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Superconductivity Web21

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

Power

American Superconductor Corporation (February 4, 2004)

American Superconductor Corporation (AMSC) and Industrial Research Limited (IRL; a New Zealand national laboratory) announced that the U.S. Patent & Trademark Office has issued a fundamental composition of matter patent for the HTS material commonly known as BSCCO 2223. AMSC is the exclusive licensee of this patent and will receive 17 years of worldwide patent protection. BSCCO 2223, the material used to make commercial first-generation HTS wire and HTS products, was first developed and patented in 1988 by IRL. In 1989, patent applications were filed in the USA and several global markets (including the UK, France, Germany, the Netherlands, and New Zealand), and the patent was assigned to a New Zealand holding company called Superlink, which is currently owned by IRL and Meridian Energy Ltd., a New Zealand power utitility. AMSC obtained exclusive, worldwide rights to this patent in 1992, after entering a presently ongoing business relationship with IRL. The patent provides AMSC with exclusive rights to the commercial use of BSCCO 2223 in the USA; with commercial applications of first-generation wire just entering the market, the patent is particularly powerful. Several companies around the world have challenged the BSCCO 2223 patent because it is fundamental to the production of commercial HTS wire. The patent actually specifies a composition ratio of 2.1:2:2:3, not 2:2:2:3; however, the superconducting composition used commercially today contains a slight excess of bismuth and lead. Consequently, the patent covers the primary superconductor material used for commercial first-generation wire. According to Alex Malozemoff, chief technical officer of AMSC, "This newly issued patent applies to all of today's commercial applications of HTS wire. It is extremely strong because it has withstood more than 14 years of review by the U.S. Patent Office and has overcome numerous legal challenges from multiple companies around the world." Competitors in the USA will not be able to sell first-generation HTS wire unless AMSC agrees to a sublicense. AMSC is, at present, the only manufacturer of BSCCO 2223 wire in the USA and has a USA and European cross-licensing agreement for first-generation wire with Sumitomo Electric Industries. Note that this patent does not cover second-generation HTS wire, which is being developed using a YBCO-123 compound.
Source:
"American Superconductor Is Exclusive Licensee of Newly Issued Patent For Material Used In Commercial High Temperature Superconductor Wire"
American Superconductor Corporation press release (February 4, 2004)
http://www.amsuper.com/html/newsEvents/news/10335061601749.html
"BSCCO Patent Announcement Frequently Asked Questions"
American Superconductor Corporation press release (February 4, 2004)
http://www.amsuper.com/html/newsEvents/news/10335061601752.html

American Superconductor Corporation (February 5, 2004)

American Superconductor Corporation (AMSC) reported their financial results for their third quarter, ending December 31, 2003. Net revenues for the third quarter were US $ 12.3 million, up 347% from the $2.8 million reported for the same period in the previous fiscal year. These results also represented a sequential increase of 28%, compared with the results for the second quarter of the present fiscal year. Net loss for the quarter was $6.5 million, compared with $12.6 million for the same period in the previous

fiscal year. AMSC received $2.9 million in new orders and contracts during the third quarter, and their total backlog of orders and contracts as of December 31, 2003, was $75.2 million, approximately $10.6 million of which is expected to be realized as revenue in the fourth quarter. AMSC ended the third quarter with cash, cash equivalents, and long-term investments amounting to $56.9 million and no long-term debt. AMSC forecasts their fiscal 2004 revenues to be in the range of $40 to $42 million, with a net loss in the range of $27 to $29 million
Source:
"American Superconductor Reports Fiscal 2004 Third Quarter and Nine-Month Results"
American Superconductor Corporation press release (February 5, 2004)
http://www.amsuper.com/html/newsEvents/news/10335061601753.html

Pacific Northwest National Laboratory (February 13, 2004)

Researchers at the Pacific Northwest National Laboratory (PNNL) have predicted that the United States will need to invest US $ 450 billion in conventional electric infrastructure to meet the expected demand over the next 20 years. Since the mortgage on new electric components is a much larger component of electric rates than fuel costs, minimizing new infrastructure will be essential to keeping electricity rates affordable. Increasing grid efficiency will also be critical, since only 75% of the USA's generation assets and 50% of its distributed systems are generally in use, with a peak capacity of 10% and 25% held in reserve to meet 400 hours of peak usage. To solve the above problems, the PNNL research group has proposed a complete transformation of the electricity system by integrating information technology, superconductors, energy storage, customer load management, and distributed generation. In particular, information technology could be used to optimize the system, minimizing the need for new infrastructure and making the system more secure while saving more than $80 billion in deferred construction costs, etc.
Source:
"PNNL envisions smart energy approach projected to save billions"
Pacific Northwest National Laboratory press release (February 13, 2004)
http://www.pnl.gov/news/2004/04-05.htm

Trithor (February 18, 2004)

Trithor announced that the European Union (EU) commission has awarded 2 million euros to a consortium led by Trithor for the development of commercial manufacturing processes for second-generation HTS wires for electric power applications. Commented Dr. Jens Müller, Managing Director of Trithor, "The combination of seed funding and networking with some of Europe's best laboratories stands for a successful jump-start into 2G wire." The consortium has narrowed the number of manufacturing approaches it intends to pursue and will employ three main criteria to all proposed elements: 1) the component must enable same or better performance than existing commercial 1G HTS wire; 2) the component must enable a price-performance ratio that compares favorably with those of conventional conductors, including copper; and 3) commercial manufacture must be feasible by 2010. Trithor is presently the only industrial manufacturer in Europe that is working on both first- and second-generation HTS wire.
Source:
"Trithor Receives Grant to Develop Second Generation HTS Wire"
Trithor press release (February 18, 2004)
http://www.trithor.de/pdf/2004-02-18%20Trithor%20received%20COCON%20grant.pdf

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Communication

Superconductor Technologies Inc. (February 4, 2004)

Superconductor Technologies Inc. (STI) has announced their preliminary, unaudited results for the fourth quarter and year ending December 31, 2003. STI expects to report net revenue of approximately US $16.4 million for the quarter, bringing the total for the year to $49.4 million. These results represent a significant increase from the $7.0 million and $22.4 million, respectively, reported for the previous fiscal year. The company also expects to announce that it reached profitability in the fourth quarter, a significant company milestone. M. Peter Thomas, STI's president and chief executive officer, stated that "As we enter 2004, we expect further market acceptance of STI's products in an improving wireless infrastructure market. We are therefore looking forward to continued commercial revenue growth and to our first profitable year in 2004." While commercial revenue is expected to be at a seasonal low in the first quarter, in parallel with a decline in government R&D revenue, commercial revenue growth is expected to offset any losses in government funding by the second quarter, as the company expands its customer base and global presence. The company's fourth quarter and full year earnings will be released on March 1, 2004.

Source:
"Superconductor Technologies Announces Preliminary Results for 2003"
Superconductor Technologies Inc. press release (February 4, 2004)
http://ir.thomsonfn.com/InvestorRelations/PubNewsStory.aspx?partner=5951&storyId=106520

ISCO International, Inc. (February 17, 2004)

ISCO International has announced their financial results for the fourth quarter and full year ending December 31, 2003. Net revenues of US $1,289,000 and $3,238,000 were reported for the fourth quarter and full year, respectively; in comparison, $1,536,000 and $3,663,000 were reported for the fourth quarter and full year, respectively, in the previous fiscal year. Net losses decreased to $319,000 for the fourth quarter and $7,156,000 for the full year, down from $2,483,000 and $14,078,000 for the fourth quarter and full year, respectively, in the previous fiscal year. The gross margin for the year was 49%, compared with 3% for the previous year. This improvement was due mainly to the continuation of the company's outsourced manufacturing strategy and its focus on higher value-added business. The company also settled a pending litigation that was scheduled for trial in March 2004. Consequently, the company recorded a liability of $350,000 on its 2003 financial results. Without this item, net income during the fourth quarter would have been positive. Commented Dr. Amr Abdelmonem, CEO of ISCO International, "ISCO's outlook has been growing along with the improvements in the telecom sector. Wireless demand continues to grow at a very strong rate, with data applications fueling an increasing amount of that growth. Capital spending in wireless networks is expected to increase from the very low levels of recent years. "

Source:
"ISCO INTERNATIONAL REPORTS FOURTH QUARTER AND FULL YEAR 2003 RESULTS; GROSS MARGIN IMPROVES FROM 3% TO 49%"
ISCO International, Inc. press release (February 17, 2004)
http://www.iscointl.com/

ISCO International, Inc. (February 24, 2004)

ISCO International, Inc. announced that it has received US $ 2 million from existing investors and has extended the due dates of existing notes until April 2005. Regarding the extended credit line

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agreement, interest on the original $ 4 million will be increased to 14% as of April 1, 2004, to match the interest rate on a $ 2 million supplement. No further warrants will be issued in connection with the extension, and the potential for borrowing the remaining $ 1 million specified by the agreement remains available, at the discretion of the lenders.

ISCO International has also settled the litigation with its former CEO, Edward Laves. The case had been scheduled to go to trial in March 2004. Mr. Laves will receive $700,000, half of which will be paid by ISCO and the other half by ISCO's insurance carrier.

Source:
"ISCO International Announces Financing and Litigation Settlement"
ISCO International, Inc. press release (February 24, 2004)
http://www.iscointl.com/

Basic

University of Illinois at Urbana-Champaign (February 12, 2004)

Scientists at the University of Illinois at Urbana-Champaign have found a hidden pattern in cuprate superconductors that may help to explain the mechanism of high-temperature superconductivity. The researchers used scanning tunneling microscopy to examine the motions of electrons in the pseudogap state and found that when cuprate superconductors were heated above their critical temperature, the orderly pairing of electrons was replaced not by randomness, but by a distinct type of movement in which the electrons organize themselves into a "checkerboard" pattern. The findings imply that two types of electron organization, coherent motion and spatial organization, are in competition in copper oxides. This concept may provide valuable insight into the mystery of high-temperature superconductivity. The researchers published their results in the online version of Science on February 12, 2004. The Central Research Institute of the Electric Power Industry in Japan was a collaborator on this project.

Source:
"Hidden order found in cuprates may help explain superconductivity"
University of Illinois at Urbana-Champaign press release (February 12, 2004)
http://www.news.uiuc.edu/news/04/0212yazdani.html

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

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Feature Articles : ISS2003 Topics

- The 16th International Symposium on Superconductivity (ISS 2003) -

The International Superconductivity Technology Center (ISTEC) held the 16th International Symposium on Superconductivity(ISS 2003) at the Tsukuba International Congress Center for three days from Monday, October 27 through Wednesday, October 29, 2003. ISS is held annually and saw its 16th anniversary this year. The purpose of ISS is to promote the development and commercialization of superconducting technology, spread the use of the technology among the general public, and familiarize the general public with the technology. These goals are accomplished through domestic and overseas research on superconductivity, presentation of results obtained from technological development, and international exchange. A total of 637 people from 15 countries including 85 overseas participants attended this symposium. There was an increase in the number of participants from the U.S.A., China, and Korea. There were a total of 444 presentations and sessions, which were composed of 123 oral sessions and 321 poster sessions, including 59 Invited speakers. This is an increase of 23 over the last year. Papers from the symposium will be published as a special issue of Physica C (Elsevier B.V.), an academic journal. At the same time, 11 companies exhibited superconducting materials, products, and technology.

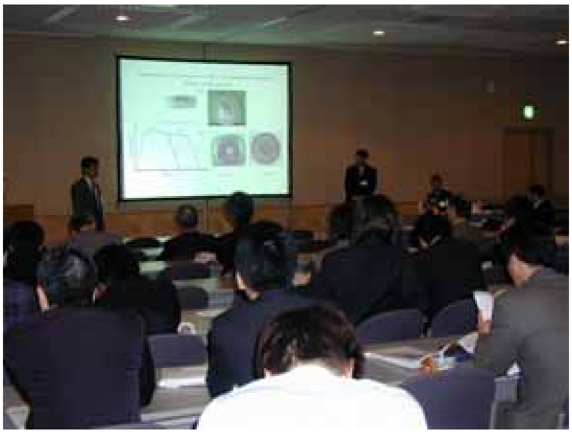
Prof. Shoji Tanaka, vice-president of ISTEC delivering an opening address

On the first day, an opening address was given by Prof. Shoji Tanaka, Vice president of ISTEC, and the congratulatory address of the Minister of Economy, Trade, and Industry was given by Mr. Bunro Shiozawa, Deputy Director-General for Industrial Science and Technology Policy and Environment Bureau, METI. Then, 2 special plenary lectures and 6 plenary lectures were delivered, with Dr. Masashi Tachiki (National Institute for Materials Science) and Dr. M. Nisenoff (M. Nisenoff Associates), both of whom are program chairpersons, presiding. Dr. Shirabe Akita of the Central Research Institute of Electric Power Industry (CRIEPI) and Dr. J. Spargo of Northrop Grumman Space Technology delivered special plenary lectures on "HTS Technologies in Electric Power Applications" and "Superconducting Digital Electronics in the U.S.". Prof. D. C. Larbalestier of the University of Wisconsin-Madison gave a plenary lecture on "Enhancing The Upper Critical Field of MgB_2," Dr. R. A. Hawsey of Oak Ridge National Laboratory on "Overview of U.S. Developments in Coated Conductors," Dr. Yuh Shiohara of ISTEC-SRL on "Progress and Future Prospect of R&D on Coated Conductors in Japan," Prof. Uichiro Mizutani of Nagoya University on "Recent Progress in Synthesis of Bulk Superconductor and Its Application," Dr. C. Foley of CSIRO on "Using SQUIDs for Mineral Exploration- a Review and Case Study," and Dr. Keiji Tsukada of Hitachi, Ltd. on "LTS & HTS SQUID Systems for Magnetocardiography." A banquet was held in the evening and the participants enjoyed the banquet and lively discussion.

On the second and third days, oral presentations were given and two poster sessions were held under 4 categories of physics & chemistry and vortex physics; bulks/system applications; wires & tapes/system applications; and films & junctions/electronic devices. The participants had earnest discussions in these presentations and sessions.

In the physics and chemistry session, two mini-symposiums titled "A New Turn of Strong Correlation Physics" and "Interactions in Superconducting State of a High-Tc Cuprates" were held where the latest topics, such as new superconducting materials and elucidation of the superconducting mechanism of a high-Tc copper oxide, were discussed. In the bulk/system applications session, the latest topics including magnetic levitation at the liquid oxygen temperature and manufacturing of large bulks in microgravity as well as the recent findings in the application of superconducting bearings, a superconducting electric generator, and a movable magnetic separator to a flywheel were reported and discussed. For the wires & tapes/system applications session, the newest development results concerning wire and tape using IBAD and RABiTS – two major processes in the U.S.A. and Japan, and the application of superconductivity to power equipment, were reported and lively discussions were held. In the films & junctions/electronic devices session, the development of the microprocessor by using SFQ devices, the application of superconducting devices to microwave equipment, extensive application of SQUID, and others were reported.

In the afternoon of the third day, Prof. Masao Ogata of The University of Tokyo summarized the presentations in the physics & chemistry and vortex physics session, Prof. Masato Murakami of the Shibaura Institute of Technology in the bulks/system applications session, Dr. R. A. Hawsey of Oak Ridge National Laboratory in the wires & tapes/system applications session, and Dr. Keiichi Tanabe of ISTEC-SRL in the films & junctions/electronic devices session. Lastly, Prof. Tanaka, the director general of SRL, who was chairperson of the organizing committee of ISS 2003, gave the closing address, looking forward to meeting again at ISS 2004, which is scheduled to meet in Niigata City for three days from November 23 through 25, 2004. The curtain fell on a successful ISS 2003.



(Masaharu Saeki, Director, Research & Planning Department, ISTEC)

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Feature Articles : ISS2003 Topics

- Physics and Chemistry -

Two mini-symposiums in physics and chemistry session were held.

The recently discovered new superconductors and new phenomena in the strongly correlated systems like high-temperature superconductors were reported in a mini-symposium, which was titled "A New Turn of Strong Correlation Physics." Dr. Takada of the National Institute for Materials Science reported a new superconductor of water-intercalated cobalt oxide. The new superconductor is characterized by a triangular crystal lattice, which is a unique characteristic conventional superconductors do not have. There are many similarities between the new superconductor and a high-temperature superconductor, such as strong two-dimensionality. This superconductor of cobalt oxide is interesting from the viewpoint of the new magnetic ordered state and new superconductivity symmetry such as the f wave. A mechanism of superconductivity appearing as a result of an increase in inter-layer distance by inserting water molecules is also of great interest. There is also much uncertainty about it including whether the insertion of matter other than water shows superconductivity or not and how much two-dimensionality is required. Much is expected of future research for a solution to these problems. A great variety of new superconductors including organic and plutonium-containing superconductors were introduced.

Another mini-symposium, titled "Interactions in Superconducting State of High-Tc Cuprates," was held based recent experiment results. Much of the debate centered on the question of which is the most important interaction in the superconducting state, the magnetic interaction or that with a lattice. Prof. Takahashi of Tohoku University claimed that the kink structure of an energy dispersion curve observed in angle-resolved photoemission spectroscopy is of magnetic origin, while Prof. Lanzara at UC Berkeley asserted a conflicting view that it is caused by the interaction with a lattice. Prof. Keller from Zurich introduced the results of an experiment of an oxygen isotope effect seen in a magnetic penetration depth. This experiment suggests that a superconducting mechanism may relate to the interaction with a lattice. There were also detailed reports on the abnormal behavior of a lattice observed by neutron and X-ray scattering experiments. Both interactions seem to be too large to ignore. It will take more time to finally judge which is involved in the formation of a cooper pair in superconductivity.

In a session of vortex physics, the flux behavior in a system having a nanostructure was focused. In particular, there were three reports on the simulation results for the flux behavior that occurs spontaneously at the interface between an s-wave and a d-wave superconductor, which suggests a possibility as a new flux quantum device.

(Setsuko Tajima, Director, Division of Material Science & Physics and Noriko Chikumoto, Division of Material Science & Physics, SRL/ISTEC)

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Feature Articles : ISS2003 Topics

- Bulks/System Applications -

This section describes some topics in the bulks/system applications session.

SRL reported a technique to improve the critical current density, which is a basic characteristic, of a bulk body in a simple and effective way. The critical current density of a bulk body has so far been to the order of tens of thousands of A/cm^2 at 77 K in a zero magnetic field. Finely ground RE211 particles to be used as raw material with a ZrO_2 ball mill enhanced the density to hundreds of thousands of A/cm^2. This has been achieved in the (Gd, Y) 123 series and (Nd, Eu, Sm) 123 series. An ultra-fined RE211 phase was recognized in the microstructural observation after a crystal growth. From the observation of TEM, it was discovered that compounds of several tens of nanometers containing the element of Zr are dispersed in large quantities. These microscopic compounds may have contributed to the enhancement of the critical current density. In particular, the (Nd, Eu, Sm) 123 series shows a critical current density of a hundred thousand A/cm^2 at 77 K and 3T and a critical current density of several tens of thousands of A/cm^2 in liquid oxygen at 90K too. This series may be applied to a liquid oxygen pump and other devices. Some experiments on magnetic levitation and a fishing effect in liquid oxygen were also included in the report.

In addition, the strength of a magnetic field captured by a bulk body has been increasing. A magnetic field at 77 K exceeded 2T in the RE123 series substituting various light rare-earth elements and a captured magnetic field of 3.05T was recorded in the Gd123 series. Since a decrease in the temperature of a material enhances its critical current density, a captured magnetic field may improve. The research and development up to now has not yielded the intended results because of the destruction of a bulk body by the hoop force applied to it when a magnetic field is captured or the generation of heat caused by flux movement. The enhancement in mechanical properties and discharge of heat, however, by combining resin impregnation with metal impregnation, has enabled a material of Y123 series to capture a magnetic field of 17.25 T at 29 K by applying a static magnetic field of 17.9 T.

Much basic research on the application of a bulk body was reported. Hitachi Ltd. and Kyushu Electric Power Co., Inc. are now developing the magnetic separator. It is expected that the separator will have a wide range of potential uses in various fields and is nearing practical use. According to this presentation, separation using a bulk body, which is quite efficient, will find wide application in many fields if it is more cost-effective than other separation techniques. Although separation using a bulk body still has substantial area for improvement such as the optimization of absorbing agents, depending on the material, and the strengthening of the magnetic field, much is expected of this technique. Film formation onto materials or pores, which was impossible with conventional equipment, has been made possible in the application of a superconductor to magnetron sputtering, which is carried out by Nagoya University and collaborators. This application is characteristic of the utilization of superconductors, which is of great interest to me.

(Naomichi Sakai, Bulk Superconductor Laboratory, Division of Materials Science & Physics, SRL/ISTEC)

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Feature Articles : ISS2003 Topics

- Wires & Tapes/System Applications -

Two full days were spent on the sessions on "Wires & Tapes/System Applications" in parallel with each other and there were lively debates. There were over 30 oral presentations including plenary. Among them, approximately 25 sessions addressed process, and three quarters of them related to next-generation wires, which are RE (rare-earth elements) system tapes. In addition to process, there were also four or five sessions concerning characterization and application. In a special plenary, Dr. Akita of CRIEPI reviewed the application of high-temperature superconductivity to electric power, giving the impression that the action is moving to a more application-oriented sphere. The following summarizes the presentations related to next-generation tapes.

Various methods are available to achieve the biaxial orientation structure necessary for developing next-generation tapes. One distinctive characteristic of this conference is that much of the research and development, which is nearing the completion of long and high-performance tapes, is being integrated into a technology using Ni-system textured substrates and IBAD buffer layers. For the IBAD buffer layer formation technology, Dr. Arendt of LANL proposed that Al_2O_3 layer be added to the first layer for the purpose of preventing oxygen diffusion in the IBAD-MgO layer and demonstrated the effect. Dr. Iijima of Fujikura investigated the effect of the spread of assist ion beams in the IBAD formation technology of $Gd_2Z_2O_7$. His results, however, demonstrated that there is not much effect within the current use range. In addition, Dr. Muroga of SRL examined the effect of materials on cap layers, which are effective in improving the production rate. The improvement of the rate is a problem to be solved in the IBAD method. He proved that CeO_2 is the most effective and manufactured a 55m long substrate tape. For the effect of this CeO_2 cap layer, Dr. Kato of JFCC showed the investigation results from TEM observation. In particular, he clarified some characteristic phenomena such as the formation of CeO_2 of a larger grain size than in the initial stage of film formation. Although some ideas have been presented, the researchers have not reached a conclusive explanation of this mechanism under the present circumstances.

As a technology to form a superconducting film on a substrate using an IBAD buffer layer, the PLD method is one of the most developed wire structures in Japan, U.S.A., and Europe. Dr. Arendt of LANL succeeded in forming a thick YBCO-layer film on a substrate containing an IBAD-MgO layer, maintaining a high Jc. He explained that he had obtained 5µm thick films of a high value of 1000 A/cm-wide at 65 K. Fujikura scored a great success in making wire longer. The company succeeded in manufacturing a 100m long tape by forming YBCO films on an IBAD-GZO orientation buffer layer and Ic value of 38A. Some SRL researchers including the present writer reported a high Ic value of 292 A as an actual current, which is accomplished by forming a thick film on an IBAD substrate provided with a CeO_2 cap through the MOD method using TFA material as a process that may reduce the cost. We also reported an Ic value of 200A or more at a length of 0.25 m through a continuous process. Dr. Kashima of Chubu Electric Power Co., Inc. reported the results in manufacturing a 1-meter long tape having 40A at his first try by forming superconducting films on an IBAD/CeO_2 layer through the MOCVD method. IGC has been devoting itself to developing a technology to form a superconducting layer on an IBAD substrate through the MOCVD method. IGC's achievement of Ic of 111A at a length of 18 m was introduced in Dr. Hawsey's plenary.

For the textured substrate system, Dr. Rupich of AMSC Inc. introduced a success in developing a wire through the TFA-MOD method as a tape using an alloy substrate such as Ni-W, which is being developed by ORNL. It is a 10m long tape with high uniformity and has 184A as an end-to-end Ic. ORNL is also working toward developing film forming technology called the All-MOD method in which all layers, including a buffer layer, are manufactured by the MOD method. Although all MOD tapes are below 1 MA/cm^2, some wires containing a MOD intermediate layer are close to 2 MA/cm^2, which is high performance. Dr. Hasegawa of Showa Electric Wire & Cable Co., Ltd. also reported on the All-MOD method, and he demonstrated that the addition of Nb to a Ce-Gd-O buffer layer developed recently had improved the characteristics of the tapes.

For characterization, the presentation of Prof. Iwakuma of Kyushu University is of special note. He compared a Bi-system tapes with other system tapes and demonstrated that the 4mm-wide Bi-system of tapes has an AC loss twofold or threefold greater than 4-mm-wide other system of tapes. Dr. Suenaga of BNL maintained that the thickness of the superconducting layer greatly affects the loss in low magnetic fields and thicker layers are more advantageous. In the special plenary lecture, Dr. Akita of CRIEPI reported that people have high hopes for applying superconducting tapes, especially next-generation tapes, to SMES, cables, current limiters, and others in the electric power field. Similarly, Dr. Neumller of Siemens presented the trends in Europe. An achievement was also reported that AMSC manufactured a tapes having a “Neutral Axis” structure for improving the workability and Southwire Company manufactured a conductor using this wire on an experimental basis. Southwire Company succeeded in test-manufacturing a spiral conducting cable using 24 wires and in passing an electric current of 4200A through it.

The above outlines the next-generation tapes. As I described at the start, we are making steady progress although we have still some challenges to overcome including the length, characteristics, and speed. I have a feeling that in response to this progress, there is growing awareness of the application of superconductivity. I am looking forward to seeing further developments.

(Teruo Izumi, Division of Superconducting Tapes and Wires, SRL/ISTEC)

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Feature Articles : ISS2003 Topics

- Films & Junctions/ Electronic Devices -

There were over 110 presentations, an increase of approximately 30 over last year. This may be because there were some presentations on new themes such as the superconducting quantum bit and because the national institutions where this symposium was held played an important role.

It was of interest to note that there was an attempt to control lattice defects on an RE-123 thin film and the nanostructure of precipitates and to improve Jc in a magnetic field by a group including Kyoto University, Yamagata University, The University of Tokyo, Nagoya University, and AIST, which aims at the application to wires, not at the application to devices. The NTT group had been reporting a high-quality superconducting thin film manufactured by strictly controlling the composition through the MBE method. In this symposium, the group reported that an Nd-123 large sized thin film manufactured by the same method shows a high-frequency surface resistance lower than that of commercial Y-123 thin films and that a high-quality film (Tc=41 K) of infinite-layer $Sr_{0.9}La_{0.1}CuO_2$, which is an n-type superconductor, can be formed on a lattice-matched substrate.

In the junction area, it is worthy to note the research on the effect of d-wave symmetry in an SIS junction at which two Bi-2212 whisker crystals cross at an angle of inclination (NIMS) as well as the manufacturing of an Nd-123 bi-crystal junction by the Tri-phase epitaxy method by which a crystalline thin film close to a single crystal can be obtained (NIMS, Tokyo Institute of Technology, Tohoku University, and others). An achievement was also reported that a [100]-tilt bi-crystal junction using a (Hg,Re)-1212 thin film having Tc around 120 K showed a high I_cR_n product of 1.4 mV at 77 K and 0.4 mV at 100 K.

Various applications were reported in the SQUID area: the exploration of minerals in Australia and Canada was reported by Dr. Foley of CSIRO, a plenary lecturer; the development of the cardiac magnetic field inspection system was reported by Dr. Tsukada of Hitachi, Ltd.; a test for foreign substances such as injection needles mixed in meat and a nondestructive test on carbon fiber composite material was presented by Toyohashi University of Technology, Sumitomo Electric Industries, Ltd., and others; an immunodiagnostics system using magnetic particulates was reported by Kyushu University; and the SQUID microscope with improved sensitivity from micro-vibrating samples was presented by Osaka City University and NIMS. The application of a superconducting filter to a booster installed where radio signals have difficulty reaching such as in tunnels and underground shopping malls, which was reported by Hitachi Kokusai Electric Inc., was also worthy of note as a new application in the microwave area. In the digital area, remarkable progress was reported in the niobium-based SFQ circuit and the process development in the U.S.A. and Japan. In Japan, some groups (SRL, Nagoya University, Yokohama National University, and CRL) have made it possible to operate various 5,000-junction-class circuits at 20 to 50 GHz by cell-based design, with a shared cell library. In addition, since a CAD tool to automatically decide the optimum cell arrangement has been developed. 100,000-junction-class circuit design will also become possible. A 60,000-junction-class microprocessor circuit called FLUX was test-manufactured by Northrop Grumman and other companies in the U.S.A, but it is not yet in full operation. The U.S.A. has a little more experience in the multi-chip module (MCM) and low-temperature high-frequency packaging technology than other countries. In the future, the competition to demonstrate superconducting systems that surpass semiconductors in performance, as well as to develop a next-generation integrated circuit process, will become increasingly fierce.

(Keiichi Tanabe, Director, Division of Electronic Devices, SRL/ISTEC)

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Feature Articles : ISS2003 Topics

- Exhibition -

At the 16th International Symposium on Superconductivity (ISS 2003) site, an exhibition was held that displaying superconductivity-related products from 11 domestic organizations in the industrial world for three days from Monday, October 27 through Wednesday, October 29 2003. Products including materials, devices, panels showing applied research and present product development, measuring instruments for manufacturing, evaluation equipment and others were on display. Some booths had products including thin films, wires, bulk materials, substrates for manufacturing, refrigerating machines, and measuring devices, while others had some panels showing the latest technological developments in each area or video showing the development and manufacturing of SMES. The exhibition covered a wide range of topics. The product display held our interest from beginning to end.

Exhibitors and Major Exhibits

・K&R Creation Co., Ltd.
YBCO Thin Films, Substrates for Superconductors, and others
・Tateho Chemical Industries Co., Ltd.
MgO Crystal Ingot, MgO Single Crystal Block, MgO Single Crystal Substrate
・Dowa Mining Co., Ltd.
Superconducting Materials (Synthetic Oxide Powder, Large Sized Melt Processed Bulk, Target, Paste, Bi2223 Thick Film)
・Nippon Steel Corporation
High Temperature Bulk Superconductors and others
・IMURA MATERIAL R&D CO., LTD.
Cryocoolers and others
・Marubun Corporation
Large-area Pulsed Laser Deposition (PLD) systems and others
・NEC R&D Technical Support Center
Superconducting Device Measuring Instruments and others
・Sumitomo Electric Industries, Ltd.
Bi2223 Superconducting Wire and others
・Fujikura Ltd.
YBCO HTS Wires and others
・Kyushu Electric Power Co., Inc.
1 kWh/1MW SMES and others
・Superconductivity Research Laboratory/ISTEC
Coated Conductors Fabricated by TFA-MOD, YBCO Current Leads and others


Scene from the Exhibition

(Nobuhiko Shimizu, Research & Planning Department, ISTEC)

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Feature Articles : SMES

- Development of Cost Reduction Technology for SMES -

Among superconductivity technology applications for electric power, SMES (Superconducting Magnetic Energy Storage) is higher in energy storage efficiency and input and output speed than conventional energy storage. We can expect various effects from SMES, which has such excellent properties as stabilizing the electric power system and maintaining the quality of electric power.

There is an increase today in dispersed power sources caused by progress toward deregulating retail electricity sales and a demand for higher electric power system control technology triggered by great power fluctuation loads and increases in electric power sources. In response, technological development has focused on SMES for controlling small-scale systems for applications in system stabilization, load fluctuation compensation, and frequency regulation, which has potential market needs and a high possibility for commercialization. The main challenge to development is reducing costs. NEDO commissioned the development of technology to lower the cost of superconducting coils and other materials to ISTEC, which carried out development from fiscal 1999 to 2003.

On the basis of the technological development conducted so far, the structure and system of the conductor and coil, which will help to reduce the SMES costs and are the most suitable to each application, were decided. Furthermore, considering the results, peripheral equipment as well as a model coil (refer to the following table) with basic specifications such as the same maximum experience magnetic field, rated current, and other factors as those of an actual SMES for controlling systems was manufactured and assembled, and a performance verification test including current-carrying characteristics, stability, and critical performance was conducted. As a result, the world's first 10,000 times, composed of 5,000 charges and 5,000 discharges, of repeated passages (10 MJ model coil for load fluctuation compensation and frequency regulation) of a current of 10 kA and a high-speed current passing test (model coil for system stabilization) of 2 kA/s were successfully conducted. The results were obtained as designed and there was stable operability in spite of current changes more violent than were expected. The compatibility between the cost and performance of superconducting coils to put SMES for controlling systems to practical use has been verified. These achievements demonstrate that SMES technology has taken strides toward commercialization as power system control equipment.

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Table Specifications of model coil for verification test

Item	System stabilization	Load fluctuation compensation and frequency regulation
Conductor system	Aluminum stabilizing NbTi CIC	NbTi stabilizing copper separation CIC
Maximum stored energy	2.85MJ	10.8MJ
Coil size Outer diameter x inner diameter x length Number of turns	(Unit coil) 1108 x 400 x 519 mm 24 turns x 16 layers	(Unit coil) 1126 x 600 x 511 mm 24 turns x 12 layers
Number of coils	1	4
Coil arrangement	Single solenoid arrangement (10.8 MJSMES represents multipolar arrangement.)	Multipolar solenoid arrangement
Operating current	9.6kA	10kA
Operating voltage	2kV	2kV
Maximum magnetic field	5.66T	4.8T
Cryostat	(Inner diameter x height) 1650 x 3075 mm	(Inner diameter x height) 3300 x 1700 mm
Features of coil	･Design of a high magnetic field ･Stabilized aluminum surface oxidation strand ･Conductor grading ･Forced cooling by SHe	･Design of a low magnetic field ･Stabilized copper external separation primary twisted wire ･Forced cooling by SHe
Scene from element model coil test		
Test site	Imajuku General Test Center of Kyushu Electric Power Co., Inc.	Superconductivity Test Center of Chubu Electric Power Co., Inc.

(Seiichi Koso, Director, Research & Planning Department, ISTEC)

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Feature Articles : SMES

- A Technical Survey of High-Temperature Superconducting SMES -

Atsushi Ishiyama, Professor
Department of Electrical Engineering and Bioscience
Waseda University

Since 1999, we have engaged in a five-year project called the Technical Development of Superconducting Magnetic Energy Storage (SMES). The project, commissioned by NEDO, is scheduled for completion this year. During the research project, we have engaged in technical research on SMES. When a high-temperature superconductive coil is applied to SMES, operation temperatures are available in a broad range of high temperatures, compared with when low-temperature metal wires are used for coils. This broad temperature range of the SMES is characterized as having a number of possible applications. For example, the SEMS system could be applied to conduction cooled refrigerator systems. SMES has a large temperature margin and a large thermal capacity, bringing about thermal stability and large excessive load withstand capacity (pulsed excessive current). These advantages are likely to contribute to cuts in manufacturing costs and operation costs (cooling costs) and to improve operation and control.

The Technical Research of High-Temperature Superconducting SMES has focused on large current conducting technology for SMES, magnet technology, conceptual design examination, technical trends of high-temperature superconducting SMES in Japan and overseas, while conducting technical research based on assessment and experimentation when necessary from time to time. Concerning large-current conducting technology, we mainly experimented with and assessed mechanical features of a transposed conductor where a Bi-2212 Rutherford conductor and a Bi-2223 tape wire are integrated. Concerning magnetic technology, we confirmed, through a small coil for assessment, that pulsed excessive current exceeding the critical current value was available under refrigerator conductivity cooling. The thermal behavior of the coil is predictable (availability of design). In addition, we developed an inner cooling system where a pulse tube refrigerator and a current lead are integrated to cool the area of high electrical pressure, to demonstrate that electrical insulation is available without vacuum. The development of a large-capacity current lead with little thermal intrusion is extremely important for element technology. In our conceptual design, we formed an optimal designing methodology for SMES coils by using a Bi-2223 wire and a Y-system wire that have anisotropism in critical current features when a magnetic field is applied. Concerning high-temperature superconducting SMES where a toroidal coil system consisting of 12 pieces of element coils, made of Bi-2212, Bi-2223, and Y-system wire, is applied, we demonstrated a conceptual design and a parameter survey in anticipation of a 100 MW/15 kWh-class SMES and load compensation for system stability, and a 100 MW/500 kWh-class SMES for frequency arrangement. The results confirmed that the necessary wire volume and operation costs (cooling costs) could be smaller and less in a temperature range of 10 K or less for the Bi-2212, and in a broad temperature range of 20 K through 50 K for the Y-system wire, compared with existing low-temperature metal wires. Concerning high-temperature conducting SMES development activities outside Japan, Ansaldo (Italy) is scheduled to make a 50 kJ-SMES prototype to conduct experiments in its HOTSMES project (2003-2005). Trithor (Germany) is also engaging in developing an SMES coil for UPS applications, which uses a Bi-2223 wire to produce 30 kJ/40 kW.

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We are going to conclude our five-year technical research project this year. At the same time, we will select technical subjects and make recommendations for development guidelines to materialize an optimal high-temperature superconducting SMES coil.

An SMES system is the superconductor-applied power equipment that is the most expected to come into existence in the near future. However, 30 years have passed since Electrotechnical Laboratory and Waseda University conducted the first SMES experiment in Japan. The time has come to leave "research for research" and build a system that can withstand practical applications in terms of performance and cost. Such a system can be built when engineers and researchers, involved in developing superconductivity and low-temperature technologies, succeed in mobilizing their knowledge and experience with enthusiasm.

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Feature Articles : SMES

- Ongoing Development and Outlook for Practical Application -

The United States and some European countries have introduced 1 to 3 MJ-class metal SMES systems against instantaneous voltage drops. They are too far behind, however, to apply to Japan's electric system in terms of capacity, specifications, and performance. The NEDO project has succeeded in operating a continuous 10,000 ampere-class 10,000-time charge and discharge stabilization of a 10 MJ model coil system for Japan's electric control system. The successful operation of this class was the first in the world, demonstrating Japan's notable capabilities in this area. Since Japan's success endorsed that coil cost and performance are compatible, ongoing research will focus elsewhere than the coil, namely on integrating a total SMES system and on the optimal electric system control technology before full-dressed practical application of SMES is materialized into electrical areas.

The past research projects have narrowed down subjects for ongoing system development. Specifically, NEDO has commissioned a development project of systematic integration between peripheral implementation technologies for a large capacity AC-DC converter system and an unprecedented large-capacity oxide material compact coil to ISTEC. This project is scheduled to start this year and will lead to another project to build up practical application technology through actual electric system link tests.

Amid ongoing deregulation, the increasing introduction of distributed power sources with different levels of stability, and a growing number of electrical energy providers, stabilizing the electrical power network and maintaining the quality are essential in supplying electrical energy to those who need it because electric energy is a common asset for people's lives and for industrial activities. In particular, considering the New York blackout in the summer of 2003 and unstable electric power supply networks in parts of European countries in 2003, the maintenance and upgrade of electric power supply networks are increasingly important in terms of social need. Under the circumstances, the possible application of SMES is a very effective means to counter this problem because the technical advantages of SMES are clear; locations can be flexibly chosen; and the economical outlook is already known.

As part of the ripple effects of the NEDO project that is applicable to the current level of electrical technology, Chubu Electric Power Co., Inc. has already made a field-in of a 5000 kW SMES against instantaneous voltage drops in its latest high-tech plant and formed an early commercialization program for SMES. This is one of the pioneering cases of SMES in Japan. A roadmap to the practical application of electric power network control technology will undergo the development of systematization technology for the coming four years or so before it will make a field-in in the actual electric system link system and demonstrate reliability test results, followed by a movement of market-in of large-capacity SMES systems which will be initiated by industrial circles. Since the future market size is predictable, NEDO's project starting this year will lay the foundation for a steadily growing market where a group of corporations in the private sector are concerned with applying SMES systems in their operations as a corporate resource.

(Yoshinori Tatsuta, Managing Director, ISTEC)

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Feature Articles : SMES

- Development of SMES for Bridging Instantaneous Voltage Dips -

Shigeo Nagaya
Leader
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Electric Power Research and Development Center
Chubu Electric Power Co., Inc.

The practical application of SMES is the most expected and nearest to coming into existence among electric power equipment that use different types of superconductivity technologies. This is because the energy storage method of SMES, which has been researched for a long time, matches the needs of Japan today.

Until today, the development of SMES has been focused on electric power storage systems because of its high efficiency compared with battery cells, and on large-scale day and night load leveling systems because of the advantage deriving from its scale and size. SMES is characterized, however, as having an electric power storage unit made of coils, allowing the storage unit to be formed only for the amount of energy necessary for its' operation duties.

Semiconductor and LCD manufacturing plants, which have backed recent technological innovations of information technology, are very concerned with measures to avoid instantaneous voltage dips on transmission lines, which are caused chiefly by lightning. This is because the power supply quality leads to the quality of semiconductor and LCD products; instantaneous voltage dips lead to producing defective products. Moreover, instantaneous voltage dips could negatively impact the plant facility.

Almost all the present instantaneous voltage dips last 1 second or less in the electric system in Japan. Thus, the operation duty of equipment for bridging instantaneous voltage dips targets a 1-second compensation against instantaneous voltage dips. The greatest feature of SMES lies in having a 1-second compensation for operation duty. Other electric power storage units such as capacitors have a shorter compensation time of 0.1 to 0.2 seconds whereas battery cells have excessive electrical power storage capacities such as hours or ten-odd minutes for short-time storage specifications.

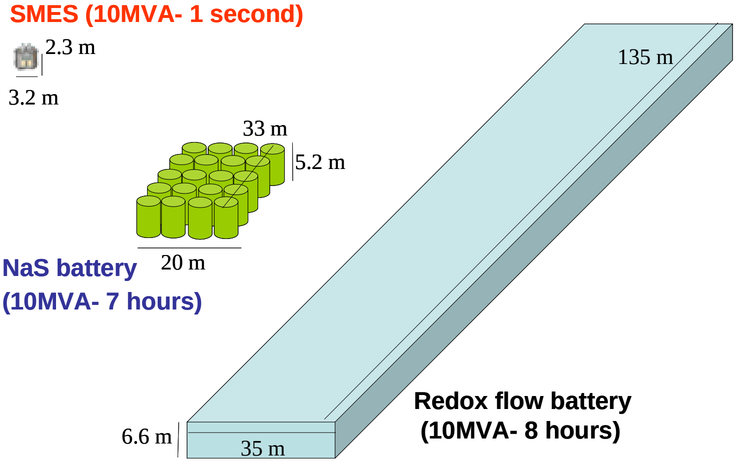

Fig.1 Comparison of Competitive Technologies
(Batteries have applications to load leveling: Outputs of 10 MVA compared)

Fig. 1 indicates a comparison of electric power storage units that can output 10,000 kW for 1 second. The

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figure shows SMES, sodium sulfide (NaS) batteries, and redox flow batteries. As shown in the figure, the SMES is extremely compact for storing 1 second of electric power for compensation compared with the other batteries.

To apply this SMES characteristic, Chubu Electric Power Co., Inc. has installed a SMES system in the latest LCD plant of Sharp Corporation, which was built recently in Mie Prefecture. The 5000 kW SMES system is undergoing demonstration tests against instantaneous voltage dips. Figs. 2 and 3 depict the specifications of the superconducting coils and external views of the system.

Major Specifications of the Coil

Coil arrangement		Quadrupole
Coil form		Close-coiled solenoid
Rated current		2657A
Rated voltage		2.5kV dc
Withstand voltage		6kV dc
Inductance		2.08H
Stored energy		7.34 MJ
Used energy		5.00MJ
Maximum magnetic field		5.3T
Coil form	Inner radius	0.265m
	Outer radius	0.324m
	Height	0.700m
Cooling system		LHe dip cooling

Characteristic:
Rutherford Conductor-Applied Pulse Coils
Dip Cooling of High-Withstand Voltage


Sectioned of conductor structure


Quadrupole coils


Cryostat

Fig. 2 Specifications and Characteristics of Superconducting Coils

This SMES system is characterized as outputting 5000 kW of power, which it can compensate with an entire load of a transformer. In other words, the SMES system can provide blanket compensation of electric power for the entire plant, unlike UPS systems in the past. Since bridging instantaneous voltage dips attenuates the current of superconducting coils, disconnecting the current to result in a zero value will enable lowering the coil tolerance, which was necessary to avoid quenching in the past. This also leads to manufacturing a compact SMES system. In addition, several small cryo-coolers can cool the coils of the SMES system sufficiently. Operation and maintenance will also become easier, requiring no assignment of personnel prescribed by law.

This demonstration test started from July 2003. The SMES system has continued operating well since the demonstrative test, which started some six months ago. The test is scheduled to last until April 2005. Precious findings and data from the test have been collected for practical application of the SMES system.

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Chubu Electric Power Co., Inc. has been working on the development and application of a SMES system and other superconductivity technologies. We hope that 2004 will be a significant year for the practical application of superconductivity technology.

Fig.3 An External View of a Superconducting Coil System

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Feature Articles : Superconducting Wires

- Until Today and the Future -

When hearing the news on a Nobel Prize winner in a superconductivity related field in 2003, it reminded me as a person concerned that superconductivity has been an attractive technology up until today and remains so for the future. Since the potential for this attractive technology remain unabated, people hope for a clear scenario where the practical application of the technology into wire is specified, considering the lengthy recession in Japan. Since some other articles refer to the detailed scenario, I would like to provide an overview on recent superconducting wire, which will also lead to seeing the future.

Recent topics on metal wires include successful developments of an NbTi conductor (Furukawa Electric Co., Ltd.) for LHC (accelerator of CERN) whose size is controlled in detail as well as an ITER-centered solenoid coil (CS coil: 46kA, 13T, 640MJ). Another successful development includes an Incoloy conduit Nb_3Sn conductor that can withstand 60 tons of electromagnetic force per meter (Japan Atomic Energy Research Institute). In addition, recent research has been focusing on adding distinctive characteristics to wire materials, such as Nb_3Sn with a higher critical current density Jc (Tokai University), Nb_3Al (National Institute for Materials Science), and a high-reinforced Nb_3Sn (Furukawa Electric Co., Ltd.).

Concerning Bi system wires, Furukawa Electric Co., Ltd. completed a 500-meter long cable in Yokosuka Research Laboratory of CRIEPI at the end of 2003. A number of companies are currently working on research for a higher Jc wire by improving thermal treatment (Sumitomo Electric Industries, Ltd. American Superconductor (AMSC)). InnoST in China also greatly raised the characteristics of a Bi system wire (90 A of critical current on a 400-meter long wire, which was disclosed at the first Asian Conference on Applied Superconductivity and Cryogenics (December 2003, Beijing)). Similarly, although Bi wire-applied cable projects are thriving in the United States, the major obstacle is how to lower the manufacturing cost. The Jc of Bi-wire in magnetic fields is too low at the liquid nitrogen temperature (77 K) to apply to high magnetic fields.

MgB_2 is a new material discovered in 2001. It has quickly been applied to wires. A number of companies have succeeded in developing MgB_2-applied wires, including a 10-meter long wire (SRL) and 100-meter long wires (Hitachi, Ltd., National Institute for Materials Science). As the critical temperature of MgB_2 is approximately 38 K, researchers are focusing chiefly on improving its characteristics targeting 4.2 K application. Recently, the National Institute for Materials Science has discovered an MgB_2 wire whose irreversibility field exceeds Nb_3Sn wires (23 T at 4.2 K). Since its manufacturing is simple and the cost seems low, MgB_2 wires are likely to replace Nb_3Sn wires in the future.

Next is YBCO wires. Since high-temperature superconductivity was discovered in 1986, researchers focused on longer YBCO wires. Still, YBCO manufacturing methods for longer wires (bi-axially texturing technology of YBCO crystal grains, IBAD (Fujikura), ISD (Sumitomo Electric Industries, Ltd.), and others) did not emerge until the first half of the 1990s. Development took a long time to handle advanced crystal orientation technology. YBCO wires in magnetic fields in liquid nitrogen 77K are high in their Jc and have a broad range of application. As expected, Y-based high-temperature superconducting wire could be the front runner. YBCO wires, backed by a superconducting application base development project, have recently made rapid developments into practical application. They are at a crucial stage for practical application. In 2003, Fujikura announced a 100-meter-class IBAD wire. SRL succeeded in developing Self-Epitaxy PLD-CeO_2 (Ceria) method that accelerates the IBAD method before announcing a 100-meter class substrate. In the United States, AMSC developed a 10-meter class wire with a chemical solution method (TFA method) whose cost seems low. SRL has succeeded in confirming that this method is available for obtaining 292 A of critical current Ic at a practical level. The practical applications for wire are advancing. Since future demonstrations will focus on tens to hundreds of meter class wires, researchers will mobilize their development efforts centering on efficiency.

The major manufacturing methods for YBCO wires have been narrowed down to the IBAD and RABiTS methods for substrate production while the manufacturing of superconducting layers have been narrowed down to the PLD, TFA, and CVD methods. In addition to research for longer wire, the basic R&D described in the NbTi, Nb_3Sn, and Bi system paragraphs above are also necessary. For example, R&D activities are urged for higher Jc, more strength, and lower alternative current loss for Nb_3Sn and lower cost and higher manufacturing rate for Bi system wire. In YBCO wire development, a 100-meter class YBCO wire has been successfully developed with the IBAD method although it has not yet grown to a major superconducting wire. Other methods could emerge as major methods through the R&D efforts mentioned above. Thus, we have to accelerate basic research efforts for longer wire and short wire (higher Jc and improvement in the manufacturing rate, which will lead to lower cost manufacturing).

NbTi wire and Nb_3Sn wire are like adults who can earn money while Bi system wire can be used for application demonstration equipment just like university students (who do part-time work). YBCO wires and MgB_2 wires are still like junior high school students who have many elements that need to be developed. Although 100-meter class wires are at the practical application stage, many obstacles are still expected in the way ahead before reaching success. The development history of materials is often compared to the Stone Age, the Bronze Age, the Iron Age, and so on. The successful development of materials greatly impacts society. This is why Japan, the United States, and China are vigorously promoting material development projects.

I visited China recently. So, finally, I would like to present my impressions on China today. InnoST Co., Ltd., an international venture capital, set up in 2000 in China, has already caught up to the level that Japan and the United States have achieved with Bi system wires. Their fast work astonished me. I had to reflect on my attitude for R&D activities. As a Japanese researcher I must now seek new developments ahead of other researchers and seek materials and technologies that cannot be imitated easily as well as specific patentable technology. Otherwise, R&D activities seem to end up as meaningless.

(Yutaka Yamada, Director, Nagoya Coated Conductor Center, SRL/ISTEC)

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Feature Articles : Superconducting Wires

- Development and Practical Application of Nb-system Superconducting Wire -

Kazutomi Miyoshi
Superconducting Development Department
Research and Development Division
The Furukawa Electric Co., Ltd.

Concerning the development and practical application of Nb-system superconducting wire, I would like to introduce The Furukawa Electric Co., Ltd. as an example. The R&D on superconducting wires by our company started some 37 years ago. Today, Furukawa Electric has grown to a major supplier of superconducting wire, backed with its world-class technology and production capacity. Our main products are classified into NbTi superconducting wire and Nb_3Sn superconducting wire, both of which center on Nb system material.

The production cost of NbTi superconducting wire, which function well for applying the magnetic fields of 8 T or less, is quite competitive. This wire is widely applied to magnets for magnetic resonance imaging apparatus (MRI), semiconductor lifting equipment, and other appliances. The world market size of NbTi superconducting wire has grown to 200 billion yen. The development of NbTi superconducting wire is based on past step-by-step advancements. The characteristics of NbTi wire have been remarkably improved through hot extrusion technology in the 1970s, multi-stage heat treatment technology in the 1980s, and high homogenious technology of NbTi material in the 1990s. The critical current density (Jc) of the superconducting wire at 5 T reaches 3,000 A/mm^2 or more. At present, a main technical improvement of NbTi wire is concerned with cost reduction and its quality, so the development widens its application fields.

Under the circumstance, Furukawa Electric has recently succeeded in developing a low loss wire where pulse-based operation is available. Specifically, the company can design and manufacture products that embrace critical current characteristics and alternative current loss characteristics as well. An example of these products is a prototype for SMES magnets.

Meanwhile, Nb_3Sn superconducting wires are chiefly used for the high magnetic field side and the high temperature side rather than for NbTi superconducting wire. In recent years, Nb_3Sn superconducting wire has been applied to the high magnetic field side section for many NMR apparatus magnets. The technological development of this superconducting wire has been focused on improvements in Jc and reinforcing mechanical characteristics. Furukawa Electric manufactures Nb_3Sn superconducting wire by applying the bronze process. To improve Jc value, a bronze matrix with high tin content and an appropriate heat treatment technology are applied to the wire. For example, Jc value has been successfully achieved to 900 A/mm^2 or higher at 12 T for ITER (International Thermonuclear Experimental Reactor).

Since the Nb_3Sn superconducting wire is composed of an intermetallic compound, its superconducting characteristics are sensitive to its strains. As demand for higher magnet fields, larger bore magnets, and cryocooler-cooled magnets has been increasing, it is important to develop a reinforced Nb_3Sn wires against strong electromagnetic force. In cooperation with the Institute for Material Research of Tohoku University, Furukawa Electric has succeeded in developing a new reinforced Nb_3Sn superconducting wire, which has 300 MPa or more of strength, namely twice or more higher than the 0.2% strength of conventional Nb_3Sn superconducting wire. The reinforced Nb_3Sn wire has high stability by compounding stabilization copper and NbTi reinforcement in the conventional Nb_3Sn superconducting wire structure. This reinforced Nb_3Sn wire was officially adopted as the conductor for cryocooler-cooled hybrid magnets, which is now under construction in the Institute for Material Research of Tohoku University. The reinforced Nb_3Sn wire with a mass productivity is going to be applied to a wide practical application.

As mentioned above, Nb system superconducting wire--NbTi and Nb_3Sn superconducting wire--are the major wires for superconducting magnets in terms of performance and mass production scale. Their technological development is unabated, opening the way to broader applications.

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Feature Articles : Superconducting Wires

- Practical Application of Bi-system Superconducting Wire -

Kazuhiko Hayashi
Manager
HTS R&D Department
Sumitomo Electric Industries, Ltd.

(1) Bi-2212 Wire

Among Bi superconducting oxides, the Jc of a Bi-2212 wire whose Tc is 85 K in its low temperature phase is characterized as high at 20 K or lower temperature and in high magnetic fields. A Bi-2212 tape wire of 0.3 mm x 3.5 mm with 2.0 of silver ratio stands at 400 kA/cm^2 at 4.2 K in the self magnetic field, and 151 kA/cm^2 at 30 T. A Bi-2212 round wire with a diameter of 1.0 mm and 2.8 of silver ratio stands at 490 kA/cm^2 in the self magnetic field, and 180 kA/cm^2 at 20T. Their Ic falls at 1100 A and 400 A, respectively.

Since Bi-2212 superconducting wire is characterized as having distinctive features in low-temperature and high magnetic fields, and the Bi-2212 wire can be easily form a round wire that can be assembled for larger capacity, a 500-meter long conductor, composed of six stranded Bi-2212 wires of 1.0 mm in diameter, is used for a high-temperature superconducting coil for SMES. Eleven coils were layered to execute excitation tests in 4.2 K of liquid helium. As a result, 560 kJ of stored energy at 550 A of reted current was reported.

(2) BiPb-2223 Wire

The silver ratio of a BiPb-2223 tape wire which has a Tc of 110K stood at 3 or so in the past. Recent development, however, has enabled the tape wire even with 1.5 to 2.0 of silver ratio to form a 1000-meter or longer wire. Such a BiPb-2223 tape wire at 77 K in the self magnetic field reaches an Ic of 100 A or more. As a result, diverse prototypes were made for assessment, some of which have been used for practical application.

Among these applications, a current lead is fixed in some superconducting synchrotron radiation equipment for safe operation and reducing liquid helium consumption. Encouraged by the economic effects, a large-capacity current lead has been developed recently to apply to a current capacity of 60 kA for nuclear fusion.

Concerning magnets, a high-rate excitation characteristic of 7 tesla per minute is developed to use for a research tool in chemical reaction and new magnetic science fields. In addition, Toshiba Corporation, Shin-Etsu Handotai Co., Ltd., and Sumitomo Electric Industries, Ltd., have jointly succeeded in developing a magnet for pulling silicon single crystals, which was supported by the Ministry of Economy and Industry for energy-saving. Assessment with the actual size has ended in success. This magnet, the largest in the world as a high-temperature superconducting magnet, has a stored energy of 1.1 MJ. The success opened the door for broader applications in areas of industry, medical field, transportation, and electric power that can use Bi-2223 superconducting wire.

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Diverse kinds of Bi-2223 superconducting wire prototypes have been developed for electric power applications. Among them, application to transformers is expected to have remarkable effects in terms of energy-savings and in-vehicle application that seeks light-weight equipment. The Bi-2223 superconducting wire is characterized as being nonflammable because no oil is used for the insulator for the superconducting wire. Thus, researchers are focusing on developing Bi-2223 superconducting wire. Power cables are expected to be an effective and compact means of large power transmission in urban areas with dense populations. When high-temperature superconducting cables are used for transmitting electric energy, no large sized tunnels (diameter: 3 to 5 meters) are needed to install them, unlike existing power cables. Since such superconducting cables can be enclosed in ducts with diameters of 15 cm or so, other underground zones can be left for different applications. Tokyo Electric Power Co., Inc. and Sumitomo Electric Industries, Ltd. jointly constructed the first 100-meter long, three-core packaged, 114 MVA (66 kV, 1 kA) power cable system in the world. The companies conducted initial testing, rated load conduction testing, performed load variable testing, and carried out excess load testing over one year to demonstrate the long-term electrical performance and cooling performance.

(3) Challenging Subjects and Outlooks for the Future

Concerning BiPb-2223 wire, we reported that a overpressure sintering method improved the filament density, which also led to improving the critical current density, mechanical characteristics, and anti-ballooning characteristics against liquid nitrogen as well. The BiPb-2223 wire is the only high-temperature superconducting wire that is produced through industrial manufacturing. Improvement in production cost and performance is expected to accelerate practical application.

Meanwhile, reducing AC loss is essential for AC use. Since Bi-2212 wire and BiPb-2223 wire have already been made into multifilamentally wire, a technological development project is underway to substantially reduce alternative current loss. An example is to raise the vertical resistance rate of superconducting filaments and twist them to cut the electromagnetic coupling between the filaments. This can be achieved by forming a high-resistant barrier layer around the superconducting filaments.

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Feature Articles : Superconducting Wires

- Development of Y-System Superconducting Wire -

Y-system superconductors need to control the three-dimensional orientations of crystal grains in order to exhibit their essential characteristics. There are two major technologies for orienting the grains up to the buffer layer in the layered structure of the Y-system superconducting tapes. One is a special technology to form an oriented buffer layer and the other is a technology to form a textured metal substrate. These technologies are subdivided into several implementation techniques. One of the former technologies is the IBAD method that Fujikura has developed, while the latter is the RABiT method which adopts adhesion.

In Japan, a national R&D project was started at 1998. Successively, another national R&D project was continued in 2003 with a new formation. Development activities based on the IBAD method succeeded in forming a 100m long tape with Ic value of 38A where a superconducting layer is formed on the $Gd_2Zr_2O_7$ buffer layer by using the PLD method. One of the problems to be solved in the IBAD method is the slow processing speed. This, however, is solved by forming a CeO_2 layer, as a cap layer, on the IBAD layer, which dramatically shortens the processing time. The cap layer contributes to fast processing and improves the texturing. In addition to the PLD method, concerning the formation technology of a superconducting layer on the IBAD buffer layer, the TFA-MOD and MO-CVD methods are also being examined. For the TFA-MOD method, the technological development of thicker layers for higher Ic values achieved in forming a layer with high Ic value of 291A in a short sample while technological development of a 0.25 m-long tape achieved Ic value of 210A as an end-to-end characteristics using a reel-to-reel system. Meanwhile, the MO-CVD method has realized $2MA/cm^2$ short tape at the rate of 10 m/h in the initial development stage, boosting expectations for future development.

Concerning development activities based on an orientation substrate as the foundation, development is underway using Ni clad materials. In addition, the SOE method has been developed, which causes orientated oxidation of the surface on the orientation substrate to form a buffer layer. This method has achieved Jc value of $1MA/cm^2$ in a short sample. In addition, a trial was made to form all layers on the orientation substrate in the MOD method at a low cost process. Adding Gd and Nb to CeO_2 has formed an buffer layer that prevents cracks and dispersions of metal elements.

The United States and some European countries have been promoting R&D activities based on the abovementioned IBAD and RABiT methods. For example, the United States has achieved in forming a superconducting layer by the TFA-MOD method on a textured substrate with several buffer layer by the physical vapor deposition technique. The method has enabled making a 10m long tape with Ic value of 184A. The tapes were also used to demonstrate the cable. Specifically, 24 tapes were made into a 1.25m long conductor where 4.2 kA of direct current was successfully conducted. Meanwhile, in development activities that use the IBAD method as the foundation, MgO-applied process development is underway which enables high-speed formation of layers, succeeding in developing Ic value of 423A in a short sample. A combination of the IBAD method with the MO-CVD method has also successfully achieved in forming an 18m long tape with Ic value of 111A. In European nation, higher Ic of 223 A/cm in a 10m long tape was realized by the IBAD and PLD methods.

As mentioned above, Japan, the United States, and Europe have been engaging in fierce development competition. Five years ago, the formation of a 1m long tape was regarded as successful. Now, several institutions can form tape that is tens of meters long or even over 100 meters long. Accordingly, researchers are focusing on developing technology with considering the applications. Such tapes, however, still needs improvement in its characteristics, production rate, and length. Reducing production cost is also another challenging subject that must be solved soon.

(Teruo Izumi, Division of Superconducting Tapes and Wires, SRL/ISTEC)

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Feature Articles : Superconducting Wires

- Critical Magnetic Field of MgB_2 Wire Made with the PIT Method -

Hiroaki Kumakura
Superconducting Materials Center
National Institute for Materials Science

MgB_2 superconductors have the advantages of high Tc, and there not being any weak couplings among the crystal grains, unlike high-temperature oxide superconductors. Thus, since orientation of crystal grains is not required, a relatively simple wire manufacturing method is available, contributing to low manufacturing costs. The low price of the raw material is also advantageous. Researchers around the MgB_2 world are now focusing on R&D on MgB_2 wire. This research group is also engaging in R&D on an MgB_2 wire with the powder-in-tube (PIT) method. We have found that an SiC-added MgB_2 wire has a critical magnetic field similar to that of Nb_3Sn.

We made this wire with a method called "in situ" among the PIT methods, by filling a mixed powder of Mg and B in a metal tube to process and perform heat treatment. Our method, however, uses MgH_2 powder instead of the Mg powder normally applied as a raw material. MgH_2 powder accelerates MgB_2 production to realize a high critical current density of Jc.

We mixed the MgH_2 powder with B powder, which is available on the commercial market, and then filled the mixture into a metal tube (pure iron) before cold-working it into a tape. The initial mixture powder had an addition of SiC fine grains of 5-10 mol%. This addition of SiC fine grains had also been reported by a research group of Professor Dou at Wollongong University in Australia. The research group indicated that the addition had some improvement in Jc. After processing it into the tape, we heat treated it at 600 to 650°C for an hour in an argon gas atmosphere. The temperature of this heat treatment was considerably lower than the heat treatment temperature for ordinary MgB_2 wire, which is 800 to 900°C. This is because the lower temperature of heat treatment enables a higher Jc although Tc becomes lightly lower. In addition, this low temperature heat treatment in a short time is likely to contribute to reducing wire production manufacturing costs.

We measured the Jc of this wire at 4.2 K with the hybrid magnet at the Tsukuba Magnet Laboratory in the National Institute for Materials Science. SiC-added tape showed Jc of 20,000 A/cm^2 or more at 10 T, which is the highest level ever achieved in the world for MgB_2 wire. In addition, we defined irreversibility field B_{irr} in a magnetic field where Jc stands at 10 A/cm^2. The B_{irr} of tape without SiC added stood at 17 T, whereas the B_{irr} of the tape with an addition of 10 mol% of SiC stood at 23 T, which is comparable to the upper critical magnetic field B_{c2} of Nb_3Sn, which is made with the bronze method and is available on the commercial market. The magnetic field was applied to the tape surface in parallel. Since the orientation of MgB_2 crystals in this tape was random, we assumed that no anisotropy of B_{irr} was caused by the direction of the applied magnetic field. It was reported that the B_{c2} of single crystals at 4.2 K stood at some 14 T on the B//a and b surfaces, and at 3 T or over on the B//c axis. The B_{irr} values of the tape without an addition and the SiC-added tape stood considerably high compared with the B_{c2} of single crystals. This seems to have been because the low heat treatment temperatures of 600 to 650°C led to imperfect MgB_2 crystallization and Tc stood at a maximum 33 K, a fairly low value compared with that of the single crystals.

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In other words, MgB_2 invited defects as the heat treatment temperature lowered, which subsequently led to an increase in B_{c2} and caused an increase in B_{irr}. As discussed above, changes in the B_{c2} and B_{irr} of MgB_2 seem to depend on the heat treatment temperature. That is, controlling B_{c2} and B_{irr} seem easier than Nb_3Sn. As is seen in a report where 40 T or over of B_{c2} of a thin film was already available, we hope that the B_{irr} of wire can be raised higher.

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Superconductivity Related Product Guide

- Superconducting Wire- (Corporations in Japanese syllabary order)

[Nb-Ti-Alloy Composite Superconducting Wire]

-- Japan Superconductor Technology Inc. (JASTEC)
Wire for NMR spectrometer, wire for solid-state physics magnets
Contact: Mr. Yukinobu Murakami
Tel: 093-391-2836 Fax: 093-391-2847
-- Hitachi Cable, Ltd.
Conductors for nuclear fusion reactors and accelerators, conductors for pulsed magnetic fields
Contact: Mr. Shuji Sakai, Research and Development Dept., Wrought Copper and Copper Alloys Business Headquarters
Tel: 029-826-7444 Fax: 029-823-2144
--The Furukawa Electric Co., Ltd.
Contact: Mr. Yoshikawa or Mr. Shimizu, Superconducting Product Sales Section
Traffic and Public Business Dept.
Tel: 03-3286-3161 Fax: 03-3286-3686
Conductors for high energy accelerators, conductors for fluctuating magnetic fields, variety of copper stabilized Nb-Ti conductors
Contact: Mr. Miyoshi, Superconducting Product Dept., Nikko Works, Metal Group
Tel: 0288-54-0504 Fax: 0288-54-2216
--Mitsubishi Electric Corporation
PVF-coated superconducting wire, polyimide-coated flat wire, and others
Tel: 0427-79-5564 Fax: 0427-79-5673

[Nb_3Sn-Compound Composite Superconducting Wire]
-- Japan Superconductor Technology Inc. (JASTEC)
Wire for NMR spectrometer, conductors for high-magnetic field magnets
Contact: Mr. Yukinobu Murakami
Tel: 093-391-2836 Fax: 093-391-2847
-- Hitachi Cable, Ltd.
Conductors for high magnetic fields magnet, conductors for nuclear fusion reactors
Contact: Mr. Shuji Sakai, Research and Development Dept., Copper Product Group Headquarters
Tel: 029-826-7444 Fax: 029-823-2144
--The Furukawa Electric Co., Ltd.
Contact: Mr. Yoshikawa or Mr. Shimizu, Superconducting Product Sales Section
Traffic and Public Business Dept.
Tel: 03-3286-3161 Fax: 03-3286-3686
Conductors for NMR spectrometer, conductors for high magnetic fields magenet, CICC
strands for nuclear fusion reactors
Contact: Mr. Miyoshi, Superconducting Product Dept., Nikko Works, Metal Group
Tel: 0288-54-0504 Fax: 0288-54-2216

-- Mitsubishi Electric Corporation
Low hysteresis loss strands for nuclear fusion reactors, high critical current density strands for direct currents
Tel: 0427-79-5564 Fax: 0427-79-5673

[Nb_3Al-Compound Composite Superconducting Wire]

-- Hitachi Cable, Ltd.
Conductors for high magnetic fields, conductors for nuclear fusion reactors
Contact: Mr. Shuji Sakai, Research and Development Dept., Copper Products Group Headquarters
Tel: 029-826-7444 Fax: 029-823-2144

[Bismuth Silver Sheath Oxide Superconducting Wire]

-- Showa Electric Wire & Cable Co., Ltd.
Silver sheathed Bi-2212 wire, silver sheath Bi-2223 wire, current leads
Contact: Ms. Takayo Hasegawa, Superconducting Project, Technical Development Center
Tel: 042-773-7163 Fax: 042-773-7291
-- Sumitomo Electric Industries, Ltd.
Silver sheathed Bi-2223 tape
Contact: Mr. Kazuhiko Hayashi, Superconductivity Development Office
Tel: 06-6466-5634 Fax: 06-6466-5705
-- Hitachi Cable, Ltd.
Contact: Mr. Shuji Sakai, Research and Development Dept., Copper Products Group Headquarters
Tel: 029-826-7444 Fax: 029-823-2144

(Yasuzo Tanaka, Editor)

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Patent Information

Introduction of Published Unexamined Patents in the 3rd Quarter of Fiscal 2003

The following are ISTEC's patents published from October through December 2003. For more information, access the homepage of the Patent Office of Japan and visit the Industrial Property Digital Library (IPDL).

1) Patent No. 2003-282981: " JOSEPHSON JUNCTION ELEMENT AND ITS MANUFACTURING METHOD"

This invention provides a method for manufacturing surface-modified high-temperature Josephson junctions at a high yield rate. The method is characterized as dividing the formation of the second superconducting layer into two steps after forming the first superconducting layer on a substrate and an insulating layer, and removing a specific part of the insulating layer.

The first step forms the second superconducting layer with a relatively low deposition rate, which is adopted to form a homogeneous junction interface. The second step for the second superconducting layer employs a relatively high deposition rate to get the specific thickness of the layer with high superconductive quality. This invention enables achieving 8% or less critical current distribution (1σ) of Josephson junction elements.

2) Patent No. 2003-283324: " SUPERCONDUCTING JUNCTION LINE"

When existing Josephson transmission line (JTL) circuits are applied to single flux quantum circuits that treat steep magnetic flux quantum pulses as signal pulses, undesirable oscillating waves remain at the rear edge of the pulses, which deter high-speed operations. In this invention, a resister is connected between the ground and an arbitrary point of each inductor which is a composing element of existing JTL. The new JTL configuration, in which a pair of resister and inductor operates as an integral element, allows attenuating steep pulses, leading to higher speed operation.

3) Patent No. 2003-300726: "TAPE-LIKE OXIDE SUPERCONDUCTOR AND MANUFACTURING METHOD THEREFOR"

This invention relates to the MOD method that uses metal organic acids whose metal elements are composite metal elements of an RE oxide superconductor.

In recent years, high critical current density films have been obtained relatively easily using MOD method. Multi-coated layers to fabricate a thick film, however, cause critical current density to deteriorate terribly. This invention featured by employing lower calcination temperature for these inner coating layers than the temperature of the outermost coating layer, including optimizing the atmosphere gases. This allows multiple coating for fabrication of thick precursor without characteristic deterioration, and the film characteristics resulted in film thickness (μm) x critical current density (MA/cm^2)$\geqq$0.8.

4) Patent No. 2003-347610: "THERMAL TREATMENT METHOD FOR OXIDE SUPERCONDUCTING THIN FILM"

This invention relates to a complex substrate with superconductive layer on an insulator substrate for ultra-high speed electronic devices. When a YBCO thin film is formed on an MgO substrate of a small dielectric constant by, for example, a physical vapor deposition method, the generation of an uneven superconducting surface is inevitable due to the lattice mismatch of the MgO-YBCO interface. This invention relates to an annealing process that rapidly heating up the complex substrate from room temperature to a range of 350-500°C within a minute in an atmosphere of 100% oxygen, resulting in reducing the surface roughness mentioned above to 1/2 or less.

5) Patent No. 2003-347611: "FABRICATION METHOD OF SUPERCONDUCTING FILM"

Superconducting thin film layers are needed on both sides of an insulated single crystal substrate for superconducting electronic devices. In the existing method, after forming YBCO layer on one side of the substrate, the substrate must be inversely placed on a substrate holder to form opposite side superconducting layer. While the substrate with the single side superconducting layer is being heated up, however, it tends to warp due to the different expansion coefficients of the insulator substrate and the YBCO layer and to form an uneven YBCO layer surface owing to temperature un-uniformity. In this invention, stacking two pieces of the single-layered substrates on the substrate holder makes reduction of the temperature un-uniformity of the upper substrate and improvement of adhesion between the substrate holder and the two single-layered substrates.

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

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Standardization Activities

-- IEC/TC90--VAMAS/TWA16 Joint Conference Held

IEC/TC90 and VAMAS/TWA16 held a joint conference on Tuesday, October 28, 2003 at 7:00 P.M. in the 2nd Meeting Room of the Main Control Building of the National Institute for Materials Science, an independent administrative agency, in the Sengen site. There were a total of 17 participants at the joint conference--three Germans, one Korean, one British, two Americans, and ten Japanese--to report their progress on R&D activities and to discuss the standardization of superconductivity on wires, bulks, mechanical characteristics, alternative current losses, stress-strain effects, advanced material measurement methods, and other standardization activities since the former Yokohama Conference.

The joint conference agendas were as follows:

1. TWA Office Report (K. Itoh)

2. Project Reports and Discussions
(1) Project number: WG1-1 (T. Kuroda); Bending strain effects on critical current in oxide superconductors
(2) Project number: WG1-3 (T. Matsushita); Measurement method of irreversibility field in oxide superconductors
(3) Project number: WG1-4 (E. Collings); Coupling loss measurement in multifilamentary HTS superconductors
(4) Project number: WG2-1 (M. Murakami); Measurement methods of trapped field and levitation force in bulk oxide superconductors, (T. Habisreuther); Report on the recent research at Jena, and (D. Cardwell); Report on European RRT
(5) Project number: WG3-1 (S. Kosaka); Measurement methods of surface resistance in thin film superconductors
(6) Project number: WG4-1 (K. Osamura); Measurement method for the mechanical properties of oxide superconductors

3. New Proposals
(1) Critical current and mechano-electromagnetic properties of MgB_2 conductors (K. Osamura)
(2) Inductive measurement of Jc in large area superconducting films (H. Yamasaki)

4. IEC/TC90
Related activities in IEC/TC90 (Y. Tanaka)

5. Future Schedule

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-- Instituting a new Standard of Ic Testing Methods for Bi-System Superconducting Wire (JIS H7305)

The Japanese Standards Association, a juridical foundation, issued the following superconductivity related JIS standards as of October 20, 2003. The superconductivity related JIS standards so far issued have totaled 6 standards--one standard for superconductivity related terms and five standards for testing methods.

- New JIS Standard and Overview
Title: Superconductivity-- Critical current measurement
--DC Critical Current of Ag-Sheathed Bi-2212 and Bi-2223 Oxide Superconductors
Standard No. JIS H 7305: 2003
Instituted: October 20, 2003
Issue: Japanese Standards Association
Organization of the Standard: Body; introduction, scope of application, reference standards, definitions, requirements, devices, sample preparation, testing method, accuracy and correctness of testing method, method for calculating testing results, reporting items, appendix A (reference); additional references from articles 1 through 9, appendix B (reference); critical current hysteresis of high-temperature oxide superconductors, bibliography, description.
Overview of testing method:
A method of testing the DC critical current with the 4-terminal method that targets bismuth 2212 and bismuth 2223 oxide short superconducting wire which is made of coated silver or silver alloy. The superconducting wire subject to the standard is wire that has critical current of 500 A and 5 or larger of the n value. The test sample must be soaked in liquid helium or liquid nitrogen during the test.

- Associated International Standard
Title: Superconductivity--Part 3: Critical current measurement--DC critical current of Ag-sheathed Bi-2212 and Bi-2223 oxide superconductors
Standard No. IEC 61788-3:2000
Instituted: December 2000
Conformity: Complete consistency

This standard is correctly translated into Japanese from the IEC (International Electrical Committee) Standard mentioned above. The translation work is conducted by the JIS Draft Preparation Working Group (WG3: chaired by Kikuo Ito of the National Institute for Materials Science), which was formed under the JIS Draft Preparation Committee, headed by Professor Kozo Osamura at Kyoto University.

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

-- TC90 and IEEJ Started Cooperation

The IEC/TC90 Superconductivity Committee (Shigeki Saito, Chairperson of Japan National Committee and Senior Managing Director of ISTEC) requested cooperation from the Institute of Electrical Engineers of Japan on January 9, 2004 for the standardization of superconducting power equipment. IEEJ accepted the request. The cooperation rank next to the international liaison agreement defined in Part 1 of the IEC/ISO Directives. The cooperation is expected to function as strong technical support for standardizing superconductivity. The IEC/TC90 Superconductivity Committee already concluded a liaison agreement with VAMAS (Versailles Project on Advanced Materials and Standards) in 1995.

The liaison, defined in Part 1 of the IEC/ISO Directives, is subdivided into three types—(1) a liaison between the two TCs of IEC, (2) a liaison between the ISO and IEC, and (3) a liaison between the IEC/ISO and other institutions. The IEC/TC90's request for cooperation from IEEJ didn't fall into any of these categories, but was close to case (3). Specifically, the IEC/TC90 Superconductivity Committee acknowledged IEEJ as an institution working in areas similar to those of TC or related areas, an interested international institution, or a regional institution with a broad activities base, before requesting cooperation from IEEJ for an international liaison.

IEEJ set up a Special Committee on the Effects of Introduction of Superconducting Equipment and Examining Testing Methods as a five-year project from fiscal 2000 through fiscal 2004. The special committee aims to research and study testing methods, technical trends, and implementation effects of superconducting power cables, superconducting current limiters, and superconducting transformers. Moreover, the special committee has reported many achievements on a national project, called the Research and Development Project of Key Technology for Alternative Current Superconducting Power Equipment, which was re-commissioned by the Superconducting Generator Related Equipment and Material Technology Research Cooperative (Super-GM). One example of the achievements of the special committee is the *Achievements Report for Fiscal 2002 on the Research of a Total System and Study of Implementation Effects, Key Technology Research and Development for Alternative Current Superconducting Power Equipment*, which was submitted to NEDO in March 2003 through Super-GM by IEEJ.

As part of the standardization activities on superconducting power equipment, the Japan National Committee of the IEC/TC90 Superconductivity Committee has also begun to work on preparing general rules of superconducting cable testing methods, superconducting current limiter testing methods, and superconducting transformer testing methods as well as a low-temperature conductor standard for SMES and a low-temperature superconducting standard for superconducting generators. These activities will also reflect the achievements of IEEJ.

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(Yasuzo Tanaka, Director, Standardization Department, ISTEC)

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