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Contents:

Top of Superconductivity Web21

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DOE Peer Review 2009 (August 4–6, 2009)

Hitoshi Tomogane
Planning & Management Division
SRL/ ISTEC

First day: conference on common themes

HTS Program Peer Review 2009 hosted by US DOE was held at The Westin Alexandria in Alexandria, Virginia from August 4 to 6. The total number of registered participants was 172 and 40 themes were reported.

Alexandria, where the conference was held, is located in the north of Virginia on the west bank of the Potomac River about 10 km south of the capital Washington D.C. and is full of brick buildings.

The Peer Review was a conference in which reports were reviewed to determine the DOE development budget. Therefore, the conference was a place in which information on the latest and detailed results of technical development in the field of HTS in US in the last year and future plans could be collected as well as where researchers and developers of HTS for electrical systems got together.

In addition, the Peer Review provided the opportunity to find fields where sharing and synergistic effect of the best practice for the community network of related industries, national laboratories, and academic communities.

On the first day, the latest information on HTS cable and HTS fault current limiter (FCL) were briefly overviewed; and on the second and third days, the present status and future plans were reported for three themes—"2nd GENERATION WIRE SESSION," "STRATEGIC RESEARCH SESSION," and "SUPERCONDUCTIVITY APPLICATIONS SESSION"—in separate sessions.

Major reports are as follows:

2nd GENERATION WIRE SESSION

AMSC developed a continuous tape of 500 m–250 A/cm-W using the TFA-MOD method on the textured metallic substrate and a technology for thickening one coating thickness with high performance was developed and a high I_c value of 445 A/cm-W with 1.2 μm/ coating was obtained. SuperPower developed a continuous tape of 1065 m–282 A/cm-W (300, 330 Am) using MOCVD/IBAD tape (the new world record) and succeeded in fabricating a tape with uniform superconducting characteristics under the magnetic field

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in the longitudinal direction by developing a pinning technology for continuous system. It seemed that SuperPower was consistently taking a lead and AMSC was catching up.

STRATEGIC RESEARCH SESSION

LANL developed TiN as a material for IBAD and showed direct film formation of IBAD layer on Hastelloy tape. Last year, ORNL had proposed a technology to fabricate a superconducting layer around Al_2O_3 single crystal fiber. They actually developed a technology and obtained a film with high J_c of 2.3 MA/cm^2 . They are now developing higher strength and lower cost technology.

APPLICATIONS SESSION

Because four projects on HTS cable and four on HTS FCL sponsored by DOE are going on, many themes were related to HTS cable and HTS FCL. In the field of cable, ORNL, together with Southwire, has set benchmarks for experimental data for various scenarios related to operation, thermal hydraulic analysis, temperature rise caused by malfunction, and calculation of recovery time of the HTS cable (First-Generation wire, 200 m,13.2 kV, 3.0 kA, 69 MVA) installed at Bixby Substation of AEP located in Columbus, Ohio. The installation of the HTS cable (Second-Generation wire, 1760 m, 13.8 kV, 2.0 kA, 48 MVA) in the transmission grid of Entergy in New Orleans was delayed because increase in demand in this area was not expected. Therefore, the development relating to Entergy Substation has been reduced as much as possible, while the total development of long-distance HTS cable is being continued. In the field of FCL, AMSC, Siemens, and Nexans fabricated FCL (current limiting effect, 63 kA→40 kA) for 115 kV, 1200 A single phase, which proved that they had technology of a certain level. Before constructing the total system, they conducted experiments to verify the consistency and functions of the system design. The final target is to fabricate, install, and operate a three-phase system of 115 kV–138 kV and 2000 A in transmission grid (Southern California Edison). A modeling technology was used to evaluate the candidate sites and predict performance of the transmission grid.

It seemed that experiments in each project were steadily making progress toward the application to actual transmission system. No lecture was given on next-generation transmission and distribution network smart grid.

Third day: questions and answers with reviewers in the applications conference room

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Top of Superconductivity Web21

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The 9th M²S International Conference Was Held in Japan for the First Time in Many Years

Hidetoshi Fukuyama, Professor
Applied Physics, Faculty of Science
Tokyo University of Science

The International Conference on Materials and Mechanisms of Superconductivity (M^2S) was held in Shinjuku, Tokyo, for September 7-12, 2009, under the auspices of International Union of Pure and Applied Physics (IUPAP). The Conference is the ninth since the first one in Interlaken, Switzerland, in 1988, and the second in Japan after the third in Kanazawa in 1991. Many important results on various superconducting materials were reported followed by lively discussions.

Discovery of a new superconducting material always results in new understanding of a possibility that condensed matter has. Therefore, material aspect of reports presented in the Conference will be focused in this brief report.

The discovery of copper oxides in 1986 has disclosed a world of “strongly correlated electron systems” and introduced a new concept of “doped Mott insulators” which are beyond the well known band theory. Then it is natural that copper oxides were one of most important subjects in this Conference as well.

At the same time, it was iron-pnictides (FePn) that have attracted much interest. The discovery of superconducting FePn in January, 2008, by Hosono was quite unexpected both in materials as Fe being the symbol of magnetism, and with high critical temperatures. In addition to the (1111) systems discovered first, new related materials such as (122), (111), (11) and (22426) have been enlisted this year one after another, thereby leading to a large material family. In (1111), (122) and (111), superconductivity evolves once antiferromagnetism (AF) of the parent compounds disappears as doping is increased, which appears to be accompanied by the ortho-tetra transition. This relationship between AF and superconductivity appears to be similar to that in copper oxides and then some presentations stressed this apparent similarity. However care must be taken since this view ignores the basics of electronic states in solids; band insulators or Mott insulators depending on even or odd number of electrons in a unit cell, respectively. Parent compounds of copper oxides are Mott insulators, whereas those of FePn are band insulators (semimetals, to be precise, because of the small overlap of conduction and valence bands). Hence the nature of AF in the parent compounds and then that of superconductivity realized under doping are expected to be different. In copper oxides the superexchange interaction is known to be crucial, while in FePn there has not been any clear concept yet. In any case, the SC in FePn is believed to be due to interactions other than electron-phonon interactions known as the well-established BCS mechanism.

Other highlights in materials include, T_c~40 K in Cs doped fullerenes under pressure, and T_c~20 K in molecular solids with aromatic picene (Pc), KxPc (x~3). It is possible that the doping processes in the latter is different from usual cases since the crystal structure might be deformed by the doping. If so, this will be a new type of carrier doping. A stimulating result was reported on the realization of FET type of carrier doping by use of electrolytes or ionic liquids leading to the observation of superconductivity on the surfaces of insulators, a new finding with very high future potential.

This series of Conference has three prizes; Matthias prize for materials, Kamerlingh Onnes prize for explorations of properties and Bardeen prize for theories. It is to be highly congratulated that Matthias prize this time was awarded to Professor Hideo Hosono and Professor Yoshiteru Maeno. This fact indicates that the research activities in finding new materials in Japan are very high.

In spite of unexpectedly low number of registered participants, reflecting the recent economic situation

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worldwide, the conference had been smoothly run thanks to the cooperation of many colleagues. Together with Professor Jun Akimitsu, I heartily thank for collaborations.

The next M^2S will be held in 2012 jointly by USA and Canada.
Let us hope the critical temperature of superconductivity is higher by that time.

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Top of Superconductivity Web21

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What's New in the World of Superconductivity (November, 2009)

Akihiko Tsutai, Director
International Affairs Division, ISTEC

Power

Nexans (November 6, 2009)

Nexans has commissioned the world's first superconducting fault current limiter (SFCL) to be installed in a power plant. As part of a pilot project for Vattenfall Europe Generation AG, the SFCL has been installed at the Boxberg brown coal power plant in Germany and will provide short-circuit protection for the internal medium voltage power supply that feeds the coal mills and crushers. Vattenfall expects the SFCL technology to provide significant benefits with regard to personnel and plant safety and is eager to gain practical experience using the SFCL in collaboration with Nexans. Dr. Joachim Bock, CEO of Nexans SuperConductors, commented, "This is the second complete SFCL system that Nexans has supplied, and the first time that this type of device has ever been used in a power plant, which is a highly challenging environment from a technological point of view. It is particularly important for us that the systems are being implemented without public grants, which is also unprecedented on the world stage".

Source:
"Nexans commissions in Germany the world's first superconducting fault current limiter to protect a power plant's internal power supply"
Nexans press release (November 6, 2009)
http://www.nexans.com/eservice/Corporate-en/navigatepub_142506_-23240/Nexans_commissions_in_Germany_the_world_s_first_su.html

Bruker Energy & Supercon Technologies (November 16, 2009)

Bruker Energy & Supercon Technologies (BEST) and AREVA's Transmission and Distribution (T&D) division have successfully designed, built, and tested a single module of a 13-MVA single-phase, shielded-type inductive superconducting fault current limiter (SFCL). The design uses a proprietary cryogenic module that incorporates BEST's second-generation high-temperature superconductors. Tests performed at the AREVA T&D Technology Centre (U.K.) have confirmed that the SFCL module was capable of limiting a prospective 68.5 kApeak fault to 9 kApeak in 5 ms, reducing a fault current by a factor of 10 after five cycles (before the opening of the circuit breaker), and exhibiting a fast recovery after a short circuit fault. Dr. Burkhard Prause, President and CEO of BEST, commented, "Based on these excellent test results, the feasibility of operation for our shielded, inductive SFCL has been demonstrated, paving the way for future commercialization. The SFCL certainly meets the expectations for reliability and durability of the most demanding utilities, while at the same time it is a true 'smart grid' device with its ability to rapidly react and recover independent of outside control or triggering."

Source:
"AREVA T&D and Bruker Energy & Supercon Technologies (BEST) Announce Successful First Test

Results for a 13 MVA Shielded, Inductive Superconducting Fault Current Limiter (SFCL)"
Bruker Energy & Supercon Technologies press release (November 16, 2009)
http://www.bruker-est.com/ifcl.html

American Superconductor Corporation (November 17, 2009)

American Superconductor Corporation (AMSC) has received a $10-million-dollar follow-on order for wind turbine core electrical components from CSR Zhuzhou Electric Locomotive Research Institute Co., Ltd. (CSR-ZELRI, China). The components will be used in CSR-ZELRI's 1.65-MW wind turbines, the design of which has been licensed from AMSC's wholly owned subsidiary AMSC Windtec™. The order is the largest that AMSC has received from CSR-ZELRI to date, bringing the total value of all orders for core electrical components received from CSR-ZELRI to more than $20 million.

Source:
"AMSC Receives $10 Million Order for Wind Turbine Core Electrical Components from China's CSR-ZELRI"
American Superconductor Corporation press release (November 17, 2009)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=1356210&highlight

American Superconductor Corporation (November 18, 2009)

American Superconductor Corporation (AMSC) has received a follow-on order for 30 sets of electrical control systems from Hyundai Heavy Industries Co., Ltd. (HHI, Korea). The control systems will be used for HHI's 1.65-MW wind turbines that are now under production in South Korea. In addition, HHI has also ordered an electrical control system for a 2-MW wind turbine prototype. All the control systems are scheduled for shipment at the end of May 2010. Both the 1.65-MW and the 2-MW wind turbine designs were licensed from AMSC's wholly owned subsidiary AMSC Windtec™. HHI began volume production of its 1.65-MW wind turbines in October 2009 and plans to begin production of its 2-MW wind turbines in 2010. Young N. Kim, Senior Executive Vice President and COO of HHI Electro Electric Systems, commented, "HHI's investment in the wind power industry has created a new growth engine for our company. Over the course of the past year, we have licensed high-quality wind turbine designs from AMSC Windtec, commissioned our first prototype systems and secured our initial wind turbine orders in Korea and the United States. We see tremendous growth opportunities in front of us and are expanding our wind turbine capacity to support our growth plans."

Source:
"AMSC Receives Second Wind Turbine Electrical Control Systems Order from Hyundai Heavy Industries"
American Superconductor Corporation press release (November 18, 2009)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=1356719&highlight

American Superconductor Corporation (November 19, 2009)

American Superconductor Corporation (AMSC) has reaffirmed its financial forecasts for fiscal 2009 and has provided its first outlook for fiscal 2010. AMSC expects revenues to grow by more than 60 % to between $300 million to $310 million in fiscal 2009, compared with revenues of approximately $183 million in fiscal 2008. The company expects a GAAP net income of $11 million to $13 million and a non-GAAP net income of $27 to $29 million for full-year fiscal 2009. For fiscal 2010, AMSC is expecting revenues to grow to more than $400 million, with a GAAP net income of more than $36 million and a non-GAAP income of more than $54 million. Greg Yurek, AMSC's founder and chief executive officer, commented, "We expect substantial earnings growth in fiscal 2010, driven by increased revenues, greater productivity in all of our operations, and lower manufacturing costs as the result of initiatives we have undertaken in recent quarters."

Source:
"AMSC Announces Initial Fiscal Year 2010 Revenue and Earnings Forecast"
American Superconductor Corporation press release (November 19, 2009)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=1357289&highlight

Communication

Superconductor Technologies Inc. (November 5, 2009)

Superconductor Technologies Inc. has reported its financial results for its third fiscal quarter ending September 26, 2009. Total net revenues for the third quarter were US $4.3 million, compared with $3.6 million for the same period in the previous fiscal year. Net commercial product revenues were $3.0 million, compared with $2.7 million for the same period in the previous fiscal year. Government and other contract revenue totaled $1.3 million, compared with $854,000 for the same period in the previous fiscal year. Jeff Quiram, STI's president and chief executive officer, commented, "As expected, we increased total net revenues sequentially with growth in both our commercial and government businesses. We are encouraged by the network enhancement projects we are working on for 2010, as capital is redirected to the upcoming 700 MHz data network build out. However, because future carrier spending on legacy networks appears to be modest, we do not expect sequential revenue growth in the fourth quarter." Net loss for the third quarter was $1.8 million, compared with $3.2 million for the same period in the previous fiscal year. As of September 26, 2009, STI had $15.1 million in working capital, including $12.7 million in cash and cash equivalents, and a commercial product backlog of $95,000, compared with a backlog of $217,000 at the end of the same period in the previous fiscal year.

Source:
"Superconductor Technologies Inc. Reports Third Quarter 2009 Results"
Superconductor Technologies Inc. press release (November 5, 2009)
http://phx.corporate-ir.net/phoenix.zhtml?c=70847&p=irol-newsArticle&ID=1351538&highlight

Accelerator

CERN (November 20, 2009)

The Large Hadron Collider (LHC) has resumed operation, with the establishment of a clockwise circulating beam. The restart comes after over a year of repair and consolidation following a serious malfunction that occurred in September 2008. The recommissioning of the LHC began during the summer, with the LHC reaching its operating temperature of 1.9 K at the beginning of October. Particles were subsequently injected, and a circulating beam has now been reestablished. The next important milestone will be a low-energy collision, which will provide the first collision data and enable important calibration work to be performed.

Source:
"The LHC is back"

CERN press release (November 20, 2009)
http://press.web.cern.ch/press/PressReleases/Releases2009/PR16.09E.html

CERN (November 23, 2009)

For the first time, two beams have been simultaneously circulated in the Large Hadron Collider (LHC). This feat is allowing operators to test the synchronization of the beams and enabling the experiments their first chance to look for proton—proton collisions. The beams crossed at points 1 and 5, corresponding to the locations of the ATLAS and CMS detectors, and at points 2 and 8, corresponding to the locations of the ALICE and LHCb detectors. The beams were first tuned to produce collisions in the ATLAS detector and then subsequently in the CMS, ALICE, and LHCb detectors. The events, occurring just three days after the LHC restart, are indicative of the beam control system's excellent performance. The next step will be to increase the intensity and acceleration of the beams.

Source:
"Two circulating beams bring first collisions in the LHC"
CERN press release (November 23, 2009)
http://press.web.cern.ch/press/PressReleases/Releases2009/PR17.09E.html

CERN (November 30, 2009)

The Large Hadron Collider (LHC) has set a new world record for high-energy particle acceleration, with the acceleration of its twin proton beams at an energy level of 1.18 TeV. This accomplishment exceeds the previous world record (9.98 TeV) held by the US Fermi National Accelerator Laboratory's Tevatron collider since 2001. The achievements provide further confirmation that the LHC is progressing smoothly towards its objective of starting physics experimentation in early 2010. At present, the LHC is scheduled to enter a concentrated commissioning phase aimed at further increasing the beam intensity and providing additional collision data. Next, the LHC will begin colliding beams for calibration purposes. The first physics is scheduled for the first quarter of 2010, with a collision energy level of 7 TeV.

Source:
"LHC sets new world record"
CERN press release (November 30, 2009)
http://press.web.cern.ch/press/PressReleases/Releases2009/PR18.09E.html

Basic

Clemson University (November 10, 2009)

Clemson University, together with the University of Texas at Dallas and Yale University, has received a five-year $3 million dollar award from the U.S. Air Force's Office of Scientific Research to search for superconductive nanoscale materials. The team will attempt to develop composite wires made from carbon nanotube-based superconductors. Such composite wires could eventually be used in a variety of applications, including the replacement of copper wiring in power lines. Researchers at Clemson are using pulsed lasers to produce superconducting carbon nanotubes that have been doped with elemental boron. Apparao Rao, a physics professor at Clemson University, commented, "We are very excited about this discovery since superconducting nanotubes are not only useful in several applications but also serve as an ideal candidate to explore the underpinning physics in low-dimensional materials, which has long been a

challenge. Clemson's role in this research is to build on this success and experiment with nanotubes doped with other elements such as sulfur, nitrogen and phosphorous with a view toward fabricating doped nanotubes that superconduct without having to cool them to very low temperatures, which is the technology used today."
Source:
"Clemson carbon nanotube research part of $3 million award to enhance energy efficiency"
Clemson University press release (November 10, 2009)
http://www.clemson.edu/media-relations/article.php?article_id=2393

University of Houston (November 18, 2009)

Professor Paul Ching-Wu Chu, a founding director of the Texas Center for Superconductivity at the University of Houston (TcSUH) has returned full time to the University of Houston after completing an 8-year term as president of the Hong Kong University of Science and Technology. Additionally, Chu has received a 5-year, $2.8 million dollar grant from the U.S. Air Force Office of Scientific Research for ongoing research on novel materials that become superconducting at higher temperatures, preferably close to or above room temperature, and that have a higher current carrying capacity. Chu commented, "In the 22 years since the discovery of liquid nitrogen high temperature superconductivity here in Houston, great progress has been achieved in all areas of HTS science and technology research and development. The time is ripe for us to bring what we have learned over the years in HTS materials synthesis, characterization and understanding to bear in the search for superconductors with higher transition temperatures and current carrying capacity, and even room temperature superconductors."
Source:
"Superconductivity leader receives $2.8M grant from US Air Force Office"
University of Houston press release (November 18, 2009)
http://www.tcsuh.uh.edu/news/show/21

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Top of Superconductivity Web21

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Feature Articles: Present Status of Superconducting Digital Device Technology
- Topics in Superconducting Digital Device Technology

Akira Fujimaki, Professor
Quantum Engineering, Graduate School of Engineering
Nagoya University

Almost fifteen years have elapsed since the research on single flux quantum (SFQ) circuits started worldwide as a major theme for superconducting circuits. Initially, the power consumption, which was 1/1000 that of semiconductors, and the operation speed of several tens GHz were considered to be a great appeal, and the central theme of research was the large-scale integration of SFQ circuits. However, as a result of technical development and changes in environment, the direction of research and development has been changed recently. The following is a brief report on the new trend.

Table 1 summarizes the type of circuit used, advantages and disadvantages, and direction of recent development for major applications of SFQ circuits. In addition to the applications described in the table, there are many other proposed applications, including AC voltage standard and digital oscilloscope, which are introduced in this special edition, as well as digital SQUID, control, and reading of superconducting quantum bit. Large-scale integration, which is not described in the table as a direction of development, is still required in any application. In this field, Japan is leading the development in the world, and an integrated circuit with 14,000 Josephson junctions has been demonstrated using the Nb/AlOx/Nb standard process developed by Superconductivity Research Laboratory. Furthermore, using 10-Nb-layer process, Nagoya University has succeeded in increasing the integration density by five times under an operation speed of almost 100 GHz.

Table 1 Major applications of SFQ circuits

Application	Major SFQ circuit	Advantages	Disadvantages	Direction of development
Array system for superconducting detector	• Analog-to-digital converter or time-to-digital converter • Multiplex circuit	• Downsizing of the system and reduction of heat inflow by introducing time-sharing multiplex circuit • Direct utilization of the low-temperature environment of the detector	• The performance of the system depends on the performance of the detector. • Competition with analog multiplex circuit	• Scale-up of detector • Higher performance of the system • Electrical power saving
Digital RF radio (software radio)	• Analog-to-digital converter • Digital-to-analog converter	• High accuracy due to quantum feedback • Increase in flexibility due to digital circuit • Increase in performance using a high-performance superconducting filter	• High cost • Application only to the base station	• Increase in dynamic range •Higher performance of the system •Downsizing and weight saving • Improvement in reliability

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High-end router	Switch	• Higher throughput • Electric power saving of the system	• Technical difference from the existing system	• Electric power saving • Downsizing
High-performance computer	General digital circuits	• Space saving, higher performance, and lower power consumption of the system • Cover-up of cooling cost	• Technical difference from the existing system	• Electric power saving • Downsizing

Let us review the recent changes based on Table 1. The first thing to be noted is that superconducting detector systems are being developed in Japan and Europe as a new application. Since it was found that the superconducting transition-edge sensor has a high-energy resolution, superconducting sensors are being actively developed. The present important item to be developed is the technology to multiplex the output of plural detectors to increase the detecting area. SFQ circuits are attracting attention as a technology that will provide multipixel of more than 10,000 in the future because it has signal forms of impulse type and ultrawide band. Fig. 1 shows an example of the SFQ circuit for neutron-diffraction equipment that is being developed by Nagoya University. In this circuit, two detectors measure the flight time of neutrons on the basis of each output and multiplex the measurements. Since the detector is used at an ultralow temperature, it is necessary to reduce the present power consumption to 1/100 in SFQ circuits.

Even for the SFQ circuit, the feature of which has been low power consumption, further power saving is strongly required. This is the second change that has taken place recently. As the environmental issues become more important, the trend is that power saving is considered to be more important than high speed for IT equipment. In the present SFQ integrated circuits, electrical power 10 times of that used in the SFQ circuit itself is consumed by the resistance for the power feed. Attempts to reduce the power consumption by the resistance to the intrinsic value are now being made in diversified ways. A new logical method has been proposed in the US, and it is being investigated to reduce the critical current in Europe. In Japan, it is being attempted to replace the resistance using choke coil. Energy saving of the total system is also important, and the optimization of the system, including the cryocooler, is a future issue from this viewpoint.

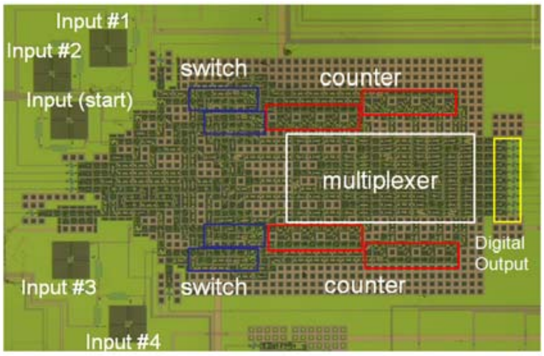

Fig. 1 SFQ time-to-digital conversion circuit for neutron -diffraction equipment, including two-channeled multiplex circuit

New trends in research on SFQ circuits have been introduced above. The direction of research and development is now very clear, and the author feels that commercialization is going to be realized soon. The author believes that some applications will be commercialized within several years.

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Top of Superconductivity Web21

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Feature Articles: Present Status of Superconducting Digital Device Technology
- Present Status of the Development of Superconducting Real Time Oscilloscope

Mutsuo Hidaka, Director
Low Temperature Superconducting Device Div., SRL/ISETEC

The speed-up of the optical network, which supports the information and communications society, is being developed steadily. In the Ethernet, for example, 10 G Ether is expected to take the leading part in 2015, while 1 G Ether is dominant at present. It is also expected that 100 G Ether will be standardized in 2011. Although 100 G Ether is expected to be transmitted with four 25 Gb/s waves, there is no oscilloscope that enables the observation of the optical communication waveform of 25 Gb/s in real time. To observe the waveform in real time, it is necessary to take more than 50-G sampling frequency in a second (50 GS/s)at least. And to increase the sampling speed of the oscilloscope, it is necessary to increase the speed of the analog/digital converter (ADC) that is being used.

As part of "Development of Next-Generation High-Efficiency Network Device Project" sponsored by NEDO, ISTEC is developing a high-speed ADC using SFQ circuit for the superconducting real time oscilloscope that enables observation of 25 Gb/s optical signals. While the high-speed of ADC using SFQ circuit has been known, there are two problems "nonlinearity" and "asymmetry (offset)." The former comes from the fact that the circuit parameter (LI_c product) cannot be made small enough, while the latter comes from L/R time constant, both of which are factors that deteriorate the high-speed performance that is intrinsic to the superconducting circuits. ISTEC proposed a new circuit called complementary-type QOS* comparator which can solve these problems. Figure 1 shows the results of the simulation of J_c dependency of the frequency of 4-bit ADC sampling using the complementary-type QOS comparator, where J_c is critical current density of Josephson junction (JJ) used for the circuit. It is known that the operation speed of SFQ circuit increases in proportion to the square root of J_c. Figure 1 shows that the sampling frequency increases with the increase in J_c and sampling frequency exceeding 150 GS/s is expected to be achieved at J_c of 40 kA/cm^2. For reference, maximum frequencies of conventional superconducting ADC, semiconductor ADC, and semiconductor real time oscilloscope are shown in Figure 1. The maximum sampling frequency of conventional superconducting ADC was 12 GS/s due to the abovementioned "nonlinearity" and "asymmetry." In the semiconductor ADC, the maximum value of 24 GS/s has been obtained using CMOS ADC developed by Notel. The value of 24 GS/s was obtained by interleaving 160 ADCs of 150 MS/s. For interleaving, it is strictly required that the characteristics of the 160 interleaving ADCs are uniform and that the sampling phase is accurately controlled. If these conditions are not satisfied, the observed waveform is distorted. Since it is practically difficult to prepare 160 ADCs with uniform characteristics, it is essential to compensate by means of software. A real time oscilloscope with maximum performance of 50 GS/s is available in the market, which also uses interleaving technique and requires correction of observation results using known signals. Judging from these facts, the superconducting sampling oscilloscope using SFQ high-speed ADC, which can provide sampling frequency in excess of 150 GS/s without interleaving, is a promising means to observe optical waveforms of 25 Gb/s that are used in 100 G Ether age.

*QOS: Quasi-one junction SQUID

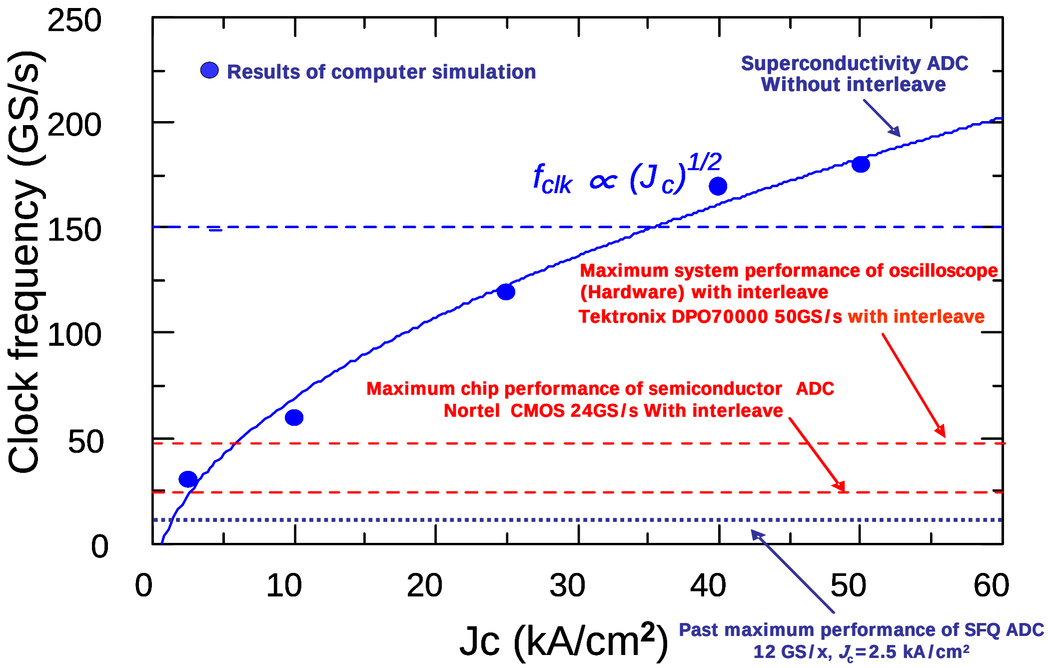

Fig. 1 J_c dependency of SFQ high-speed ADC sampling frequency using complementary-type QOS comparator

ISTEC made a prototype 4-bit ADC using a complementary-type QOS comparator whose chip is shown in Figure 2 and evaluated the characteristics of the product. The results shows that it is very likely that the sampling frequency shown by the simulation can be obtained using JJ of J_c = 2.5 kA/cm^2. In future, increase in sampling frequency will be attempted at J_c = 10 kA/cm^2. In addition, JJ of J_c = 40 kA/cm^2 is being developed. An experiment to operate the SFQ circuit with optical signal input has already succeeded up to 40 Gb/s, and it is intended to develop superconducting real-time oscilloscope that enables the observation of 25 Gb/s optical signals for the 100-G Ether age by combining these technologies.

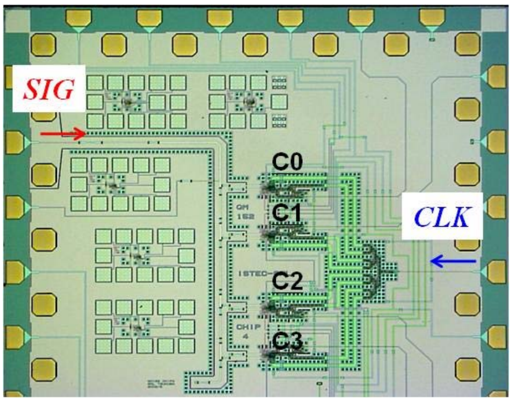

Fig. 2 Photo of the chip of 4-bit SFQ high-speed ADC

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Top of Superconductivity Web21

Winter, 2010 Date of Issue: January 15, 2010

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Featured Articles: Present Status of Superconducting Digital Device Technology
- Single Flux Quantum Digital-to-Analog Converter for Metrology

Masaaki Maezawa
Nanoelectronics Research Institute
National Institute of Advanced Industrial Science and Technology

1. Introduction

The most unique feature of single flux quantum (SFQ) circuit is to process signals by using the motion of the magnetic flux Φ_0 = h/2e, which is exactly quantized. By positively utilizing this characteristic, we are developing a SFQ digital-to-analog (D/A) converter that accurately generates arbitrary voltage waveforms. A wide range of applications of the SFQ D/A converter in the metrology field, including the next-generation AC voltage standard, are expected.

2. High-precision voltage based on Josephson effect

By integrating and averaging the well-known Josephson voltage-phase relational expression $v = (\Phi_0/2\pi)d\phi/dt$ with respect to time, the following equation is obtained where N is an integer.

$$V = (\Phi_0/2\pi)\, N\, \omega = \Phi_0\, N f \qquad (1)$$

That is, when a Josephson junction is excited by an electromagnetic wave at a frequency f, a voltage proportional to f is generated. The flux quantum Φ_0, which is a physical constant, is an invariant, and the integer N cannot take a halfway value and is precisely determined. Furthermore, the frequency f can be determined most precisely among the physical quantities that are generally handled. For example, the uncertainty of the frequency standard on the basis of the atomic clock is as small as 10^{-14}. Equation (1) shows that voltage can be generated with accuracy equal to that of frequency due to the Josephson effect. By changing the integer N or the frequency f as a function of time, the following equation is obtained from equation (1).

$$v(t) = \Phi_0\, N(t)\, f(t) \qquad (2)$$

Equation (2) indicates that a precise AC voltage waveform $v(t)$ can be accurately generated.

3. Present status of the development of SFQ D/A converter

Figure 1 shows a block diagram of a SFQ D/A converter based on the operation principle given by equation (2). The converter consists of three elementary circuits, and the total system operates in synchronization with the reference clock, Ref, at a frequency f_c. The reference clock Ref

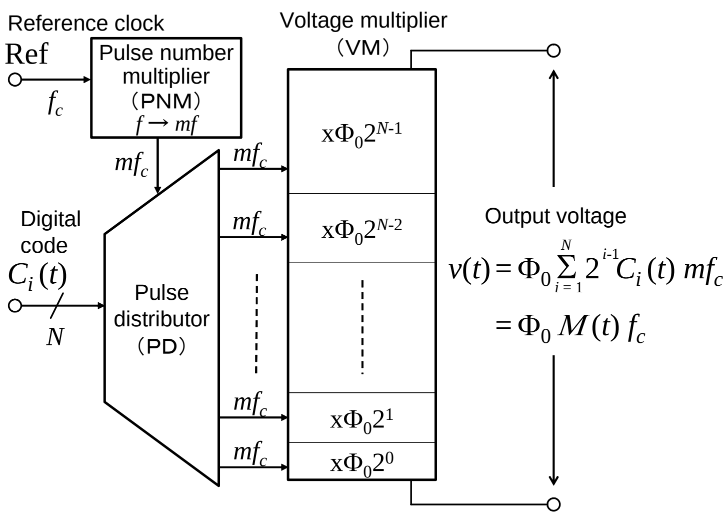

Fig. 1 Block diagram of SFQ D/A converter

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is converted into a high-speed SFQ pulse train with an effective frequency mf_c by pulse number multiplier (PNM) and distributed to each bit of voltage multiplier (VM) by pulse distributor (PD) according to the N-bit binary code $C_i(t)$ = 0 or 1. The final output voltage $v(t)$ is accurately determined using frequency f_c and integer $M(t) = m\Sigma 2^{i-1}C_i(t)$.

Figure 2 shows a 10-bit SFQ D/A converter chip and an example of output waveform. At the present, the details of the output waveform are being evaluated to verify the high accuracy that can be applied to metrology and AC voltage standard.

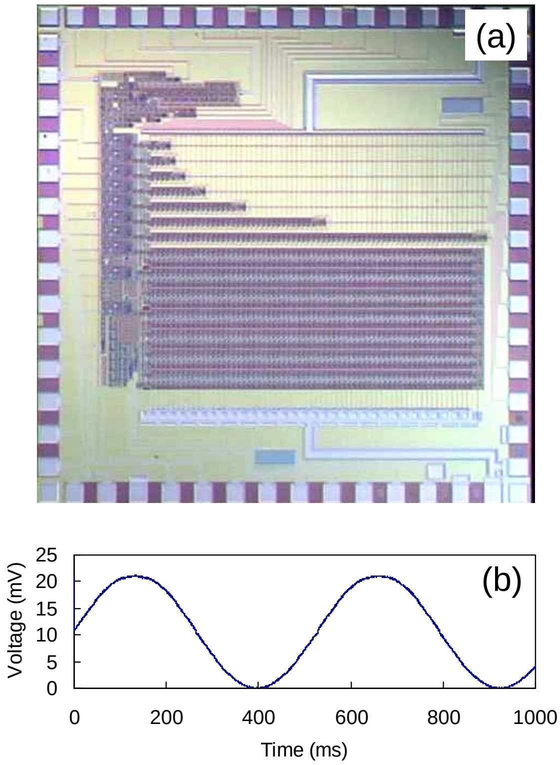

Fig. 2 10-bit SFQ D/A converter and an example of output waveform

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Top of Superconductivity Web21

Winter, 2010 Date of Issue: January 15, 2010

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Featured Articles: Present Status of Superconducting Digital Devices - Overview of the Development of SFQ Physical Random Number Generator

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Random number sequences are used in a wide field of applications, including simulation and cryptographic communication. Quality of the random number is very important for cryptographic communication, and security of the communication is threatened because the cryptographic key can be predicted if the quality of a random number sequence is poor. For this reason, physical random-number generator that generates a random number sequence using physical phenomena that are essentially random is being developed. This paper reports the physical random number generator being developed that uses superconducting single flux quantum (SFQ) circuit.

The SFQ physical random number proposed by us consists of SFQ comparison circuit (comparator), which is made up of serially connected two Josephson junctions. The SFQ comparison circuit is a circuit in which the probability of obtaining output against an input can be changed by DC control current supplied from the external current source. By setting the probability to 0.5, a random number sequence that gives exactly the probability of 0.5 for the output of “0” and “1” is obtained.
In this circuit, the randomness of the random numbers comes from the thermal noise of the resistance existing in the circuit. Since the SFQ circuit is very sensitive to electric current, it is not necessary to amplify the noise as in the case of semiconductor physical random-number generator, and a random number generator with a high speed performance can be formed with a very simple constitution. Furthermore, since the signals are expressed by voltage pulses with a time width of about 10 picoseconds, there is no correlation between adjacent outputs; therefore, high-quality random numbers are generated at an ultrahigh rate. The results of simulation assuming the 2.5 kA/cm^2 Nb process developed by SRL shows that the SFQ physical random number generator can generate truly random numbers at a generation rate of 30 Gbit at the operating temperature of 4.2 K. This generation rate is much faster than that of the existing physical random number generator.

By an on-chip high-speed test using superconducting random number generator, random number sequences have been successfully generated at a speed of 20 Gbit per second. 30,000 sets of random number sequences consisting of 20 kbit were generated, and a statistical evaluation was implemented on the basis of FIPS 140-2, which has been established by NIST. The results showed that the quality of the generated random number sequences were sufficient for practical application.

The SFQ physical random number generator has much higher performance as compared to the existing devices, while its circuit area is extremely small. It is highly expected that the generator is put into practical use and commercialized by the advancement of growing technology of superconducting circuits and use of SFQ circuits based on high-temperature superconductor.

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Top of Superconductivity Web21

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Feature Articles: Present Status of Superconducting Digital Device Technology
- Present Status of Research and Development of Low-power, High-performance Processor Using SFQ Circuit

Naofumi Takagi, Professor
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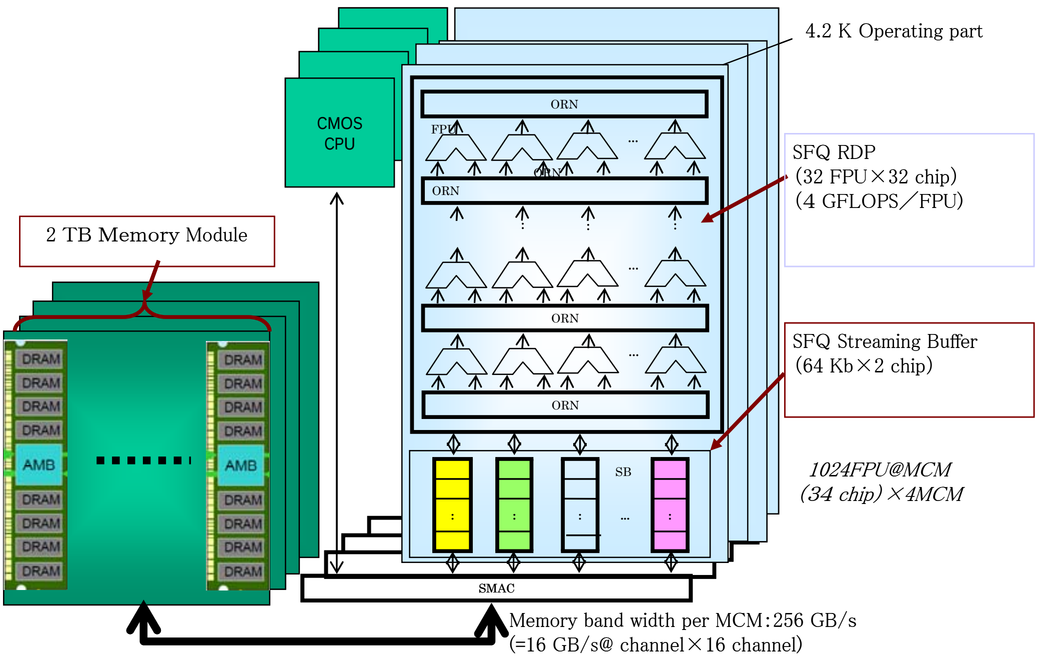
Superconducting single flux quantum (SFQ) circuit technology is expected as a circuit technology with ultrahigh-speed and ultralow power processing which cannot be achieved by semiconductor circuit. SFQ digital circuits operate by pulse logic using very small voltage pulses (SFQ pulses) as information carriers. At a logic gate, the input pulses must wait for each other, and each logic gate is basically a clocked gate. Therefore, the circuit is suitable for pipeline processing of streaming-type data.

As a CREST-JST project, we started research on low-power, high-performance computer with a large-scale reconfigurable data path (RDP) by SFQ circuit in October 2006. RDP is a data path consisting of several thousand floating-point arithmetic units (FPUs) and operand routing networks (ORNs) that connect the FPUs. We realize high computation performance by reconfiguring the RDP according to a series of calculations in iteration loops that appear in a large-scale calculation, letting a large number of FPUs operate in parallel with pipelining, and thereby, directly executing multiple instructions with data dependency. Once the connection of ORN is constituted, the data flow in a constant direction and the data to be processed flow into each FPU one after the other, which makes the RDP suitable for implemented by SFQ circuit. The figure shows a constitution of a computer of 10-teraflops class with SFQ-RDP. RDP, and the streaming buffer, which interchanges data with RDP at high speed, are implemented by SFQ circuits, while the CPU and the main memory are implemented by semiconductor circuits. The computer is expected to be realized when a SFQ integrated circuit fabrication process technology of about 0.35 μm is established.



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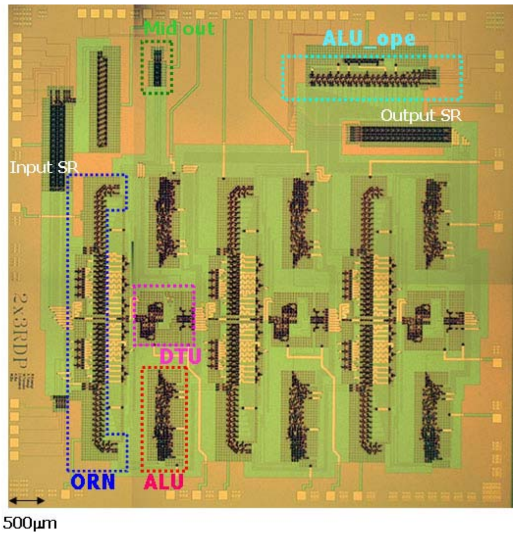
Optimization of RDP architecture, including the function of FPU and constitution of ORN, on the basis of the analysis of applications, such as molecular orbital calculation, as well as the development of FPU and ORN on the basis of SFQ circuits, is being made. A half-precision floating point adder and a multiplier and an RDP with 2x3 ALUs (Photo) have been fabricated using the ISTEC standard process of 2 μm, and their operation at about 25 GHz has been confirmed.



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Top of Superconductivity Web21

Winter, 2010 Date of Issue: January 15, 2010

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Feature Articles: Development of Superconducting Power Equipment - Trends in Superconducting Power Equipment

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Relating to recent trends in superconducting power equipment, coated conductors (CCs) and the policies of Japan and the US are overviewed in this report.

Coated Condu ctors The performance of CCs has been improved remarkably. Fujikura, who had succeeded in the development of 300 A × 500 m wire in the previous project, announced that they developed wire exceeding 1000 A/cm as a result of M-PACC project and started the sales of CCs separate from the national project. Super Power of the US succeeded in the development of wire (280 A/cm) longer than 1000 m. Therefore, CCs not only for power equipment but also for general-purpose use are being prepared already in the market. Several actual trades have been reported. AMSC announced that they had received an order as long as 80 km (4.4 mm wide) from the Korean cable company LS Cable. LS Cable is going to develop superconducting cables using the wire and supply them to the grid of Korea Electric Power Corporation. While the research and development of CCs is being advanced, commercial trade is also expanding steadily.

Policies of Japan and US Changes of U.S president and Japanese Prime Minister, which were big events in this year, had no small effect on superconductivity. President Obama proposed Green New Deal Policy, which was aimed at steady supply of electric power and introduction of renewable energy, and United States Department of Energy (DOE) requested a budget for Smart Grid, in which the budget for superconducting power equipment (cable and current limiting device) is included. In Japan, the Democratic Party of Japan, which won the lower house election in August, clearly describes in its manifesto that research and development and practical applications of environmental technology, including superconductivity, shall be promoted (excerpted from the manifesto). After the election, Prime Minister Hatoyama attracted attention by declaring that the medium-term goal of greenhouse effect gas reduction by 2020 should be 25 % compared to that in 1990 at the United Nations Summit on Climate Change at September. Since superconducting cables are effective for CO_2 reduction because of the high efficiency in transmission, transforming, and downsizing, early introduction of superconducting cables and superconducting transformers will be demanded strongly. In addition, to utilize renewable energy, whose output is unstable, by introducing it to electrical systems, power storage facilities are essential. Therefore, much use of SMES that contributes to the stabilization of electrical systems and improvement of electricity quality is anticipated.

Conclusion Although the number of reports on SA (Large Scale System Applications) at ISS (International Symposium on Superconductivity) in 2008 was 81; the number increased to 110 in 2009. As the performance of superconducting wires is improved and wires applicable to devices become available in the market, research on applications and devices will be initiated. We must pay attention to international and domestic trends in the abovementioned devices that are approaching the practical application stage.

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Top of Superconductivity Web21

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Feature Articles: Development of Superconducting Power Equipment Technology
- New Development of SMES Technology

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Electric power-storage technology is divided into two main types. One type stores electricity by converting the electric energy to some other type of energy and generates electricity later using the stored energy, such as pumped storage in which electricity is converted to potential energy or batteries that utilize chemical reactions caused by change of substance. The other type directly stores electric energy like capacitors. The characteristics of the former are large quantity and high density of stored energy; while that of the latter is its high storage efficiency.

SMES is a method that directly stores electric energy belonging to the latter and in which electricity can be stored because apparent coil current does not decay due to the zero electric resistance under the superconducting state. For this reason, not only the high storage efficiency but also excellent responsiveness to charge and discharge and durability for repeating are the characteristics of this method. Furthermore, it provides high output, as compared to other methods, which is an advantage. Making full use of these characteristics, the technology to stabilize the electric power network that requires large power and instantaneous input/output is being developed using this method. Momentary voltage-drop compensation device has been already put into practical use.

By applying oxide superconductors, particularly Y-based wires, much improvement in the characteristics of SMES coil is expected as compared to those of conventional metallic superconducting material.

Firstly, stability due to the high critical temperature and improvement of cooling penalty are expected. SMES has a problem of AC loss accompanying the charge and discharge, which causes serious problem for certain applications. However, since oxide superconductors are essentially stable due to the high critical temperature and large heat capacity, quench scarcely occurs during operation, which has been a problem in conventional metallic superconductors. Furthermore, since liquid helium is not required for cooling, conduction cooling by cryocooler becomes possible. This contributes not only to the improvement in cooling efficiency but also to significant simplification of the cryostat structure, which provides many advantages in maintenance and reliability.

Secondly, high mechanical strength of Y-based wire provides the most advantageous characteristic to the SMES. In SMES, electric power is stored as the form of magnetic energy, and the energy-storage density is proportional to the magnetic energy density; therefore, the amount of stored electric power is determined by the stress level generated in the coil. High-strength coils that endure high magnetic fields are advantageous for SMES in all aspects, including performance, function, and cost. Therefore, Y-based wires, which have high strength, provide possibilities to dramatically improve the SMES coil system. Although at a wire level, the principle verification of high-stress coil that cannot be made using conventional metallic superconductors has been implemented. On the basis of this result, a coil with a stress of 600 MPa, which is twice as much strength as that of metallic coils, has been designed, and the verification test is scheduled this year during the Yttrium-based Superconducting Power Equipment Development Project.

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The purpose of this project is to apply yttrium-based wire to the coil system, which is the key-component of SMES, to obtain the performance limit and to optimize not only the coil itself but also the system. Such a coil is difficult to constitute using conventional metallic superconductors, and the development is being implemented aiming at the next-generation SMES that satisfies the requirements of storing large capacity of electric power as a result of the introduction of large capacity of renewable energy. (For details, refer to the NEDO website.)

Dramatic advancement not only in SMES but also in other applications of superconducting technology to power equipment is expected as the result of availability of yttrium-based superconducting wires, and steady development is being made aiming at the completion of the targets in cooperation with industry-government-academia. In future the importance of the technology will increase as a global environment technology and will become one of the most important technologies in which Japan has advantages in international competition.

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Top of Superconductivity Web21

Winter, 2010 Date of Issue: January 15, 2010

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Feature Articles: Development of Superconducting Power Equipment Technology
- Present Status of Technical Development of Superconducting Power Cable

Takato Masuda
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Sumitomo Electric Industries, Ltd.

Since superconducting power cables can transmit large capacity of electricity with low loss in a compact configuration, the technology is expected to lead the future large volume electric transmission. The technology will also contribute to the reduction of CO_2 emission, which has come to be an issue these days, by reducing the transmission loss and construction cost by the simplification of the structure.

At present in Japan, two projects related to superconducting cables are in progress under the sponsorship of Ministry of Economy, Trade, and Industry and New Energy and Industrial Technology Development Organization (NEDO).

One of them is "High temperature superconducting cable demonstration project." This project is to develop a superconducting cable of 66 kV / 200 MVA class using Bi-based wires and demonstrate long-term operation in an actual network from 2011 for the first time in Japan. The demonstration site has been determined to be Asahi Substation (Yokohama) of Tokyo Electric Power Company, and the technical development of elemental technologies, such as reducing AC loss (1 W / m / ph @ 2 kA) and measures for short-circuit current (31.5 kA @ 2 sec) are being promoted. Before the construction of the demonstration system, a cable system of 30-m class has been constructed in Sumitomo Electric Industries and preliminary verification test is being conducted (refer to Photo).

A 30 m HTS cable system for pre-verification

The other is a project being carried out as part of "Technological development of yttrium-based superconducting power equipment" and the following themes are being pursued:

① development of large-current, low-AC-loss superconducting cable,

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② development of high-voltage, large-capacity superconducting cable.
Sumitomo Electric Industries is in charge of ① by developing a 66 kV / 5 kA three-core cable and demonstrating 2.1 W/m/ph @ 5 kA; and Furukawa Electric Co. is responsible for ② by developing a 275 kV / 3 kA single-core-type cable and demonstrating at high voltage. Both of the system tests are scheduled to be implemented in 2012.

While the technical development of superconducting cable is steadily proceeding in Japan, overseas also, many projects of actual operation are in progress or being planned, in which the US and Korea are leaders. Under such circumstances, requests for the preparation of international standards of superconducting cables are being made by many countries. In Japan also, standardization of superconducting cables has been studied by an *ad hoc* committee consisting of the members of TC90/TC20, IEC Japan as the leader, and proposal of early standardization has been made to International Electrotechnical Commission (IEC). In response to this proposal, IEC requested Conseil International des Grands Réseaux Electriques (CIGRE) to study the possibility of standardization, and preliminary investigation was made by a task force (TF) of CIGRE SC-B1 last year. Consequently, a working group (WG) to study the possibility of standardization relating to testing of superconducting cables has been established this autumn to work for three years. Japan is going to participate in the WG, provide the results and data of the two projects, and positively propose ideas.

(Published in a Japanese version in the November 2009 issue of *Superconductivity Web 21*)

Top of Superconductivity Web21

Winter, 2010 Date of Issue: January 15, 2010

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Feature Articles: Development of Superconducting Power Equipment - Technical Development of Superconducting Transformer— Key Technologies for Practical Use of Superconducting Transformer and Challenges in Carbon Reduction

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Kyushu Electric Power Co.

The application of superconducting wire to transformers provides downsizing, high efficiency (carbon reduction), and noncombustibility. Since Y-based superconducting wires (YBCO, GdBCO), particularly, have a large critical current in a high magnetic field with lower loss by using thin wires, thereby resulting in lower cost in the future, we started technical development of superconducting transformer for practical use using Y-based wires in 2008 as part of "Technical development of yttrium-based superconducting power equipment," a granted project of Agency for Natural Resources and Energy and sponsored by NEDO. Superconducting transformers are expected to be used for new installation due to increase in demand, replacement of aging transformers, and improvement of existing transformers (high efficiency, downsizing, noncombustibility, and longer life). It is also expected that superconducting transformers provided with current limiting function operate as a current limiters of electric power systems and contribute to the improvement of transmission capacity and short-circuit capacity when superconducting cables are applied.

In this project, the target is practical application of distribution transformers of the 66 kV/6 kV-20 MVA class on the basis of the following concepts (refer to Figure 1) :

1) Development of elementary technologies for superconducting transformers: stable supply of superconducting wires (target: wires 100 m long; 5 mm wide; divided into three parts; 40 A @ 0.1 T); winding technology (low loss 1/3; large current of 2 kA class; 66 kV voltage resistance); cooling technology (2 kW @ 65 K; COP 0.06 @ 80 K),
2) development of system technology (development, demonstration, and design guidelines of 66/6 kV-2 MVA class model of actual equipment),
3) development of technology for providing current limiting function (single-phase model of several hundred kVA class),
4) Formulation of the effect and roadmap of introduction and guidelines for international standardization.

Y-based wires are supplied by depositing wire material on the substrate prepared by ion-beam assisted deposition (IBAD) using pulsed laser deposition (IBAT-PLD) and metal organic deposition (IBAT-MOD), in which stable supply technology has been developed for improving the yield of wires. For the wire fabrication process, high-speed fabrication technology has been developed, including high-speed splitting technique for dividing wires about 10 mm wide into two parts and a technique that reduces I_c deterioration by dividing 100 m long wires into three parts. We succeeded in thinning the 30 m wire by using a combination of YAG laser and etching and obtained excellent results: critical current of the wire (I_c) lowered only by 14.7 % and the resistance between filament was 100 kΩ/30 m (permissible value: 0.3 kΩ/30 m; refer to Figure 2). For supporting technologies, tapestar for continuous measurement of I_c, SQUID inspection equipment, evaluation apparatus for the resistance between substrates have been developed and results of high-speed and highly-accurate evaluation are being fed back.

Winter, 2010 Date of Issue: January 15, 2010

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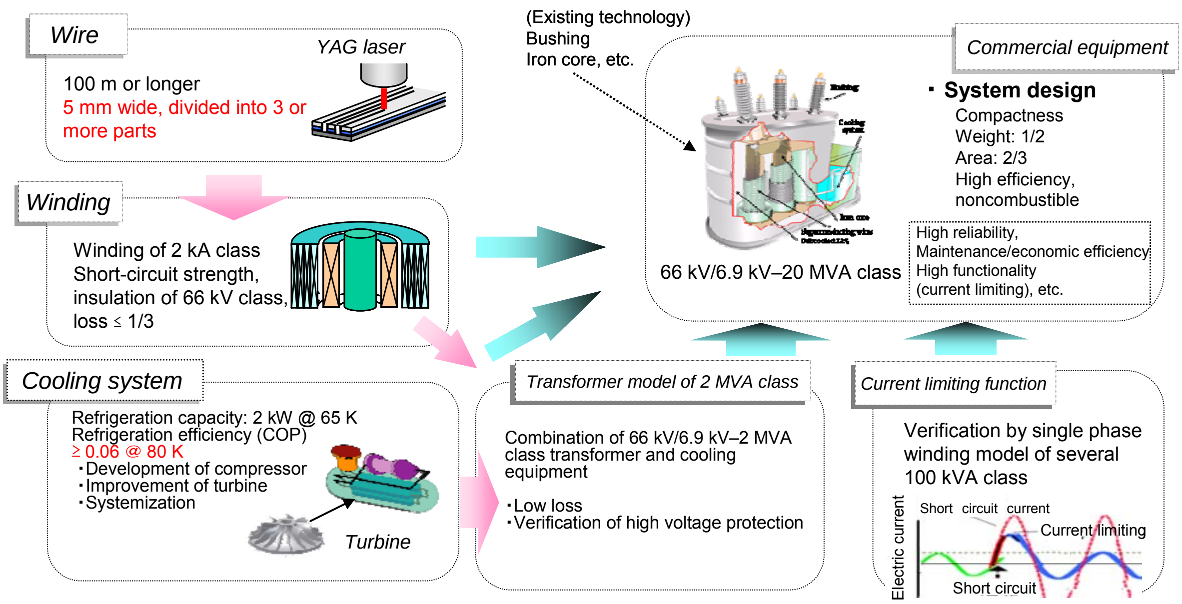

Fig.1 Technical development of superconducting transformer and targets

For winding, I_c measurement and overcurrent test (corresponding to the short-circuit current per strand) of three parallel-winding model of (ID: 250 mm; 12 turns) were implemented in liquid nitrogen at 66 K as a basic technology for multiparallel winding (actual equipment: 24-parallel) (Figure 2). Overcurrent of 1,395 A (465 arms/strand) was uniformly divided, no decrease in I_c was observed, and the winding was sound. It is scheduled to develop large-current technology.

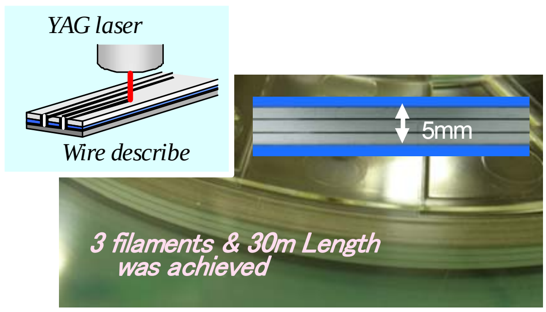

Fig. 2 Thinning of Y-based wires
(5 mm wide; 30 m divided into three parts)

Current limiting technology for transformers is being developed in the following steps: basic test of winding model, verification of mechanism of a transformer of four-winding structure, and verification of a transformer model with a current limiter of 100 kVA class. An overcurrent test corresponding to the short circuit current has been performed using a winding model (diameter, 250 mm; 12 turns; I_c :150 A) and the current limiting effect was confirmed from the generation of voltage, etc. (Figure 3).

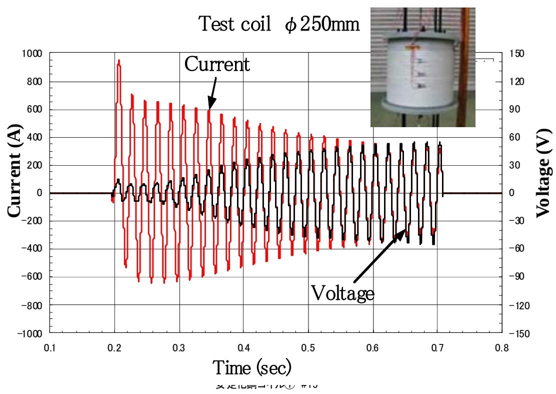

Fig. 3 Results of short-circuit test of winding model

A turbine system with neon cryogen has been adopted for the cooling system because of its small size, high efficiency, and easy maintenance (no sliding part), and the system is being developed aiming at a cooling capacity of 2 kW @ 65 K. An impeller for expansion turbine has been developed and 65 % or higher adiabatic efficiency has been demonstrated. It is also scheduled to develop turbo compressor and systemization technology in the future.

Furthermore, it is scheduled to systemize, demonstrate, and evaluate a transformer fabricated by combining the abovementioned technologies using the 66 kV/2 MVA as a model. In addition, we are working on internal standardization of the effect of introduction and test methods on the basis of these results. This project is being conducted in cooperation with ISTEC, Kyushu University, Iwate University, Fujikura Ltd., SWCC Showa Cable Systems Holdings Co., Taiyo Nippon Sanso Corporation, Japan Fine Ceramics Center, and Kyushu Electric Power Co.

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Top of Superconductivity Web21

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Standardization Activities

Topics in November

- ISTEC Held the 7th Panel Discussion of Superconducting Power Equipment in Dresden, Germany

On November 15, 2009, ISTEC held the 7th Panel Discussion of Superconducting Power Equipment at Room 101, Auditorium Centre, Technical University of Dresden, Germany as part of "Technical development of yttrium-based superconducting power equipment" sponsored by NEDO. Eighteen participants from eight countries participated, and the panel discussion was concluded successfully.

Mr. Teruo Matsushita of Kyushu Institute of Technology (chairperson of Technology Investigation Committee on Superconducting Power Equipment) was the host. Following the report on the outline of the results of past six panel discussions by the chairperson, study and discussion of technical trends and international standardization were performed in two fields—superconducting power cable with Ken-ichi Sato (Sumitomo Electric Industries) as the leader and superconducting wire with Kozo Osamura (Research Institute for Applied Science) as the leader.

1. Superconducting power cable

◇Technical trends in superconducting power cable

–Hiroyasu Yuyama (Sumitomo Electric Industries) explained three projects on superconducting power cable in Japan. These were Yokohama project using Bi-based wire, the project using YBCO cord wire being conducted by ISTEC, and the project of DC superconducting cable being conducted by Chubu University.

–Dag Willen (ULTERA, Denmark) introduced several projects in Europe and Russia.

–Ying Xin (Innopower, China) explained two projects in China.

–Steven Fleshler (AMSC, USA) introduced a LIPA project in the US

◇International standardization of superconducting power cable

–Ken-ichi Sato explained projects on superconducting power cable, which is in progress and in the planning stage. And then he, representing Lindsay who could not attend the meeting, explained the CIGRE and IEEE activities on superconducting power cable.

–It was reported and accepted that a new working group would be established in CIGRE in which activities on pre-standard were carried out, and recommendations would be submitted to the IEC in about three years after investigation of test methods.

–There was a question whether the future cables should be based on the conventional standards or new standards should be established. It was concluded that the issue was to be investigated in future by submitting to IEC/TC20 the information on special items relating to superconducting cables from IEC/TC90.

2. Superconducting wire

◇Technical trends in superconducting wire

–Chan Park (Seoul N. Univ., Korea reported SmBCO coated wire being developed in the DAPAS project.

–Ying Xin (Innopower, China) introduced Nb-Ti and Nb_3Sn wires, Bi-2223 tape, 2G superconducting wire, and MgB_2 wire for ITER, which has been developed in China.

◇International standardization of superconducting wire

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–Kozo Osamura distributed drafts for the standardization of superconducting wires prepared by *ad hoc* group 3 of IEC/TC90 on the basis of past discussion (Ver. 1 and Ver. 2 that has been modified by the committee members) and explained the drafts.
–Dissent was expressed against the definition of superconducting wire as "monolithic strand" in scope. After discussion during the conference, it was agreed to change the definition to "single strand."
–Opinions were exchanged on what should be described as normative information on the label, particularly, the substance name. Representative opinion was "since the interested parties of the trade know well about the material, the description may be limited to what can be understood between the interested parties such as the contract number." However, when several kinds of superconducting products are placed in a stock yard, it is desirable to describe specific items such as "substance name," "weight," and "length" for the interested parties to instruct workers. Since investigation of labels of other substances, such as copper wire, and aluminum wire would be informative, it was decided to ask specialists in industries to study and submit opinions.
–A German participant expressed an opinion that when wires are divided into HT wire and LT wire, there are *de facto* specifications for LT wire among interested parties; therefore, there is no need for new standards. Against this opinion, however, there was also an opinion that the primary spirit of international standardization is to activate the market by making common knowledge and technologies open. Therefore, unified and open standards are more understandable and easy to use for newcomers to the market. It should be noted that since Nb-Ti ingots and materials and products, such as MRI are monopolized by certain international companies, it seems to be difficult for IEC/TC90 to formulate international standards.
–On the basis of the opinion of a German participant that committee members from industry should be added to the committee that discusses superconducting wire, which is an industrial product, a proposal of new constitution of *ad hoc* group three members with new members added to initial members was introduced. Furthermore, it was requested that US and Germany should participate in the committee, and Fleshler promised that he would consult Cooley.
–The *ad hoc* group three will operate with new members from henceforth.

(Editorial Office) This report has been prepared on the basis of the report submitted by Teruo Matsushita, who attended the panel discussion.

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Top of Superconductivity Web21

Standardization Activities

Topics in November

- Industrial Standardization Award 2009 was granted to Prof. Takakazu Shintomi and Prof. Hisao Hayakawa

On October 15 (Thursday), 2009, the award ceremony of Industrial Standardization Award 2009 was held at Cosmos Hall on the third floor of Toshi Center Hotel. In the award ceremony, Professor Takakazu Shintomi of Nihon University and Honorary Professor Hisao Hayakawa of Nagoya University were awarded Minister of Ministry of Economy, Trade, and Industry Award and Director-General of Industrial Science and Technology Policy and Environment Bureau of the Ministry of Economy, Trade, and Industry Award, respectively; Honorary Professor Hisao Hayakawa of Nagoya University was also granted the IEC1906 Award.

Minister of Ministry of Economy, Trade, and Industry Award
(Back second, third right, Prof.Takakazu Shintomi)

From 1992, professor Takakazu Shintomi has been the convener of IEC/TC90/WG6 (Matrix to superconductor volume ratio measurement-copper ratio of copper-stabilized niobium-titanium composite superconductor and copper to non-copper volume ratio of Nb_3Sn composite superconducting wires) and the chairman of the Japanese deliberation committee of the WG. He has significantly contributed to Japan's two original proposals and its subsequent amendments by actively coordinating domestic and international opinions by playing a central role. He has also greatly contributed to domestic and international standardization in the superconductivity field by participating in the drafting committee for transferring international standards to JIS.

Honorary Professor Hisao Hayakawa has greatly contributed to standardization in the superconductivity field by building consensus for the international proposal for superconducting surface resistance as the convener of IEC/TC90/WG8 (Superconductivity-superconducting electronic characteristic measurements-Surface resistance of superconductors at microwave frequencies) and as the chairman of the Japanese deliberation committee of the WG 8 for five years since 1997.

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Director-General of Industrial Science and Technology Policy and Environment Bureau of the Ministry of Economy, Trade, and Industry Award (Back, fourth left, Prof. emeritus Hisao Hayakawa)

The IEC1906 Award (Back, second left, Prof. emeritus Hisao Hayakawa)

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Top of Superconductivity Web21