://www.corporate-ir.net/ireye/ir_site.zhtml?ticker=VARI&script=410&layout=-6&item_id=639689

**Varian, Inc. (November 4, 2004)**

Varian, Inc. has announced plans to build an Imaging Applications Laboratory in Oxford, U.K., for MRI customers, focusing on providing European support. The new laboratory will expand Varian's existing facilities, which include an imaging laboratory in Palo Alto, USA. The U.K. facility, which will be located in Magnex Scientific Limited's Magnet Technology Center, should be completed by early 2005. (Varian recently completed the purchase of Magnex Scientific Limited; for further details, please see previous summary.) The MRI laboratory will be the first of three laboratories to be built on the same site; the other laboratories will be for analytical and NMR applications.

Source:
"Varian, Inc. to Build First Magnetic Resonance Imaging Applications Laboratory in U.K."
Varian, Inc. press release (November 4, 2004)
http://www.corporate-ir.net/ireye/ir_site.zhtml?ticker=VARI&script=410&layout=-6&item_id=640514

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## Communication

### Superconductor Technologies Inc. (November 4, 2004)

Superconductor Technologies Inc. (STI) reported their financial results for the third quarter, ending October 2, 2004. Total net revenue amounted to US $7.3 million, compared to $14.2 million for the same quarter in the previous fiscal year. Net commercial product revenues amounted to US $6.1 million, compared to $11.6 million for the same quarter in the previous fiscal year. Government and other contract revenue amounted to $1.2 million, compared to $2.6 million for the same period in the previous fiscal year. Net loss for the quarter was $5.2 million, compared to $851,000 of the same period in the previous fiscal year. M. Peter Thomas, president and chief executive officer of STI, commented, "Our relationships with our largest commercial customers continue to develop positively, and we are adding new customers, as well as new distributors. We believe we will see growing demand for our SuperLink(TM) Solutions as interference becomes more and more of a challenge for carrier network performance in the developing era of wireless data. This year's restructurings, which have been focused on manufacturing infrastructure and on operating expenses reductions, have led to quarterly savings in the third quarter of $2.3 million as compared to the first quarter of 2004." As of October 2, 2004, STI had a commercial product backlog of $380,000. STI expects fourth quarter 2004 total revenue to increase to $8.0 to $10.0 million.

Source:
"Superconductor Technologies Announces Third Quarter 2004 Results"
Superconductor Technologies Inc. press release (November 4, 2004)
http://phx.corporate-ir.net/staging/phoenix.zhtml?c=70847&p=irol-newsArticle&ID=640691&highlight

### ISCO International, Inc. (November 10, 2004)

ISCO International, Inc., has announced a new RF$^2$ product platform to boost wireless networks, enabling coverage holes to be filled, the range of sites to be extended, and network performance to be improved. To ramp up production queues, ISCO and its lenders have agreed to increase the company's discretionary credit line by US $2 million, $1 million of which will be immediately drawn. Sales of the product are expected to grow significantly in the fourth quarter of 2004 and in 2005. The increased credit will help ISCO to meet these customer demands.

Source:
"ISCO International Announces Financing to Support Revenue Growth"
ISCO International, Inc. press release (November 10, 2004)
http://www.iscointl.com/

### ISCO International, Inc. (November 19, 2004)

ISCO International, Inc., had announced the receipt of more than US $2 million in customer orders for its new RF$^2$ product platform, to be delivered during the first quarter of 2005. Additional orders are also expected in the near term. Dr. Amr Abdelmonem, Chief Executive Officer of ISCO International, commented, " Customer feedback concerning the RF$^2$ product family has been very strong, particularly in conjunction with high-speed data network deployments. The incorporation of our solutions offers enhanced signal processing, thus expanding site coverage and improving call quality, and provides an answer to the type of power and flexibility issues that wireless operators face in order to launch next generation services."

Source:
"ISCO International announces more than $2 million in orders for RF$^2$ ™ Solution"
ISCO International, Inc. press release (November 19, 2004)

  

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http://www.iscointl.com/

**Superconductor Technologies Inc. (November 24 and 30, 2004)**

On November 30, 2004, Superconductor Technologies Inc. (STI) closed the sale of US $10.9 million of common stock in a registered direct offering that had been announced on November 24, 2004. All together, STI sold 15.6 million shares of common stock to a select group of institutional investors, generating net proceeds of $10.1 million.

Source:
“Superconductor Technologies Announces $10.9 Million Directed Public Offering”
Superconductor Technologies Inc. press release (November 24, 2004)
http://phx.corporate-ir.net/staging/phoenix.zhtml?c=70847&p=irol-newsArticle&ID=647279&highlight
“Superconductor Technologies Closes $10.9 Million Directed Public Offering”
Superconductor Technologies Inc. press release (November 30, 2004)
http://phx.corporate-ir.net/staging/phoenix.zhtml?c=70847&p=irol-newsArticle&ID=648243&highlight

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

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## Feature Articles: Advancing Superconducting Single Flux Quantum (SFQ) Device Technology

## "Development of Innovative Process Technology to Integrate 100,000 Josephson Junctions onto One Chip"

The single flux quantum (SFQ) circuit, which is only achievable with superconductor, can realize 100 times faster speed and 1000 times lower power consumption than those of semiconductor circuit. We have been developing SFQ circuits using a metal superconductor named niobium (Nb), and the upper limit of integration by conventional process was 10,000 Josephson junctions (JJs) onto a single chip. We have recently developed a process technology capable to integrate 100,000 JJs onto a single chip. This is 10 times more than the integration by the conventional process.

The point of this process is an accelerated multi-layer structure by introducing a new planarization process. To improve the integration level, increasing the number of Nb layers is essential. And this increasing requires planarization at each layer to avoid short or open circuit due to the difference in level on each layer. For planarization, there was a problem that an even planarization is unavailable when patterns with different widths exist together, called "pattern-width-dependence". We have newly developed a two-step planarization process that eliminates pattern width variation first, and then performs planarization. Fig. 1 is a cross-sectional electron micrograph of the device consists of six Nb layers, one JJ layer and one molybdenum resistive layer, fabricated by using new planarization process. The silicon dioxide film, which is the same material for semiconductor device, was used as interlayer insulation film. While the maximum number of Nb layers achievable by the conventional process without planarization was four, a six-Nb-layer structure was achieved by using new planarization process. The electrical characteristics of this device such as JJ characteristics, interlayer leakage and interline leakage have been confirmed to be at a level sufficient to operate 100,000-JJ-level SFQ circuits. In addition, we have advanced the miniaturization to the limit of our equipments. Together with the advancement of multi-layer structure, the new process enabled the improvement of integration level by a factor of ten. By advancing the JJ's miniaturization further, 80GHz clock operation, which is twice as fast as conventional one, can be expected.

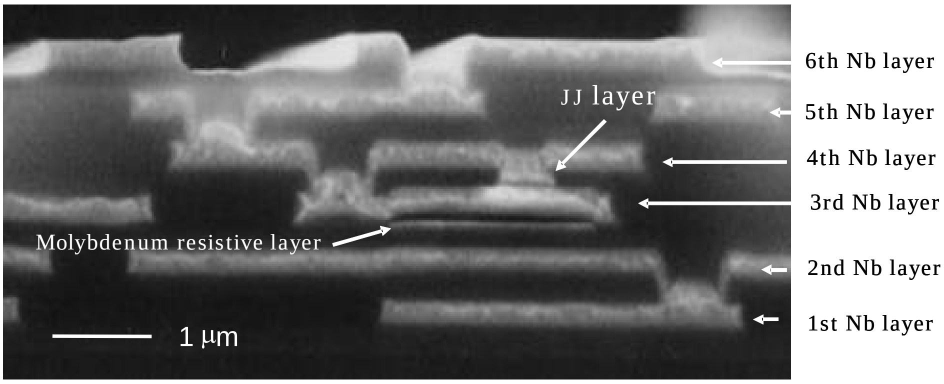


Fig. 1 Cross-sectional electron micrograph of six-Nb-layer-structure device

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The SFQ circuit of 100,000 JJs on a single chip is the beginning of practical level. To step up efforts toward practical applications of processor, switch, etc., the further integration is necessary. The development this time provided the prospects for further process improvement. By advancing multi-layer structure using planarization process and advancing the miniaturization by introducing the existing equipments having been developed already for semiconductor processes, the next target - SFQ circuit integrating 1,000,000 JJs onto a single tip that operates at 100GHz clock is grounded in reality.

This work was supported by the New Energy and Industrial Technology Development Organization (NEDO) as superconductors network devise project.

(Mutsuo Hidaka, Director, Low Temperature Superconducting Device Laboratory, Division of Electronic Devices, SRL/ISTEC)

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# Feature Articles: Advancing Superconducting Single Flux Quantum (SFQ) Device Technology
## "Challenge Large-Capacity IP Router with SFQ Switch"

Nowadays, the Internet usage is advancing with diffusion of ADSL etc. The increase in communications traffic will run hot and cold in the short term, however, continue steadily in the long term. As for access-related infrastructure, 100Mbps-class optical fibers are perceived to be installed in every home. When such days have come, the necessary core router capacity is expected to be 100Tbps-class, which is approx. centuple of the current capacity. Until now, the router switch capacity has been improved along with the growth of semiconductor LSI's performance. According to the road map, however, the progress of semiconductor technology will slow down and stick around several times the current level even around 2010. That is, if nothing is done, the traffic growth has the potential to become difficult to cope with. Therefore, there is no doubt that new technology is expected to arrive.

As a breakthrough technology for this problem, we are researching the application of SFQ technology to the router technology. A normal router consists of parts called "line card" (packet preprocessing) and "switch" (actual packet switching). The line card processing is done for each packet input port and has a character like distributed processing. In contrast, the switch control is a central control on which IP packets from all line cards are concentrated. This switch is one of the bottlenecks in router performance improvement. Until this point, the parallel processing has been adopted as a stopgap measure. The parallel processing, however, causes an increase in hardware volume and has limitations for its processing capacity. The SFQ circuit operates up to a clock rate close to 100GHz. Therefore, it can limit unnecessary parallel processing and process massive amounts of data with few circuits. The concept is shown in Fig. 1. The more throughput, the more remarkably this effect appears. The switch that needs to process massive amounts of data stream at a high speed can be described as an application extremely suitable for SFQ circuit.

Currently, we are developing prototype switches and switch schedulers. As for switch, we have implemented up to the scale of 4x4 using the Nb-based LSI fabrication line at Superconductivity Research Laboratory. Total number of Josephson junctions was 4316 and we succeeded in 40GHz-clock operation. This means that the total throughput of 160Gbps was demonstrated. This is an equivalent level as the current high-end routers'. After this, we will accelerate the scale expansion and aim for the realization of high-capacity and high-quality router.

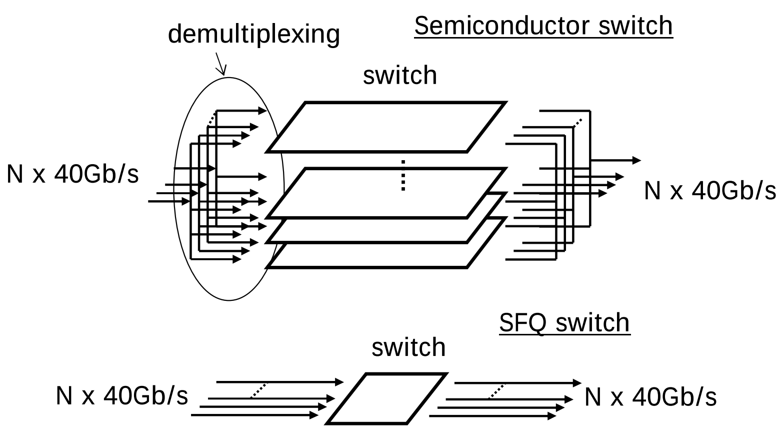


Fig. 1 Basic concepts of semiconductor switch and SFQ switch compositions

  

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This work was supported by the New Energy and Industrial Technology Development Organization (NEDO) as a Superconductor Network Device Project.

(Shinich Yorozu, Low Temperature Superconducting Device Laboratory, Division of Electronic Devices, SRL/ISTEC)

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# Feature Articles: Advancing Superconducting Single Flux Quantum (SFQ) Device Technology
# "Progress of Oxide Integrated Circuit Technology Created the Vision for Realization of Functional Circuits"

When an SFQ circuit formed with oxide superconductors is realized, as it can operates at a high temperature of 30 to 40K and can be cooled by simple one-stage cryocooler, it opens the way to the application to a compact system with restrictions on its weight, size, cost, etc. such as measuring instrument and wireless communications. However, to form SFQ circuits with thin oxide films was extremely difficult and the oxide-specific technical problems should be solved.

The basic structure of oxide superconducting circuit consists of magnetic shielding film, superconducting junctions, upper and lower electrode films to compose the junctions and become wirings, and interlayer insulation films to isolate these superconducting films electrically (Fig. 1). The technical problems to be solved for forming a circuit are (1) to reduce the spread of critical current values of superconducting junctions and uniform such values (standard deviation: 8% or less), (2) to assure the insulation between superconducting layers (100kΩ or more), (3) to restore the superconductivity of magnetic shielding film deteriorated during the oxide thin film lamination process, etc. The critical current of junction mainly depends on the upper electrode film forming process. The desired uniformity was accomplished by adjusting the laser energy etc. for laser deposition. For interlayer insulation film, the $SrSnO_3$ film was selected. The $SrSnO_3$ film was found not to cause a diffusional reaction with $YBa_2Cu_3O_{7-x}$ superconducting films when forming a film at 600-700 degrees. In addition, we succeeded in restoring the superconductivity by making up the amount of oxygen of magnetic shielding film with the heat treatment in the presence of oxygen after completing the processes to form and process oxide thin film. In this way, we have obtained the basic process technologies to form oxide SFQ circuits.

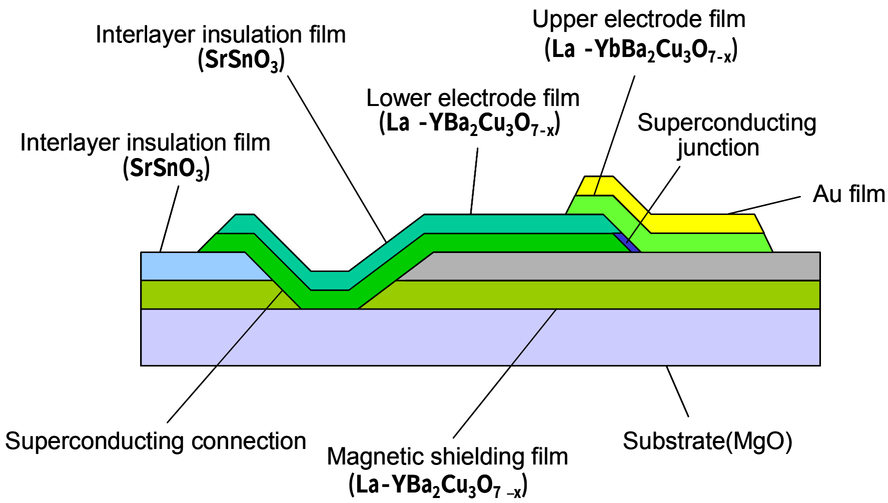


Fig. 1 Cross-sectional structure of SFQ circuit

  

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The basic components of the SFQ circuit are JTL (Josephson Transmission Line) to let SFQ pass, SFQ-dc converter, confluence buffer to let SFQ signals pass from two paths to one path, RS-FF (Reset-Set Flip-Flop) for timing, etc. We formed these oxide element circuits and confirmed their successful basic operations. Especially, we formed a long JTL as shown in Fig. 2 and confirmed that SFQ signals passed through the 100-junction JTL. Based on these results, we would like to develop functional circuits such as oxide analog-digital conversion circuits in the future.

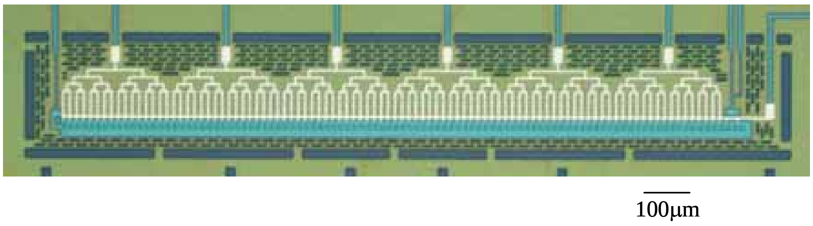


Fig. 2 100-junction JTL ciruit

This research was conducted as the low-power-consumption-type superconducting network device development project commissioned by New Energy and Industrial Technology Development Organization (NEDO).

(Yoshinobu Tarutani, Division of Electronic Devices, SRL/ISTEC)

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# Feature Articles: Advancing Superconducting Single Flux Quantum (SFQ) Device Technology
# "Observation of Ultrahigh-Speed 45GHz Current Signal Using HTS Sampler Circuit"

Signals over 1GHz are now used in a variety of equipment around us brought about by high-speed digital circuits, which are triggered by the spreading of the Internet and personal computers. Research and development is underway for faster signals. Sampling oscilloscopes are used to observe waveforms of high-speed signals of several GHz or above. Sampling oscilloscopes measure amplitudes of measured waveforms that vary over the time using a one-shot pulse of a narrow duration called the strobe pulse. This pulse duration determines the time resolution, namely, the frequency bandwidth. The superconducting SFQ circuit uses picosecond high-speed pulses and is suitable for this application. The sampler circuit can be composed of a small-scale circuit of about several tens of junctions. High-temperature (oxide) SFQ circuits can be cooled by a small cryocooler and are one of the promising targets to the commercialization on a system level.

From fiscal 2003, as part of superconductors network device project supported by the New Energy and Industrial Technology Development Organization (NEDO), Superconductivity Research Laboratory has taken over the R&D conducted by NEC Fundamental Research Laboratory[1] and has started the R&D of a system of above 100GHz. In circuit design, the configurations of conventional samplers were reexamined and a new circuit with an expanded frequency band was devised. Computer simulation showed that the performance of 110GHz band was achieved even when the typical junction parameter ($I_cR_n$ product: 0.7mV) of the present process was used. The hole structure of ground plane called the moat was optimized to avoid flux trap to the circuit[2], and a process to provide a lower ground plane structure for SFQ circuits has been developed. As the signal input method, a method to input voltage through high-frequency line and a method to measure a magnetic field produced by the current of a measured signal by using a superconducting pickup coil (Fig. 1) are under development. This time, we succeeded in observing 45GHz signal, which exceeded the previous high frequency record of 20GHz, using the current input method (Fig. 2). The high-frequency current measurement has been reported as useful in evaluating electromagnetic noises, printed circuit boards and the inside of LSIs[3]. The application of superconducting SFQ sampler to a more-sensitive and broader-band current measurement is expected.

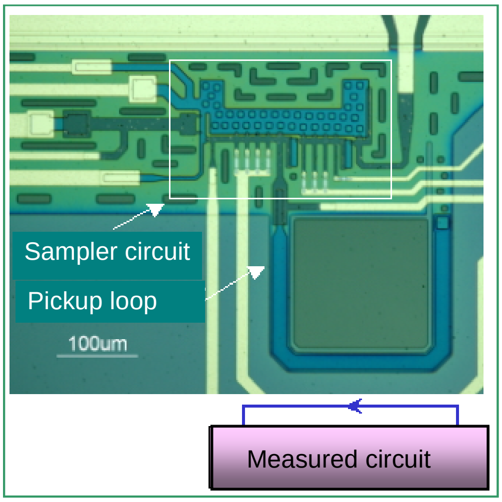


Fig. 1 Photo of current-Input- type sampler chip

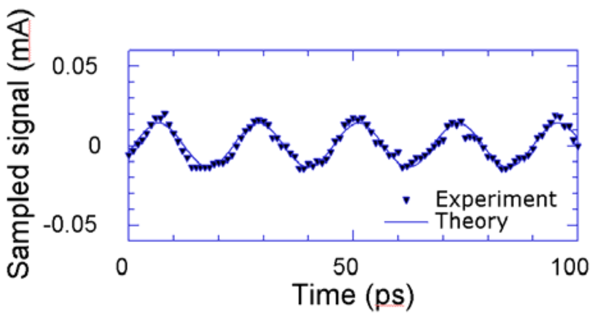


Fig. 2 45GHz signal waveform observed

  

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This work was supported by the New Energy and Industrial Technology Development Organization (NEDO) as Superconductors Network Device Project.

**References**

1) Mutsuo Hidaka, Michitaka Maruyama and Tetsuro Sato, Journal of Institute of Electronics, Information and Communication Engineers, Nov., 2003, p. 1128-1135.
2) Koji Suzuki, Superconductivity Web21, Fall, 2004, p. 21.
3) Norio Masuda, Nikkei Electronics, July 5, 2004, p. 123

(Hideo Suzuki, Division of Electronic Devices, SRL/ISTEC)

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# Feature Articles: Advancing Superconductivity Standardization - IEC/TC90 (Superconductivity) Held the 9th International Standardization Meeting -

IEC/TC90 (International Electrotechnical Commission/Technical Committee 90 (Superconductivity)) held its 9th international meeting* at Argonne National Laboratory in USA on September 1 through 3, 2004, with 22 participants from 6 countries and VAMAS**. In addition, prior to the plenary meeting on September 3, WG2, WG3, WG4, WG5, WG7, WG8, WG10 and WG11 meetings were held on September 1 and 2. The agenda items for the plenary meeting were progress report on IEC/TC90 activities, deliberation on standard, deliberation on maintenance, activity reports from each country and association, revision of standardization strategy, new work item, deliberation on the place for next meeting, etc.

* IEC/TC90 (Superconductivity) international meeting will be held every 18 to 24 months.

** VAMAS: Versailles Project on Advanced Materials and Standards

The reports or deliberations made at the plenary meeting are as follows:

(1) Progress report on IEC/TC90 activities

The minutes for previous 8th meeting in Vienna (Vienna Meeting) was approved. The standards established after Vienna Meeting were IEC61788-8 (AC loss measurement by pickup coil method) and IEC61788-13 (AC loss measurement by magnetometer method).

(2) Deliberation on standard

Regarding the standard under deliberation (IEC61788-9), a discussion about CDV results was made and the transition to the stage of preparing FDIS (Final Draft International Standard) which covered all comments filed was approved.

(3) Deliberation on maintenance

The handling of the results of DCs (Documents for Comment) for existing eight IEC standards referred on May 16, 2003 was reported. Among them, the transition of four standards to the stage of MCR (Maintenance Cycle Report) was confirmed, and the sequential transition of remaining four standards to the stage of MCR was approved.

(4) Activity reports from each country and association

There was no report from Austria and China. Germany reported on maintenance, IEC standard translation and draft preparation of new tension test method. Korea reported on surface resistance test, current leads, draft preparation of irreversibility field measurement method, etc. supported by national projects. Japan reported on the progress of standardization activities for products such as conductors for superconducting generators, conductors for SMES and superconducting current leads in addition to maintenance activities. USA reported on superconductivity-standardization-related activities at IEEE and NEMA in addition to IEC/TC90 activities. VAMAS reported on the progress of basic standardization activities mainly composed of test methods by four WGs.

(5) Revision of standardization strategy

Each country was requested to make a proposal about the review of 2003-version superconductivity standardization strategy.

(6) New work item

The procedure to refer DCs for maintenance of existing standards IEC61788-8 and IEC61788-13 (AC loss measurement methods) was proposed and approved. Establishment of ad hoc groups for converting "deliberation on design method for superconducting current leads" proposed by Japan to a product standard and for the handling of "Uncertainty" left pending was determined, and Kozo Osamura and L. Goodrich were appointed Rapporteur of each group respectively.

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(7) Place for next meeting

Japan was recommended as the place and 18 to 24 months later was approved for next 9th IEC/TC90 international meeting.

(8) Others

Messrs. Hitoshi Wada, Kazuo Funaki, M. Thoener, Takakazu Shintomi and Teruo Matsushita were introduced as IEC 1906 Award recipients.

(Yasuzo Tanaka, Director, Standardization Department, ISTEC)

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# Feature Articles: Advancing Superconductivity Standardization - Meaning of METI "Action Plan for Strengthening the Foundations of International Standardization Activities" -

Akio Iwanaga, Director
Standardization Office for Industrial Infrastructure Standards Development and Planning Division
Industrial Science and Technology Policy and Environment Bureau
Ministry of Economy, Trade and Industry

As the economic globalization is expanding further, the international economic competition is increasingly intensified. In such situation, the importance of international standardization activities has been highlighted as a means to utilize Japan's technical superiority and maintain international competitiveness of Japanese industries.

Japan Industrial Standards Committee (JISC) has ever shown the importance of international standardization as well as necessity and direction of strategic efforts many times in repeated recommendations and reports, however, had never shown any detailed sectoral strategies targeting international standardization.

For this reason, aiming at the further development of international standardization, JISC recommended concrete proceedings of international standardization activities such as to grasp and evaluate sectoral preparation status of international standardization response system and the status of aggressive efforts at international standardization activities, to select sectors to be addressed by Japan intensively in the future and what a necessary support measure should be, and announced them as an action plan in June 2004.

The action plan consists of two parts. One is "generalities" part consists of the separation of roles of public sector and private sector, the establishment of new support system for international standardization activities, the roles of each party, and the actions. And the other is "particulars" part describing sectoral international standardization strategies. Especially, priority sectors shown in "particulars" were extracted from the viewpoints of strengthening industrial competitiveness, meeting social needs, etc. and expected for their aggressive international standardization activities in the future. One of such sectors is IEC/TC90 "Superconductivity".

In the superconductivity sector, since its establishment in 1989, Japan has played a central role in the activities. To accelerate the market introduction of superconducting technologies in the future, from the conventional standards for vocabulary and test method to the standardization activities related to superconducting equipments are essential. Particularly, the application development in the electric power equipment sector has proceeded. In the research related to standardization of technical basis for superconducting electric power equipment from FY2003, the research results and Technical Reports (TRs) on applied power equipments such as Superconducting Magnetic Energy Storage (SMES) and power transmission cable have been examined, and examination of a preliminary draft and preparation of a draft of pre-standard "Publicly Available Specification" (PAS), "Technical Specification" (TS), etc. are under way sequentially for each applied power equipment toward a new recommendation. We set the smooth international standardization activities of these results as immediate goal, and expect that maintenance activities of the existing basic standards will be implemented also as technology advances.

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# Feature Articles: Advancing Superconductivity Standardization - Deliberation of Maintenance Drafts for Existing Eight Superconductivity-Related IEC Standards Started -

IEC/TC90 (International Electrotechnical Commission/Technical Committee 90 (Superconductivity)) has started maintenances of existing eight IEC standards based on the resolution of its 8th international meeting (Vienna Congress) held on February 26, 2003 in Austria, and most of them have reached around the stage of issuing Maintenance Cycle Reports (MCRs).

The maintenances have been implemented according to the following procedure.
(a) Determine the target standards for maintenance: 2003-02-26
(b) Issue DCs (Documents for Comments): 2003-05-16
(c) Vote for/against DCs: 2003-09-26
(d) Prepare findings of secretariat country and drafts for revised standards
(e) Refer or amend drafts for revised standards
(f) Issue MCRs
(g) Issue CDs (Committee Drafts)
(h) Issue CDVs (Committee Drafts for Vote)
(i) Issue FDISs (Final Draft International Standards)
(j) Issue ISs (International Standards)

The target standards for maintenance are as follows:
(1) IEC 61788-1 (DC Ic measurement of Nb-Ti composite superconductors)
(2) IEC 61788-2 (DC Ic measurement of $Nb_3Sn$ composite superconductors)
(3) IEC 61788-3 (DC Ic measurement of Bi-system superconductors)
(4) IEC 61788-4 (Residual resistance ratio measurement of Nb-Ti composite superconductors)
(5) IEC 61788-5 (Copper to superconductor volume ratio measurement of Cu/Nb-Ti composite superconductors)
(6) IEC 61788-6 (Room temperature tensile test of Nb-Ti composite)
(7) IEC 61788-7 (Surface resistance test of superconducting films)
(8) IEC 61788-10 (Critical temperature measurement of superconductors by resistance method)

The progress of each maintenance as of September 2004 is as follows:
(1) IEC 61788-1 (DC Ic measurement of Nb-Ti composite superconductors): In the stage of MCR
(2) IEC 61788-2 (DC Ic measurement of $Nb_3Sn$ composite superconductors): In the stage to refer or amend the draft for revised standard
(3) IEC 61788-3 (DC Ic measurement of Bi-system superconductors): In the stage of CD
(4) IEC 61788-4 (Residual resistance ratio measurement of Nb-Ti composite superconductors): In the stage of CD
(5) IEC 61788-5(Copper to superconductor volume ratio measurement of Cu/Nb-Ti composite superconductors): In the stage of CDV
(6) IEC 61788-6 (Room temperature tensile test of Nb-Ti composite): In the stage to refer or amend the draft for revised standard
(7) IEC 61788-7 (Surface resistance test of superconducting films): In the stage to refer or amend the draft for revised standard

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(8) IEC 61788-10 (Critical temperature measurement of superconductors by resistance method): In the stage to refer or amend the draft for revised standard

(Yasuzo Tanaka, Director, Standardization Department, ISTEC)

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# Feature Articles: Advancing Superconductivity Standardization - IEC/TC90 Established an Ad Hoc Group for Standardization of Superconducting Products -

IEC/TC90 decided to establish an ad hoc group to deal with the design method for superconducting current leads at its 9th international meeting held on September 3, 2004 at the Argonne National Laboratory in USA, and launched the standardization of superconducting products.

At the meeting, a representative from Japanese National Committee (JNC) explained about the necessity of standardizing superconducting products. Such explanation was made successively from its 8th meeting held in Vienna, Austria. The pending issue from the previous meeting was to find out an appropriate standardization procedure for various superconducting products of different market scales and in different development stages.

The needs and difficulties of standardizing superconducting products have been recognized as follows:
(1) The standardization of those in technological maturation period and have large market scales such as MRI and NMR involves considerable difficulty in gaining a consensus among interested parties getting established.
(2) The standardization of those just introduced to markets and each market scale is relatively small such as superconducting current lead is expected to gain a consensus easily with the parties involved in superconductivity-applied equipments, and its start seems relatively easy.
(3) The standardization of those under technical development such as superconducting conductors for superconducting generator or SMES needs considerations of technical versatility and applied equipments' deployabilities, as the technologies of such products tend to be biased toward the ones relating to particular projects.

The "establishment of ad hoc group to deal with the design method for superconducting current leads" decided at this Argonne meeting is relating to the second category mentioned above. This ad hoc group is an expert group to deliberate only on "standardization related to the design method for superconducting current leads", and comprised of Prof. Kozo Osamura, Rapporteur (the person in charge of reporting to the parent committee) assigned by IEC/TC90 and experts assigned by IEC/TC90 as appropriate.

As a specific activity of this ad hoc group in the future, the following meeting has been proposed.
Open Discussion on Standardization of HTS Current Leads
-- General Requirements for Design --
Hosted by Council of Superconductivity, IEEE, and cooperated by IEC/TC90
Date and Time: October 6, 2004 at 14:30-16:00
Place: Adam's Mark Hotel, Jacksonville, FL, USA (The same place as for ASC2004)

(Yasuzo Tanaka, Director, Standardization Department, ISTEC)

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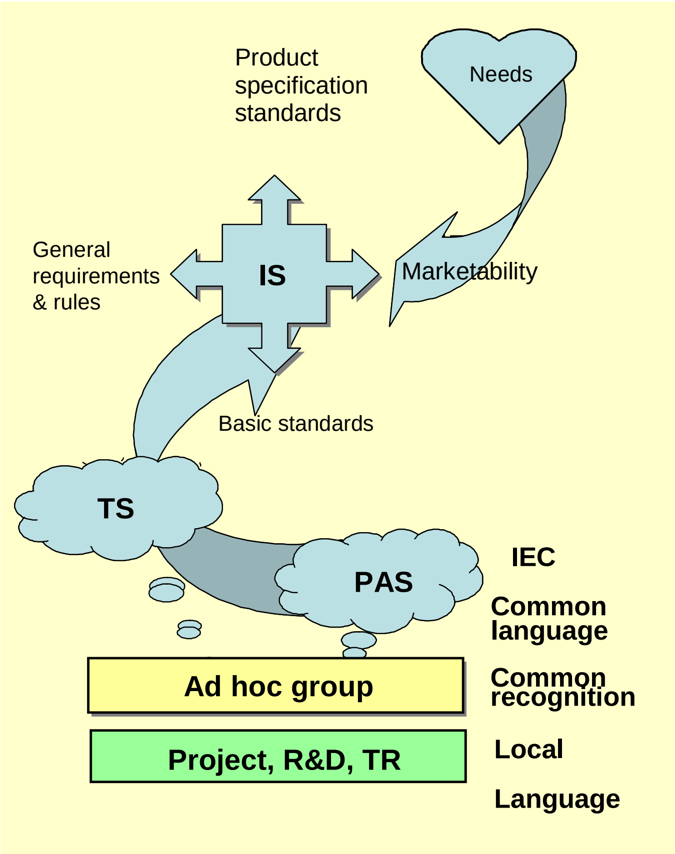
# Feature Articles: Advancing Superconductivity Standardization - Road Map to Standardizing the Results of Superconductivity-Related Projects -

IEC/TC90 established a road map to standardizing the results of superconductivity-related projects and the superconducting products at its 9th international meeting held on September 3, 2004 at the Argonne National Laboratory in USA. The feature of this road map is the establishment of an ad hoc group in the conventional process of standardization.

That is, an ad hoc group was established in the runup to the standardizations of the results of superconductivity-related projects and the superconducting products, in addition to the conventional basic standardizations of vocabulary, test method, etc. The aim of this ad hoc group is to understand the interest problems becoming obvious, deepen the understanding of individual products, as well as to establish a common recognition.

Toward the standardization of superconducting products, the ad hoc group activity specialized for "general requirements for design of superconducting current leads" has started already.

At the same time, the standardizations of the results of specific R&D projects such as "superconducting conductor for superconducting generator" and "superconducting conductor for SMES" are also proceeding. The percentages of technical completion of the results of these R&D projects themselves are high as they had been conducted under specific themes by specific associations or in specific areas, however, many items to be studied such as the versatilities, international needs, near-future marketabilities of such technologies are still unclear. Therefore, as the place to understand these items to be studied and establish common recognitions as international standards, the establishment of ad hoc groups or advisory councils consist of international experts is required.




Road Map to standardizing the results of superconductivity -related projects and the superconducting products

The higher committee IEC/TC90 will receive reports from ad hoc groups or advisory councils, and make a judgment on whether the technical field developed from the results of each R&D project is expandable toward Publicly Available Specification (PAS), Technical Specification (TS), and International Standard (IS).

(Yasuzo Tanaka, Director, Standardization Department, ISTEC)
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# Feature Articles: Advancing Superconductivity Standardization

## - Superconductivity-Related 13 IEC Standards and 6 JIS Standards Issued -

**IEC Standards:**

- IEC 60050-815: 2000 International Electrotechnical Vocabulary-Part 815: Superconductivity
- IEC 61788-1: 1998 Superconductivity-Part 1: Critical current measurement--DC critical current of Cu/Nb-Ti composite superconductors
- IEC 61788-2: 1999 Superconductivity-Part 2: Critical current measurement--DC critical current of $Nb_3Sn$ composite superconductors
- IEC 61788-3: 2000 Superconductivity-Part 3: Critical current measurement--DC critical current of Ag-sheathed Bi-2212 and Bi-2223 oxide superconductors
- IEC 61788-4: 2001 Superconductivity-Part 4: Residual resistance ratio measurement--Residual resistance ratio of Nb-Ti composite superconductors
- IEC 61788-5: 2000 Superconductivity-Part 5: Matrix to superconductor volume ratio measurement--Copper to superconductor volume ratio of Cu/Nb-Ti composite superconductors
- IEC 61788-6: 2000 Superconductivity-Part 6: Mechanical properties measurement--Room temperature tensile test of Cu/Nb-Ti composite superconductors
- IEC 61788-7: 2002 Superconductivity-Part 7: Electronic characteristic measurements--Surface resistance of superconductors at microwave frequencies
- IEC 61788-8: 2003 Superconductivity-Part 8: AC loss measurements–Total AC loss measurement of Cu/Nb-Ti composite superconducting wires exposed to a transverse alternating magnetic field by a pickup coil method
- IEC 61788-10: 2002 Superconductivity-Part 10: Critical temperature measurement–Critical temperature of Nb-Ti, $Nb_3Sn$, and Bi-system oxide composite superconductors by a resistance method
- IEC 61788-11: 2003 Superconductivity-Part 11: Residual resistance ratio measurement--Residual resistance ratio of $Nb_3Sn$ composite superconductors
- IEC 61788-12: 2002 Superconductivity-Part 12: Matrix to superconductor volume ratio measurement--Copper to non-copper volume ratio of $Nb_3Sn$ composite superconducting wires
- IEC 61788-13: 2003 Superconductivity-Part 13: AC loss measurements--Magnetometer methods for hysteresis loss in Cu/Nb-Ti multifilamentary composites

**JIS Standards:**

- JIS H 7005:1999 Terms and definitions related to superconductivity (harmonized with IEC 60050-815: 2000)
- JIS H 7301: 1997 Superconductivity--Test method-Part 1: Critical current--Section 1: DC critical current of Cu/Nb-Ti composite superconductors (harmonized with IEC 61788-1: 1998)
- JIS H 7302: 2000 Superconductivity-Part 2: Critical current measurement--DC critical current of $Nb_3Sn$ composite superconductors (harmonized with IEC 61788-2:1999)
- JIS H 7303: 2002 Superconductivity-Part 6: Mechanical properties measurement--Room temperature tensile test of Cu/Nb-Ti composite superconductors (harmonized with IEC 61788-6: 2000)
- JIS H 7304: 2002 Superconductivity-Part 5: Matrix to superconductor volume ratio measurement--Copper to superconductor volume ratio of Cu/Nb-Ti composite superconductors (harmonized with IEC 61788-5: 2000)
- JIS H 7305: 2003 Superconductivity-Part 3: Critical current measurement--DC critical current of Ag-sheathed Bi-2212 and Bi-2223 oxide superconductors

To order IEC or JIS Standards, please visit website of IEC or Japanese Standards Association (JIS) (http://www.jsa.or.jp) .

(Yasuzo Tanaka, Director, Standardization Department, ISTEC)

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# Patent Information

## Introduction of Published Unexamined Patents in the 2nd Quarter of Fiscal 2004

The following are ISTEC's patents published from July through September in 2004. For more information, access the homepage of the Patent Office of Japan and visit the Industrial Property Digital Library (IPDL).

**1) Publication No. 2004-203727: "Oxide Superconductor having High Critical Current Density"**

This invention relates to RE system oxide superconductors having a high critical current density at a relatively high temperature even in a high magnetic field. By dispersing non-superconducting particles below 500nm particle diameter of $RE_a$-$Ba_b$-$Cu_c$-$Z_d$-O or $RE_a$-$Ba_b$-$Cu_c$-$Z_d$-$Pt_e$-O ( Z is one or more elements selected from Ti, Zr and Hf) in RE123 matrix of the RE-Ba-Cu-O oxide superconductors (RE is one or more rare-earth elements ), a critical current density of 50,000A/cm$^2$ or above is demonstrated in a magnetic field of 3T. The irreversible magnetic field also becomes 5T or above. By making particles 200nm or below, a critical current density of 5,000A/cm$^2$ or above can be gained at a liquid oxygen temperature(90K) in a zero field.

**2) Publication No. 2004-250289: "Carbon-Sulfur System Superconductor"**

This invention relates to a carbon-sulfur system superconductor whose transition temperature of the magnetic susceptibility is equal to or higher than the highest transition temperature of oxide superconductors. In this invention, the fabrication method of the superconductor includes, compression molding of mixed powder of graphite and sulfur to form a molded precursor, calcination of the precursor at 110 to 350°C in an inert gas atmosphere or pressure calcination at 500 to 800°C by placing the precursor in the metal mold, annealing at around 200°C, and cooling to room temperature. The element ratio of carbon and sulfur of obtained superconductors is varied depending on the fabrication conditions, then the transition temperature of the magnetic susceptibility of those superconductors distribute at 300K or above or around 120K.

**3) Publication No. 2004-262673: "Manufacturing Method of Oxide Superconductor, Oxide Superconductor and Base Material for Supporting Its Precursor"**

This invention provides a technology to manufacture flawless oxide superconductors in large bulks by controlling generation of cracks caused by a difference between thermal expansion coefficients of precursor and supporting base material in top-seeded melt growth method. The most important feature of this technology is that the top-seeded melt growth is introduced to partially melted precursor on the supporting base composed of fusible compound or pure metal material. As specific examples for RE-Ba-Cu-O system superconductors, the compound is selected from oxides that contain Ba or Cu and do not contain rare-earth elements, and the metal is selected from Ba, Cu and noble metals. Comparing that the maximum bulk diameter of Nd123 superconductors ever manufactured was 20mm, this invention allows the manufacture of single grain boundary bulks of 30mm or larger in diameter.

**4) Re-publication 002-095093: "Single Crystalline $MgB_2$, Manufacturing Method of the Same and Superconducting Materials Containing the Same"**

This invention relates to the method of manufacturing of single crystalline $MgB_2$. A mixture of magnesium and boron or a precursor fabricated from small crystals of $MgB_2$ obtained by reacting magnesium and boron was reacted by keeping it in a high temperature and high pressure condition (1300

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to 1700°C, 3 to 6GPa) while contacting it with hexagonal boron nitride to grow single crystalline $MgB_2$. The single crystalline $MgB_2$ is characterized by achieving irreversible magnetic field of 95% or above of the secondary critical magnetic field by selecting the direction of applying magnetic field, so a superconductor with an excellent characteristic can be obtained by adjusting the crystal orientation. In addition, during the time of above-mentioned reaction, addition of a reducing agent such as Mg and applying gradient temperature to the melted raw materials are more useful for the single crystal growth.

(Katsuo Nakazato, Director, Research & Development Promotion Division, SRL/ISTEC)

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## Standardization Activities

### - Professors Ogawa, Funaki, Matsushita, Shintomi and Wada Received Superconductivity- Standardization-Related Awards -

On October 12, 2004, Professor Rikuo Ogawa at Hakodate National College of Technology received the Ministry of Economy, Trade and Industry (METI) Minister Award for the promotion of industrial standardization related to superconductivity, Professor Kazuo Funaki at Kyushu University, Professor Emeritus Takakazu Shintomi at High Energy Accelerator Research Organization, Professor Teruo Matsushita at Kyushu Institute of Technology, and Professor Hitoshi Wada at the University of Tokyo received IEC 1906 Awards from International Electrotechnical Commission (IEC) respectively.

The award ceremony was held by Senior Vice Minister Hachiro Okonogi of METI, President Takuma Yamamoto of Japanese Industrial Standards Committee, and Japanese Standards Association at "FY2004 Standardization and Quality Control National Convention (Theme: Develop human resources, products and systems- Quality Nation Japan)", which is one of the events for "Industrial Standardization Promotion Month" on October 12 and 13, 2004 hosted by METI, in the JA Hall (Otemachi, Tokyo). The numbers of recipients this time were 31 individuals for the promotion of industrial standardization, 5 institutions for the contribution to industrial standardization, 19 individuals for IEC 1906 Awards, 2 individuals for standardization document incentive awards.


Recipients of METI Minister Awards for the promotion of industrial standardization

The reason of receiving Minister Award for the promotion of industrial standardization related to superconductivity was Professor Rikuo Ogawa's contributions to the JIS draft preparation and the reflection to international standards by serving as chairman etc. of IEC/T90's Working Group 1 (superconductivity-related vocabulary) in the non-ferrous metal field. Meanwhile, the reasons of receiving IEC 1906 Awards are that Professors Kazuo Funaki, Takakazu Shintomi, Teruo Matsushita and Hitoshi Wada, together with Manfred Thoener (European Advanced Superconductors), greatly contributed to the electrical and electronics standardization and the furtherance of related activities' interests in association with IEC/TC90's technical activities.


Recipients of IEC 1906 Awards

(Yasuzo Tanaka, Director, Standardization Department, ISTEC)

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