超電導 Web21
Superconductivity

Spring, 2012 Date of Issue: April 16, 2012

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Reporting on the 20 th International Superconductivity Industry Summit (ISIS-20)

Shinya Hasuo, Senior Research Fellow
ISTEC

The 20th International Superconductivity Industry Summit (ISIS-20) was held at Khongjiam, a ski resort located 50 km southeast of Seoul, Korea, on 31st October (Mon) – 1st November (Tue) 2011. In addition to usual participation from Japan, USA, Europe, New Zealand and Korea, this meeting welcomed a participant from Russia, making up 50 participants in total.

Scene of conference room

The theme was "100 years of Superconductivity – Role in an Era of Renewable Energy". The meeting opened with a greeting from Dr. Hyun, Chairman of Korea Industries Confederation for Commercialization of Superconductivity (KICS), who stated in his address, "KICS are exploring new markets for cables, current limiters and motors etc. ISIS forms a significant contribution to the potential development of future new markets, in particular, technologies contributing to smart grid and green technology. After this meeting, a trip to the Icheon substation is arranged. I would like you to see the Korean technology".

Mr. Park, Vice President of Korea Electric Power Corporation (KEPCO), stated that, "In order to address environmental equipment, climate change and changes in fuel prices, the development of green and low carbon technologies are required. KEPCO wants to take leadership in this initiative. Superconductor technologies are expected to address those demands. Korea undertook the Development of the Advanced Power system by Applied Superconductivity technology (DAPAS) project. At the Icheon substation, a reliability test was undertaken. We wish to continue to nurture superconductor experts, and we are grateful to receive cooperation from each country participating in ISIS".

Dr. Lauder, Chairman of ISIS, stated, "ISIS-20 is a historical meeting as KICS became a host country for the first time. KICS was established in 2007 and joined ISIS in 2010. Korea has become a leader in the field of superconductivity over the past ten years. Market requirements have prompted the advancement of

FCLs based upon HTS technologies. Trials verifying FCL performance have been undertaken at the Icheon substation. Representatives from each country participate at ISIS, and moreover, it is wonderful to see many industrial leaders also present at this meeting. A bridge between industry, government and academia is necessary. Since ISIS started over twenty years ago, various technologies have been developed, which have formed the basis of the superconductor industry. The exchange of productive ideas and opinions between ISIS members is important for future development".

The meeting was then opened to all representatives from Korea, USA, Japan and New Zealand, who summarized the status of superconductivity research and development in their countries.

Presentations on the theme of, "Role in an Era of Renewable Energy" was made, and included an update from USA on the present status of the Washington-New York maglev linear motor, Japan's efforts for renewable energy, HTS applications for smart grids installed at Jeju Island, Korea, and HTS NMR and MRI in New Zealand.

There were not many presentations related to electronics apart from Northrop Grumman Corporation based in USA and ISTEC who presented the current status of their research and development.

The closing session discussed the future prospectus in the commercialization of the next generation wires. Regarding the future market development, opinions were exchanged between Korea, Japan, USA and Europe. This concluded the ISIS program.

Following the close of the meeting, a tour to the Icheon substation was arranged on 2nd November. A 500m superconducting cable (22.9kV/50MVA) was installed together with a superconducting fault current limiter (SFCL) at the existing Icheon substation. The cable was connected to the grid on 28th September 2011 and stability tests have been undertaken.

It is inspiring to learn that both Korea and New Zealand have been energetically progressing HTS applications. Russia has also begun initiating efforts in this field. Until now, HTS applications have been mainly discussed by groups in Japan, USA and Europe, however it is favourable that HTS applications are gradually being discussed globally.

Next year's summit (ISIS-21) is being planned to be held in Portland, USA, on 4th (Thurs)-5th (Fri) October, the week prior to the Applied Superconductivity Conference (ASC), which is being held in Portland on 7th (Sun)-12th (Fri) October. At this meeting, Russia participated as an observer, but will be considered as an ISIS member depending upon its future participation.

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A link for information regarding the Icheon substation
http://mydocs.epri.com/docs/publicmeetingmaterials/1110/7TNRSL46577/06%20-%20The%20Research%20Progress%20Concerning%20the%20Application%20of%20Superconducting%20cable%20system%20on%20Power%20Grid%20in%20Korea%20(Ryu).pdf

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SRL Director General Awards for Autumn 2011

The SRL Director General Awards take place twice a year (spring and autumn) at the Superconductivity Research Laboratory, and awards those researchers who have made significant achievements in their fields. The 2011 autumn awards were held on 15th November, with recipients of those awards as follows.

The SRL Director General Awards were presented to Hato, Tsukamoto, and Adachi from the Electronic Devices division for their work on "the development of high performance SQUID magnetometers for next-generation SQUITEM", and Nagasawa from the Low Temperature Superconducting Devices division for his work on "the establishment of testing methods for the fabrication of SFQ circuits, and the exceptional performance demonstration of 70000 JJ shift register circuits to viral infection".

The photo of recipients of SRL Director General Awards

As well as SRL Director General Awards, there were a number of Technical Excellence Awards, which were presented to Takagi, Nakaoka, and Takahashi from the Superconducting Tapes and Wires division for their work on "the development of a fabrication process for producing high-I_C long wires by MOD method".

Distinguished Service Awards were presented to three researchers. (The details can be found at http://www.istec.or.jp/web21/pdf/12_Spring/1112J2list.pdf)

A summary of SRL Director General Awards

Director General Awards are presented to those researchers who have shown superior performance and have achieved recognition at an international level for their research and development as well as having societal impact in the superconductivity field.

Technical Excellence Awards are presented to those researchers who have shown superior performance and have achieved recognition within Japan for their research and development as well having societal impact in the superconductivity field.

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Distinguished Service Awards are presented to those researchers who fall into the following categories:

1. Researchers who have played a significant supporting role in the superconductivity research and development field.
2. Researchers who have made a significant contribution in the research and development activities though their actions of research management, operations and business support.
3. Researchers who have made a significant impact towards the effectiveness and rationalization of business operations.

(Editorial Office)

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Looking back at 2011 – Superconductivity, Advancing Globalization and Japan's Role

Yutaka Yamada
Principal Research Fellow
SRL/ISTEC

For the start of 2012, I would like to express our best wishes for a Happy New Year.

You will be aware that last year the Great East Japan Earthquake struck the Tohoku region on 11 March. It was also the year that Professor Shoji Tanaka, Honorary Director General and Advisor of Superconductivity Research Laboratory, International Superconductivity Technology Center, passed away. Thus, 2011 will forever remain long in our memory. On the other hand, the superconductivity industry has seen large changing trends reflect the generations, the likes of which have never been seen. At the start of 2012, I look back over the past year and provide here a summary of industrial topics.

Fig. 1 REBCO coated conductors promoted as commercial product (from the PR advertisement in the magazine) 1)

1. Advancing commercialization of REBCO coated conductors

The autumn meeting of the Cryogenics and Superconductivity Society of Japan was held in Kanazawa last November. Companies reported on their wide-ranging research developments, from the foundation to the applications of superconductors, and on issues such as superconducting materials, equipment and cooling. In particular were national project contributions, where the progress of research relating to (1) commercialization of REBCO coated conductors and (2) R&D and subsequent trials aimed at the realization of superconducting power devices was presented.

The commercialization of REBCO coated conductors is noticeable as they have emerged in many trade and industry magazines, with Japanese manufacturers now already offering km-long REBCO coated conductors, as shown in Figure 1. Recent advances in wire technology have led to the evaluation of RE-based coiling trials, as shown in Figure 2. Coils are an indispensable component technology for superconducting device applications such as high magnetic field coils, NMR, MRI, maglev train, generators, motors and accelerators. For such applications, it is important to understand many fundamental characteristics involved in coiling methods, excitation characteristics, characteristics under electromagnetic force, cooling characteristics, stability etc. Studies reported pancake coil configurations, shown in Figure 2, racetrack-shaped coils and saddle-type coils, all utilizing wide RE-based tape shaped coated conductors that could possibly be applied to a wide range of applications (coil component technology development aimed at device applications, as well as more advanced superconducting power device applications such as cables, transformers and SMES).

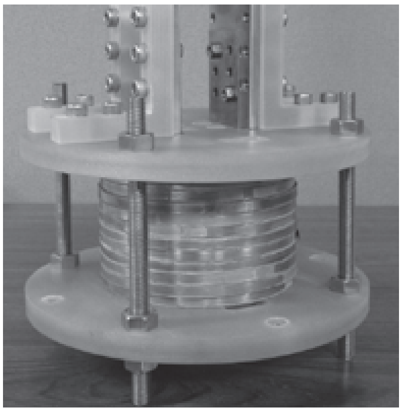

Fig. 2 Typical RE-based pancake type coil configuration [2)]

2. Globalization and M&A waves

The superconductor industry has also succumbed to mergers and acquisitions (M&A) and the pressures of globalization. These stories, often prevalent in the IT industry, have affected the superconductor industry due to the recent appreciation of the Japanese Yen against other currencies. Increased M&A activities and international collaboration seen in the superconductor field mean that companies are finally able to set certain commercial goals in their business strategy, advancing past their research and development stages. Examples follow that highlight these facts.

Example 1: Furukawa Electric Co., Ltd acquires SuperPower, Inc.

This was a sudden shock announcement to the industry, reported in a newspaper on 17 October 2011. SuperPower Inc., a US venture, had already successfully manufactured 1km-long REBCO coated conductors, and thus a first-mover advantage for potential commercialization. The acquisition of SuperPower allowed Furukawa Electric Co., Ltd to secure the top spot in the field of high temperature superconductors, as well as acquire the technical know-how and necessary key materials required for RE-based high temperature superconducting wires, in addition to conventional low temperature superconducting wires such as NbTi and Nb_3Sn. The synergies associated with the acquisition of technology, human resources and intellectual property are expected to lead to shorter development cycles. Their strategies and goals towards future commercialization are highly anticipated (Figure 3).

Profile of SuperPower Inc.

(1) Head Office	Schenectady, NY USA
(2) Turnover	¥4bn (approx.)
(3) Employees	59
(4) Business activities	Developer and producer of second-generation high-temperature superconducting wires

Fig. 3 SuperPower HQ (NY states) and brief description (right) [3)]

Example 2: Collaboration between Showa Electric Wire & Cable Co., Ltd and a Chinese company

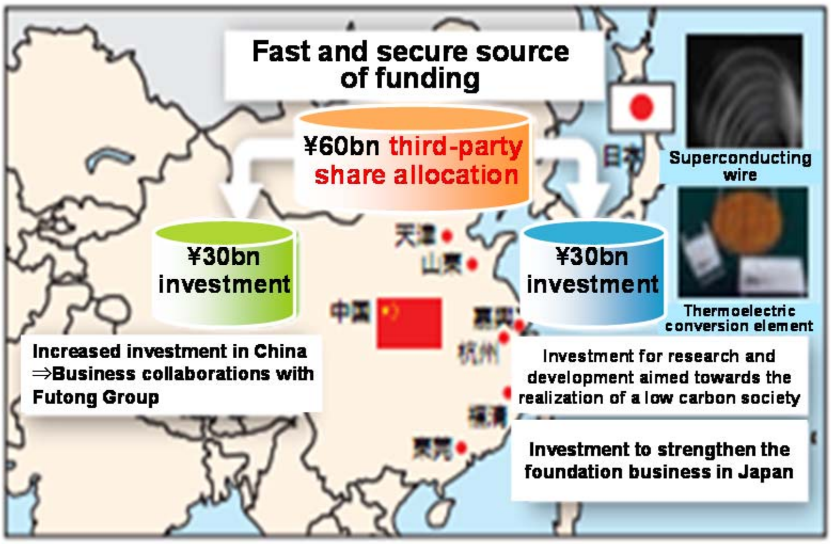

Fig. 4 Globalization strategies of Showa Electric Wireand Cable Co., Ltd. [4)]

Referring to the homepage, Showa Electric Wire & Cable Co., Ltd has been steadily advancing their international presence. As a part of their activities, in spring of 2011, the company received a capital investment of ¥60bn from the Futong Group in China to enable it to undertake reconstruction and promotion for research development activities and business operations in both China and Japan. Figure 4 outlines their strategy. The superconducting wires visible in the photograph imply that, not only general products, but also high technology development needs to advance from the globalization point of view. This is an example where industries have made active collaborations with enterprises overseas in order to optimize manufacturing sites overseas and the business operational roles in Japan.

The two topics mentioned above emphasize the industry's future trends, with the need to reconstruct an environment where all research and development, manufacturing, and sales are undertaken without borders. Another important issue is the need to optimize capital investments and their returns amidst fluctuating foreign exchange markets. These examples highlight that such issues are important even for the superconductor industry.

3. Earthquake and superconductors

Also reported at the autumn meeting of the Cryogenics and Superconductivity Society of Japan was important earthquake-related information relevant for researchers working in the superconductor field. A superconducting 1 GHz-NMR system at The National Institute for Materials Science, shown in Figure 5, which boasts the world's greatest magnetic strength, was in operation during the

Fig. 5 A world class superconducting 1 GHz-NMR at NIMS, which survived the Great East Japan Earthquake of 11 March [5)]

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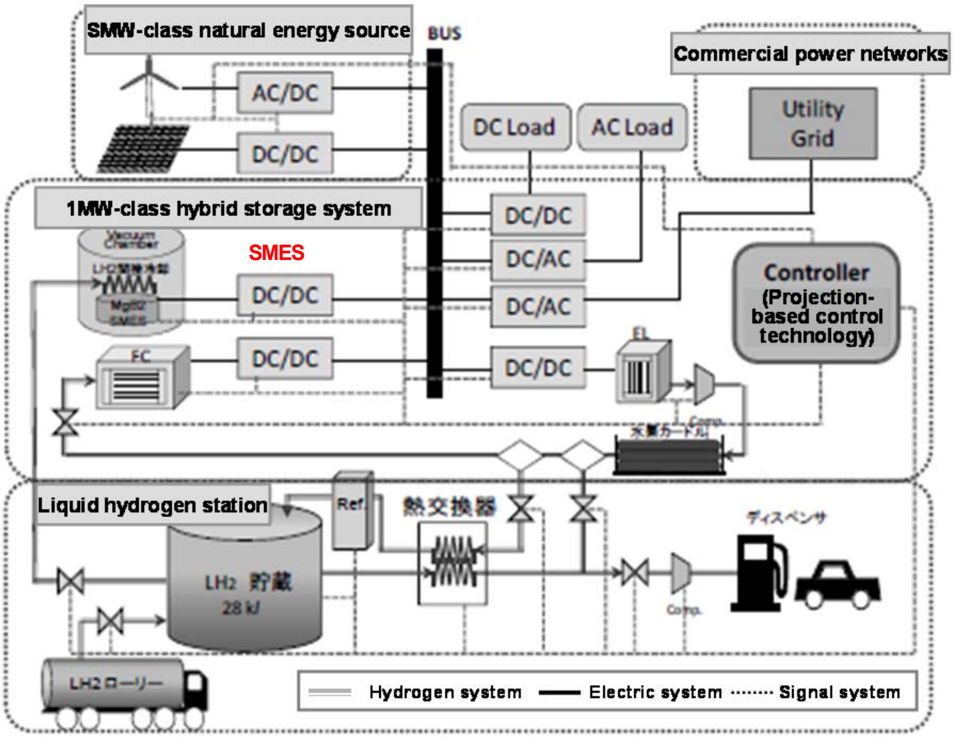
great earthquake. As is documented, the main earthquake had a seismic intensity of 6 and with two after-shocks with a seismic intensity of 5, caused violent tremors. However, even during this turmoil the NMR system remained fully operational, with no reports of fluctuations in field strength, changes in homogeneity or instability. In fact, reports stated that individual system components such as the air suspension and bellows, showed 10-times the specified tolerances, and thus allowed the system to operate without any major damage. NMR is very sensitive to fluctuations in magnetic fields and thus it is pleasing to ascertain that the reliable operation of the superconductor-based system was proved on this occasion. Also, the National Institute for Materials Science reported RE-based coiling for a 24 T NMR system.



Advanced Superconducting Power Conditioning System (ASPCS)

Fig. 6 A proposal for a superconducting-based renewable energy system [6)]

Many broadcasts have also featured on renewable energy applications as a route for Japan's recovery from the earthquake. Amongst the plans suggested for the superconductor field include one from Tohoku University, which is at the centre of earthquake reconstruction, and involves a system combining wind power, SMES (Superconducting Magnetic Energy Storage), fuel cells and hydrogen energy (Figure 6). The proposal involves utilizing hydrogen in either a liquid or gaseous form, for the purpose of a superconductor coolant, energy transportation, and energy storage, allowing the realization of a stable supply and renewable source of electricity provided by superconductors. This will be an ideal opportunity for superconductivity to contribute further to the smart green energy network. However, cryocooling remains the bottleneck of superconductor technology and if this can be overcome within the entire renewable energy system, will result in efficient and stable system operation, increasing the reliability of superconductors in our social infrastructure.

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4. “Japan” the leader in superconductivity

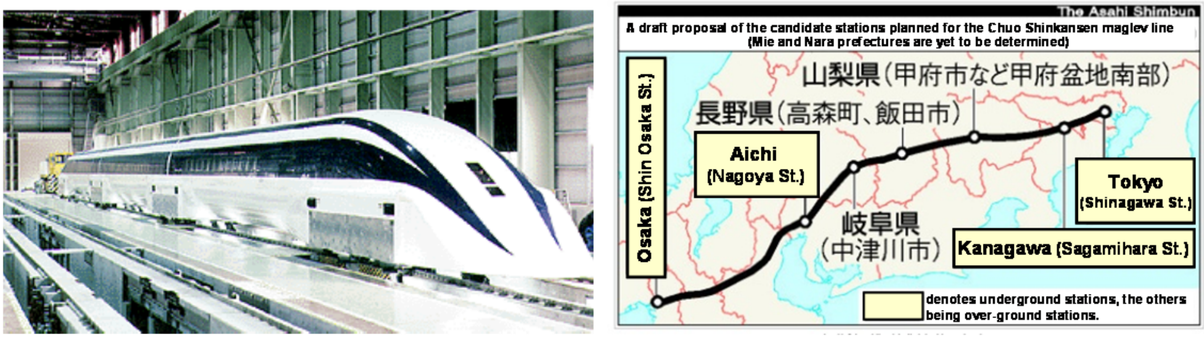

Fig. 7 The superconducting maglev train and the proposed routes.
Construction begins from 2014. [7]

Japan leads the superconductor field in areas ranging from materials development to applications utilizing Nb_3Sn, Bi-based, MgB_2, iron-based, RE-based conductors and etc. A prime example of an upcoming and world’s first transportation infrastructure application is the construction of a superconducting maglev train that will finally begin in 2014 (Figure 7). This is not so far into the future being only two years away, with full passenger service operation set to begin by 2027. A trip between Tokyo and Nagoya will take 40 minutes, and it is understood that underground stations will be built in Shinagawa, Sagamihara and Nagoya. This is expected to welcome a new generation of transportation.

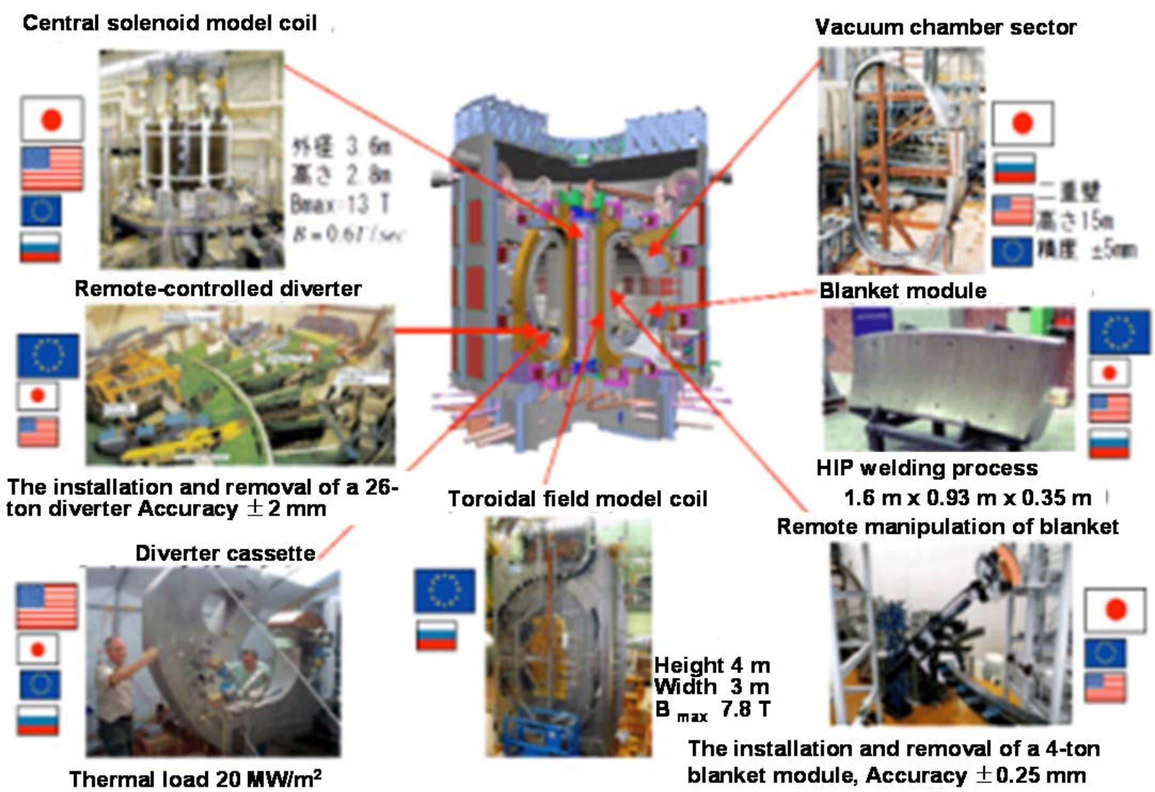

Fig. 8 Japan’s contribution to the ITER project [8)]

International collaborations of ITER projects are also progressing. As shown in Figure 8, Japan has an important and leading role to play in many areas of this project, and Japan's activities are greatly anticipated. Further to prior-mentioned RE-based projects, where component technology such as coil development for superconducting device applications are being performed, as well as national projects aimed at investigating further advanced superconducting power applications such as cable, transformer and SMES, with their realization highly anticipated.

5. Summary

The recent deterioration of Japan's vigour in various fields is a misgiving. However, as mentioned in this article, Japan leads the world in superconductivity in areas ranging from fundamental research and development to applications. Superconductivity would also lead to product differentiation if developments in high technology hardware were taken into account (core competency). Globalization is unavoidable in a future international society, and thus it is important to have unique national characteristics and climate to nurture and grow technological developments to achieve future prosperous industrialization. Taking into consideration these multiple factors, it is my belief that Japan has achieved the pinnacle of leading the world in the superconductivity industry, from fundamental materials research to state-of-the-art applications. An additional factor is the role that national resources have and their impact on research themes that can be exploited by industrial, governmental and academic sectors. Since many of the superconducting applications are large-scale, support at a national level is essential to maintain Japan's lead in future superconducting application research and development. In parallel, during this recessionary period, support at a national level is feasible to compensate for prior company blunders where the impetuous has been for immediate product development.

In future, further globalization of companies will evolve with an optimized division of labour attempted worldwide. As yet none of the industrial fields has arrived at a conclusive decision. However, I believe that in the superconductivity field the recent trends of companies focusing on research and development will serve as a large sample template for other industrial fields to follow.

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ISTEC Exhibit Exhibits at “Eco-Products 2011”

Shinya Hasuo
Senior Research Fellow
SRL/ISTEC

Japan’s largest environmental exhibition, “Eco-Products 2011,” sponsored by Nikkei Inc., was held at Tokyo Big Sight, Ariake, Koto-ku, Tokyo on the 15th - 17th December. The sponsor reported a total of 181,487 visitors over the three days. International Superconductivity Technology Center (ISTEC) exhibited at the Smart Community zone of the exhibition. It was very successful with many visitors to the ISTEC booth.

The originally planned idea for the booth was modified on this occasion. We produced a comic-style cartoon strip to explain in a simple manner the relationship between the Smart Community and superconductors, and the applications of superconductivity. As shown in Figure 1, the cartoon strip was placed along the entire length of the booth, and introduced a fictitious story involving a superconductor expert explaining to junior high school student about superconductor concepts.

Fig. 1 The ISTEC exhibition booth

For the visitors who did not fully grasp the concepts of superconductivity from the cartoon strip, once per hour, a lady disguised as a junior high school student and a superconductor expert explained and demonstrated the concept of superconductivity (Figure 2). Visitors passing by the booth were intrigued with demonstrations of magnetic levitation and Fishing effect.

Fig. 2 Attentive listeners at the ISTEC booth

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At the booth were real cutouts and replicas of superconducting wires, superconducting power cables and transformers that are currently under research and development as part of the NEDO project. Each product had an explanation displayed in a photo frame. Many visitors attending this year's event were not enquiring about what superconductivity is, but instead increasing numbers were interested to learn about when superconductor technology would be realized. My belief is that these changing attitudes are influenced by news story reports on maglev train operation between Tokyo-Nagoya, and thus reflect the general public's recognition of superconductivity.

Another highlight at this year's exhibition was the demonstration of a magnetic-levitating train model called "SF Train". The SF Train did a round-trip at the front of the diorama, mimicking the Omura-line in Nagasaki Prefecture. The principle of levitation in this model train is different to that of the superconducting maglev train of JR Tokai. A four-carriage SF Train was levitated on an 8m-long rail installed with powerful magnets. The entire rails were not lying flat, but constructed with a tilt of 45 degrees to the left in one section and another tilt of 45 degrees to the right in another section. Both the Meissner and pinning effects ensured the train operated without fall. This train utilized superconducting wires fabricated by ISTEC, and successfully operated continuously for more than five minutes under liquid nitrogen cooling. Children were excited to chase after the train (Figure 3). Grown-ups too showed their interests by directing many questions to our experts in the booth.

Fig. 3 Children chasing the SF Train Magnetic levitation train operation (Movie)

Located close to ISTEC booth, the exhibition was also attended by Fujikura Ltd, Showa Electric Wire and Cable Co., Ltd, Furukawa Electric Co., Ltd who too had their displays and demonstrations. I believe that this exhibition helped visitors to understand more about superconductivity.

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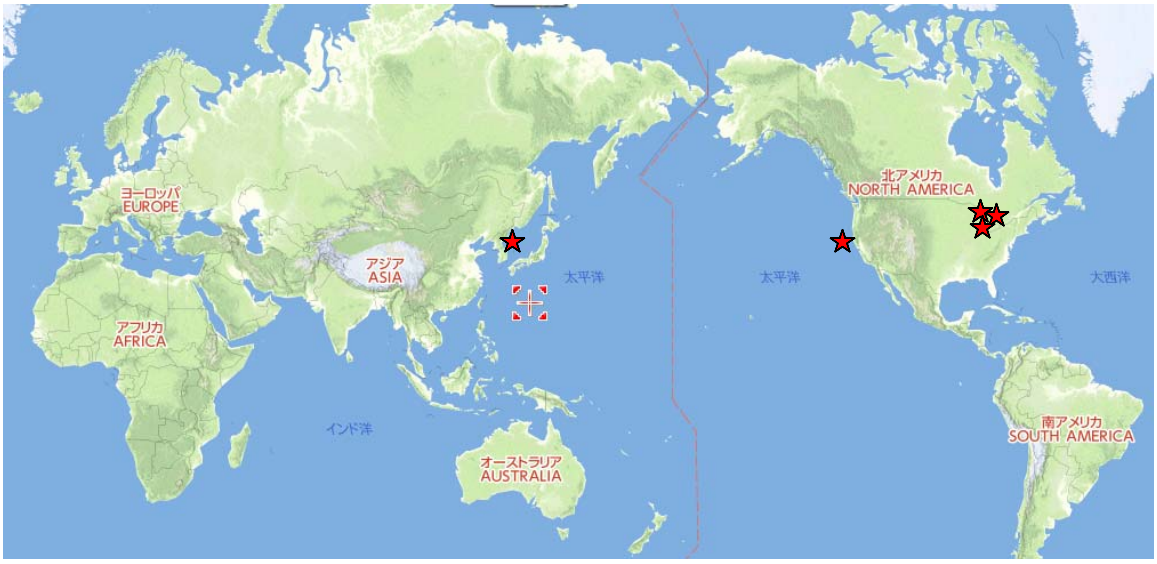
What's New in the World of Superconductivity (February, 2012)

Principal Research Fellow, Yutaka Yamada
Superconductivity Research Laboratory, ISTEC



★News sources in this issue

Wire

American Superconductor Corporation (February 6 and 15, 2012)
AMSC has provided two updates regarding its previously reported legal actions in China. AMSC has filed for arbitration in addition to three civil lawsuits in the Chinese courts against Sinovel Wind Group Co., Ltd. and related companies for contractual breaches and intellectual property theft. In total, AMSC is seeking to recover more than $1.2 billion for contracted shipments and damages.
The smallest of the civil cases is a copyright infringement complaint against Sinovel and Dailian Guotong Electric Co., Ltd. (a supplier of power converter products to Sinovel). AMSC is seeking a cease and desist order and damages totaling approximately US $200,000 in this case. The case was filed with the Hainan Province Number 1 Intermediate People's Court, but Sinovel filed a jurisdiction opposition motion requesting dismissal under the grounds that the case should be governed by the Beijing Arbitration Commission. On February 3, 2012, AMSC was informed that the court had granted Sinovel's motion and dismissed the case. AMSC President and Chief Executive Officer Daniel P. McGahn commented, "We are starting to see motion from the Chinese courts, and proceedings are getting underway as expected. The Hainan court's dismissal of our smallest case is not altogether unexpected, and we are appealing the ruling. We continue to have confidence in all of our cases and expect that our legal actions will yield a positive outcome."
In a second update, AMSC discussed a civil action filed with the Beijing No. 1 Intermediate People's Court against Sinovel for software copyright infringement. This case alleges Sinovel's unauthorized use of

portions of the AMSC's wind turbine control software source code developed for Sinovel's 1.5-MW wind turbines and the binary code of AMSC's software for its PM3000 power converters. AMSC is seeking a cease and desist order and damages totaling US $6 million. Sinovel filed a motion to remove this case from the Beijing No. 1 Intermediate People's Court and to transfer it to the Beijing Arbitration Commission. AMSC has now reported that on February 14, 2012, the court denied Sinovel's motion to remove the case.

Source: "AMSC Provides Litigation Update"
AMSC press release (February 6, 2012)
http://files.shareholder.com/downloads/AMSC/1730279451x0x540248/ed795563-7f0c-4acd-87e1-dd3691e854a1/AMSC_News_2012_2_6_General.pdf
"AMSC Provides Litigation Update"
AMSC press release (February 15, 2012)
http://files.shareholder.com/downloads/AMSC/1730279451x0x542595/cf9b0569-cc11-4bc4-9984-edc1f5522b71/AMSC_News_2012_2_15_Commercial.pdf

American Superconductor Corporation (February 9, 2012)
AMSC has reported its financial results for the third quarter of fiscal year 2011, ending December 31, 2011. Revenues for the third quarter totalled US $18.1 million, compared with $31.6 million for the same period in the previous fiscal year. This decline is mainly the result of lower shipments from the company's Grid segment. The new loss for the quarter was $26.3 million; this figure includes approximately $6.5 million in expenses related to the company's litigation against Sinovel Wind Group Co., Ltd., as well as restructuring and impairment charges related to the workforce reduction announced in November 2011. This figure compares with a net loss of $18.2 million for the same quarter in the previous fiscal year. AMSC's non-GAAP net loss for the third quarter was $17.5 million, compared with $13.4 million for the same period in the previous fiscal year. AMSC President and Chief Executive Officer Daniel P. McGahn commented, "I am pleased to report that AMSC exceeded each of its financial targets for the third fiscal quarter. We again generated a diversified revenue stream, with solid contributions from both our Wind and Grid segments and with Australia, India, Korea and the United States each contributing more than 10 percent of our total quarterly revenues. We further streamlined our cost structure in the third fiscal quarter, allowing us to reduce our cash usage and better position AMSC for sustainable profitability." As of December 31, 2011, AMSC's cash, cash equivalents, marketable securities, and restricted cash totaled $75.5 million, and the company had a total backlog (excluding contracts related to Sinovel) of $300 million.

Source: "AMSC Reports Third Quarter Financial Results"
AMSC press release (February 9, 2012)
http://ir.amsc.com/financials.cfm

Furukawa Electric (February 6, 2012)
Furukawa Electric has acquired SuperPower Inc. from Royal Philips Electronics, NV. The acquisition was finalized on February 3, 2012. With this acquisition, Furukawa Electric has acquired control of one of the only two companies in the world capable of producing second-generation HTS wire on a commercial basis. Furukawa Electric is planning to aggressively grow both its and SuperPower's businesses in the globally expanding smart grid market and alternative energy and industrial sectors by providing superconducting wire and applied superconductor devices.
Now the overview of SuperPower Inc. is (1)Headquarters; Schenectady, New York, U.S.A., (2)President; Yusei Shirasaka, (3)Ratio of holdings; 100 %, (4)Number of employees; 58, and (5)Business description;

Development, manufacture and sales of 2G HTS wire as in the announced materials.

Source: "Furukawa Electric Completes Acquisition of 'SuperPower Inc.' From the Philips Group"
Furukawa Electric press release (February 6, 2012)
http://www.superpower-inc.com/system/files/2012_0206+Acquisition_of_SPI+FINAL.pdf

Superconductor Technologies Inc. (February 17, 2012)
Superconductor Technologies Inc. (STI) has entered into agreements with institutional investors for a registered direct placement of approximately US $4.6 million of common stock at a price of $1.05 per share. Additionally, STI will issue warrants to the investors for the purchase of up to 3,259,646 shares of common stock, with an exercise price of $1.35 per share, that are exercisable 6 months after issuance and terminate five years after the date of issuance. The offering is expected to close on or about February 22, 2012.
Furthermore, the similar second registered direct placement of approximately US $2.5 million of common stock was also announced in February 21, 2012.

Source: "Superconductor Technologies Inc. to Raise $4.6 Million in Registered Direct Offering"
Superconductor Technologies Inc. press release (February 17, 2012)

Source: "Superconductor Technologies Inc. to Raise Additional $2.5 Million in Registered Direct Offering"
Superconductor Technologies Inc. press release (February 21, 2012)

Information and Communications

Superconductor Technologies Inc. (February 6, 2012)
Superconductor Technologies Inc. has signed a product development agreement with a global market leader to develop its Reconfigurable Resonance™ (RcR) technology within the mobile communications products industry. This novel technology represents an extension of analog passive circuit design into the arena of active analog circuitry, resulting in an entirely new circuit design methodology with the potential to be broadly applicable to many of the challenges facing analog circuit design today. A newly formed subsidiary of STI, Resonant Inc., will participate in the product development agreement and will be responsible for the development effort. Resonant will require financing to commence active development, and STI is presently exploring financing options. Jeff Quiram, STI's president and chief executive officer, commented, "While our main focus continues to be 2G HTS wire, STI has long sought to exploit other parts of its intellectual property portfolio where opportunities present themselves. This agreement is the result of these ongoing efforts. Our RcR technology shows exciting promise and this agreement is an important validation of our strategy."

Source: "Superconductor Technologies Inc. Signs a Product Development Agreement With a Global Leader in Mobile Communications Products"
Superconductor Technologies Inc. press release (February 6, 2012)

Medical Equipment

TechPrecision Corporation (February 22, 2012)
TechPrecision Corporation has announced that its Rancor subsidiary has received orders totaling more

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than US $1.1 million for various components required for advanced proton beam cancer treatment equipment. The orders include the large-scale machining, fabrication, and testing of radiation treatment equipment based on superconducting technology. The orders are expected to ship with the first or second quarters of fiscal year 2013. The new technology is expected to increase access to proton beam therapy by offering a smaller, cost-effective alternative capable of preserving all the treatment benefits of traditional proton treatment systems while removing the obstacles of size, cost, and complexity.

Source: "TechPrecision Corporation Receives $1.1 Million Order for Proton Beam Therapy Equipment"
TechPrecision Corporation press release (February 22, 2012)
http://www.techprecision.com/News/TechPrecision%20Corporation%20Receives%20$1.1%20Million%20Order%20for%20Proton%20Beam%20Therapy%20Equipment

Quantum Computer

IBM Research (February 28, 2012)
IBM Research has announced a major advance in quantum computing device performance that may accelerate the realization of a practical, full-scale quantum computer. Using a variety of techniques, IBM researchers have established three new records for reducing errors in elementary computations and retaining the integrity of quantum mechanical properties in quantum bits. IBM has selected the use of superconducting qubits, which use established microfabrication techniques developed for silicon technology, providing the potential for the eventual scale-up and manufacturing of thousands or millions of qubits. David DiVincenzo, a professor at the Institute of Quantum Information, Aachen University and Forschungszentrum Juelich, commented, "The superconducting qubit research led by the IBM team has been progressing in a very focused way on the road to a reliable, scalable quantum computer. The device performance that they have now reported brings them nearly to the tipping point; we can now see the building blocks that will be used to prove that error correction can be effective, and that reliable logical qubits can be realized." The researchers presented their results at the annual American Physical Society meeting in Boston, Mass. (Feb. 27 – March 2, 2012).

Source: "IBM Research Advances Device Performance for Quantum Computing"
IBM Research press release (February 28, 2012)
http://www-03.ibm.com/press/us/en/pressrelease/36901.wss

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Feature Articles: ISS2011
- 24th International Symposium on Superconductivity (ISS2011)

Satoru Miyazaki Director
Public Relations Division, ISTEC

The International Superconductivity Technology Center (ISTEC) sponsored the International Symposium on Superconductivity (ISS2011) at Tower Hall Funabori (Edogawa-ku, Tokyo), for three days, 24th(Mon)–26th(Wed) October 2011. ISS is held annually, providing a place of international exchanges between domestic and foreign research institutions with a number of research presentations on superconductor technology. The symposium aims at promoting the development of superconducting-based industrial technology, the realization of practical applications and the campaigns designed to diffuse superconductor knowledge and applications to the general public. This year marked the 24th symposium. The symposium attracted 15 countries with 555 participants in total, including 131 participants from overseas. There were a total of 416 presentations of which 65 were invited talks, 118 oral presentations and a total of 298 poster presentations. The symposium reports will be made available in either Physics Procedia or in a special issue of Physica C, (both published by Elsevier), after having undergone a peer review process. The symposium also hosted an exhibition involving 9 companies and associates, related to superconductor materials, products and technologies.

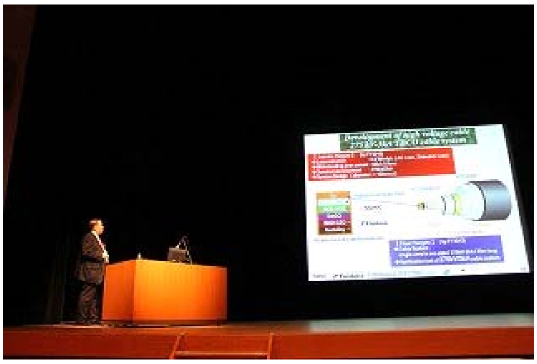
Opening Address by Committee Chairperson

The first day opening address was made by Shoji Tanaka, Honorary Director of Superconductivity Research Laboratory, ISTEC. This was followed by a congratulatory message from Yukio Edano, Minister of Economy, Trade and Industry (message was read by Hironori Nakanishi, Industrial Science and Technology Policy and Environment Bureau at Ministry of Economy, Trade and Industry). Dr. Keiji Enpuku (Kyushu University) and Dr. K. R. Marken (Los Alamos National Laboratory) both acted as chairpersons for two special keynote lectures and six keynote lectures.

Special plenary lectures, were given by, Dr. P. H. Kes (Leiden University) with a presentation entitled, “The Early History of Superconductivity,” and Yuh Shiohara (SRL/ISTEC) presented the “Future Prospects of High T_c Superconductivity; Expanding the Frontiers of Materials and Electric Power Applications”.

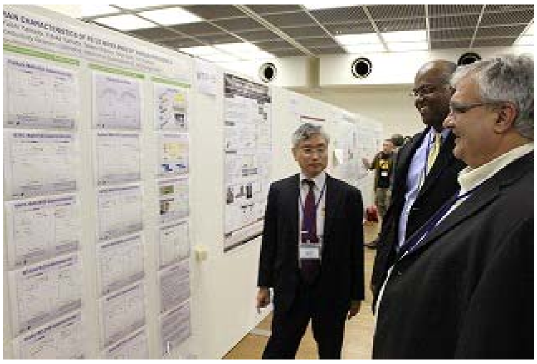
A plenary lecture given by Dr. J. J. Gannon Jr. (American Superconductor Corporation) was entitled, “Recent Advances in MOD/RABiTS 2G Wire For Power Applications,” and Dr. Masashi Tachiki (Tohoku

University) gave a talk on "Superconductivity 100 Years Present and Future". Further presentations included, Dr. F. N. Werfel (Adelwitz Technologiezentrum GmbH) entitled "Large-Scale HTS Bulks for Magnetic Application", Dr. Hiroyuki Kayano (Toshiba Corporation) entitled "Narrow-band Transmitting Hybrid Filter Technology for Weather Radar Application", Dr. M. Noe (Karlsruhe Institute of Technology) entitled "Superconductivity for Future Energy Technology", and Dr. Hidemi Hayashi (Kyushu Electric Power Co.,Inc.) entitled "Development of REBCO Power Transformer".


Special Keynote Lecture


Oral Session

The second and third days of the symposium saw a number of oral presentations in five fields including, Physics/Chemistry/Vortex Physics, Bulks/Characterization, Wire/Tapes/Characterization, Film/Junctions, and Electronic Devices and Large Scale System Applications. Additionally, two poster sessions took place as well as related discussions.


Poster Session

As this years marks the 100th anniversary of the discovery of the superconducting phenomenon, seven special lectures entitled "Histories of superconducting wires and tapes – Discovery and Development –" in the field of Wire/Tapes/Characterization were held on the third day of the symposium.

The closing session of the third day of the symposium was a summary of the research fields presented, and included talk by Dr. P. H. Kes (Leiden University) on Physics/Chemistry/Vortex Physics, Dr. J. R. Hull (Boeing Research and Technology) on Bulks, Dr. X. Obradors (Institute of Materials Science of Barcelona) on Wire/Tapes, Dr. P. Seidel (Friedlich Schiller University Jena) on Film/Junctions/Electronic Devices, and Dr. Hideaki Maeda (Riken) on Large Scale System Applications. The Steering Committee Chairperson of ISS2011, Yutaka Kiyokawa, Executive Director of ISTEC, made the closing remarks. It was noted that the next ISS meeting, ISS2012, would take place at Tower Hall Funabori (Edogawa-ku, Tokyo), for three days on 3rd(Mon)–5th(Wed) December 2012.

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Feature Articles: ISS2011
- Physics, Chemistry, and Magnetic Flux Physics

Hiroshi Kontani, Associate Professor
Department of Physics
Nagoya University

There were a total of 32 oral presentations (including one keynote lecture) and 75 poster presentations at this year's ISS2011. This year again saw many presentations pertained to iron-based superconductors (18 oral presentations). Even though three and a half years have passed since the discovery of these materials, it was clearly evident that research into this material system is still popular as ever. Research efforts have focused on the possible existence of a sign-reversing gap function at superconducting states (s±wave states, s++wave states), as well as new many-electron states (e.g. two-fold (nematic) symmetric electronic structure not accompanied by a lattice deformation). This article focuses on iron and copper oxide based high temperature superconductors.

Dr. Analytis (Stanford University) reported the remarkable in-plain anisotropy of electrical resistance in the orthorhombic phase and in the electron nematic symmetry states of $Ba(Fe,Co)_2As_2$ and $BaFe_2(As,P)_2$. Dr. Yoshizawa (Iwate University) reported the significant softening of the elastic constant C_{66} in the tetragonal phase of $Ba(Fe,Co)_2As_2$, emphasizing the existence of orbital fluctuations in an iron-based superconductor. On the other hand, Dr. Fernandes (Colombia University) presented a theoretical report regarding the spin nematic symmetry derived from spin fluctuations. Dr. Machida (Japan Atomic Energy Agency) reported their research findings for orbital order based on a first-principle calculation approach. From experiments of transport phenomena and magnetic penetration depth, Dr. Kasahara (Kyoto University) clarified the existence of a quantum critical point in $BaFe_2(As,P)_2$. Furthermore, Dr. Li (National Institute for Materials Science) argued the possibility of s++wave states since the effect of impurities on T_C is small for $(Ba,K)Fe_2As_2$, while Dr. Nabeshima (The University of Tokyo) argued the possibility of s±wave states by measuring the effects of impurities in Fe(Se,Te). Dr. van der Beek (Ecole Polytechnique) indicated that considered the pinning strength of quantum flux, $Ba(Fe,Co)_2As_2$ was a dirty superconductor that would contradict the s±wave states. Dr. Tamegai (The University of Tokyo) reported the effects of radiation on the measured critical currents in $(Ca, RE)Fe_2As_2$, a 122 system with the highest reported T_C. Dr. Okada (The University of Tokyo) argued the superconducting symmetry in LiFeAs by measuring microwaves.

The development of new iron-based superconductor materials is currently very vigorous, with a number of interesting reports highlighting the research undertaken. Dr. Guo (National Institute for Materials Science) and Dr. Zhang (Chinese Academy of Science) reported on the electron states and the lattice structure of $K_xFe_2Se_2$, a new iron-based superconductor that has sparked interest due to it having a no hole-like Fermi surface. Dr. Shirage (National Institute of Advanced Industrial Science and Technology) and Dr. Katagiri (Tokyo Institute of Technology) reported on composite materials comprised of a so-called perovskite structure iron-based superconductor, detailing its superconducting states. Dr. Nakajima (The University of Tokyo) also reported on the superconducting states of a new superconductor, $Lu_2Fe_3Si_5$.

This symposium also addressed the latest research findings on copper oxide high temperature superconductor. Dr. Fujita (Cornell University) showed the existence of nematic order in the pseudo-gap regime from accurate STM/S measurements. Dr. Yamamoto (NTT) highlighted that using pure thin films of

Pr_2CuO_4 and Nd_2CuO_4 fabricated by Molecular Beam Epitaxy, superconducting states were present without the need of carrier doping. Dr. Nojima (Tohoku University) successfully fabricated n-type metal from a p-type composite YBCO by an electrostatic carrier doping technique.

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Feature Articles: ISS2011
- Bulk Superconductors and Characterization

Naomichi Sakai
Superconducting Tapes and Wires Division
SRL/ISTEC

Presentations in this field mainly reported on the characteristic improvements of bulk materials such as RE, Bi and MgB_2 systems, applications for strong compact magnets and levitation applications. The following summarizes a select few presentations mainly pertaining to application studies.

A plenary lecture given by Dr. Werfel (Adelwitz Tech. GmbH, Germany) introduced their recent research and development activities on RE-based bulk superconductors. In particular, he reported on a superconductor flywheel energy storage system that utilizes non-contacting bulk superconducting magnetic bearings, and ways to reduce manufacturing costs by adopting a multiseed method. A video of a levitating vehicle, shown travelling over a distance of 80 m, designed to carry two passengers was presented. Using bulk materials as strong magnets requires an effective magnetization. Pulse-field magnetization is an effective method to achieve magnetization in a compact system, however difficulties associated with its efficiency remain. Dr. Fujishiro (Iwate University) focused on the inhomogeneity of materials during pulse-field magnetization, showing experimental results and simulations of magnetic-field trapping behavior. Their findings showed that long pulse widths of around 10 seconds, multi-pulse and vortex-type coil magnetization i.e. creating magnetic field pathways, were the effective methods to achieve highly efficient magnetization. Dr. Murakami (Shibaura Institute of Technology), in collaboration with medical organizations, investigated potential applications in regenerative medicine in particular, effective treatments for articular cartilage injury, which can possibly be treated by accumulating regenerative components onto affected tissues by utilizing the powerful magnetic forces produced by the magnetization of a bulk superconductor. The results from this study are not yet conclusive but it is expected that powerful magnetic fields and magnetic field gradients present during the magnetization of bulk superconductors can be used for new medical applications in the future. Dr. Chuzawa (Osaka University) studied the application for a magnetic drug delivery system using a magnetized bulk superconductor, and reported on the verification tests of fundamental magnetic attraction. Not only RE-based but also MgB_2 bulk superconductors have now been fabricated to trap powerful magnetic fields. Dr. Tomita (Railway Technical Research Institute) showed that MgB_2-based bulk superconductor was able to trap a magnetic field at approximately 3T. Furthermore, he reported on potential NMR and MRI applications arising due to the portability of the magnet, which was formed into a ring-shape and fabricated from a RE-based bulk superconductor. A prototype liquid nitrogen pump utilizing magnetic coupling between a bulk superconductor and a permanent magnet was also reported. I would also like to add that there were several reports in the system applications field such as NMR applications and magnetic separation systems utilizing the bulk superconductor magnetization. Other than those mentioned above, there were many reports on the property-control and evaluation of material characteristics.

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Feature Articles: ISS2011
- Wire, Tape, and Characterization

Teruo Izumi, Director
R&D Division of Superconducting Tapes and Wires
SRL/ISTEC

There were about 30 oral and 70 poster presentations in the superconducting wire-related fields, including plenary and special plenary lectures.

This year's ISS included a special session commemorating the 100th anniversary of the discovery of superconductivity, with a programme looking back at the historical development of superconducting wire technology. Amongst the arrays of existing and major superconducting wires/tapes available two types of superconducting wires, the metallic- system such as Nb and MgB_2 and the oxide-system such as Bi- and Y-based superconductors were selected for the presentations. Japanese experts made presentations under the themes of material discovery and important development on the fundamental wire technology, and themes of long and high performance wire development. The sessions were meaningful, each reflecting their individual personalities, their career backgrounds as well as their professionalism.

For Y-based superconducting wires, Fujikura reported a world record I_CxL product of 467 kAm (572A x 816 m), adopted worldwide as an important performance benchmark. Contrary to this was the USA who reported no remarkable progress, however the Korean's progress was remarkable. At SuNAM, Korea, wire development has advanced via a co-evaporation technique called the RCE-DR process, the results from which showed this rapid development. Together with the record-breaking value, the successful fabrication of wires with 247 kAm (405 A x 610 m) was reported at this symposium. Amongst the technical topics on improvement of in-field performance, ISTEC group developed new artificial pinning centres, which showed extremely high performance, i.e. realization of 81 A/cm-w (77 K, 3 T), with 3 μm thickness, without deterioration of in-field J_C properties.

Dr Shiohara and the author gave presentations addressing future wire development targets. These are the so-called third generation wires having an I_C of 2000 A at 2 μm thickness, generating a low-loss Iwakuma effect under a wide range of temperatures and magnetic fields. Furthermore, the required specifications of these conceptual third-generation wires include superior in-field characteristics of more than 500 A in a 5 T magnetic field at liquid nitrogen temperatures, significantly exceeding changes in performance over what could be expected from existing wire development. The realization of this wire should lead to an even greater array of superconducting equipment, which is able to diffuse widely into the market i.e. this wire is required in order to realize "superconductor worlds".

Additionally, there were reports highlighting world project (PJ) research trends. In Japan, for example, PJs involve mainly Y-based superconducting power devices. However, in USA, most of the PJs for materials development were undertaken mainly by the DOE, this has now ended leaving only a PJ called ARPA-E, which involves wire development for wind power generators. There are no clear content details for this new PJ yet. In Korea, an application-related PJ has been launched, but a successor to the DAPAS PJ has yet to be determined. On the other hand, Europe reports of a new movement in wire development PJ called EUROTAPE, which are destined to begin soon.

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Sumitomo Electric Industries Ltd., reported on Bi-based superconducting wires, describing the optimization in the fabrication process of short and long DI-BSCCO wires, which achieved characteristics of 250 A (77 K s.f.) and 200 A (77 K, s.f.), respectively. Regarding MgB_2, Dr. Doi from Kyoto University reported the research outcomes from thin film deposition studies, achieving a J_C exceeding 1 MA/cm^2 for a thin film in a magnetic field of 10T at 4.2 K.

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Feature Articles: ISS2011
-Thin Films, Junctions, and Electronic Devices

Shinya Hasuo, Senior Research Fellow
ISTEC

Oral presentations in the above-mentioned fields totalled 21, (including a keynote lecture), with a total of 57 poster presentations. This report highlights some of the presentations. Overall, the majority of presentations focused on SQUIDs and sensor-related applications, with a minority focused on digital themes, which were fewer in numbers than previous years.

Dr. Kayano, from Toshiba Corporation gave a keynote lecture with a presentation entitled, "Narrow-band Transmitting Hybrid Filter Technology for Weather Radar Application". The weather radar transmitter outputs a series of pulse waves, from which the sidelobes are filtered out. At a bandwidth of 40 MHz there is not much difference in the insertion loss of a superconducting filter compared to that of a conventional filter. However, if the bandwidth reduces to 3 MHz, this difference becomes significant.

The system comprises of a conventional filter (waveguide-type) to deal with noise generated at high frequencies and a superconducting filter to reduce noise at the peripheral low frequencies. Utilizing this technology a hybrid filter was fabricated. This filter system was installed at a weather radar system site based at Shin Yokohama and Saitama Shintoshin and rack-mounted together with the 100 kW Klystron. System tests performed at 100 kW and at a bandwidth of 0.055 % confirmed an insertion loss of 1.7 dB and an attenuation of 33.5 dB.

Prof. Siebel from Dresden University reported on the development of an iron-based superconducting device. A Shapiro step was confirmed in a Josephson Junction of $BaFe_{1.8}Co_{0.2}As_2$ (Ba-122) with an epitaxial thin film (thickness: 80 nm) of Ba122-Au-PbIn with an approximate 5 nm Au barrier. As well as this study there were 5 additional oral presentations and 7 poster presentations all pertaining to iron-based materials.

Prof. Tsukada from Okayama University presented the development of HTS-SQUID magnetometers designed for both DC and AC power systems. The presentation reported a number of damage evaluation trials involving fuel and solar cells, and also measurements on the magnetic properties of rice, soil and concrete.

Prof. Enpuku from Kyushu University reported on a highly sensitive HTS-SQUID magnetometer that utilizes a pick up coil made from litz wires. They reported that compared to conventional single copper wires the pick up coils made from stranded-litz wires reduced field noise to below 1 $fT/Hz^{1/2}$(f>30 kHz).

Dr. Kawano from ISTEC utilized HTS-SQUID magnetometers for non-destructive testing of magnetic materials. A discrete input coil was connected to the SQUID with the SQUID itself being magnetically shielded by bulk Bi2223. This allowed measurements on samples with inherently strong magnetic properties in which they successfully detected slit-type defects. It was also shown that there was no influence on the measurements when a ferrite magnet (10 mT) was placed upon an Al sheet.

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A poster presentation by Prof. Hatsukade from Toyohashi University of Technology showed non-destructive testing of Carbon Fiber Reinforced Polymer (CFRP) by HTS-SQUIDs. Comparing a non-mixed CFRP and one mixed with a carbon nanofiber (CNF), tests of the mechanical characteristics and the tensile strengths between the CFRPs were undertaken. Results from these tests revealed distinct differences between the mechanical characteristics and tensile strengths of the two types of CFRPs evaluated.

There were more than 15 presentations related to SQUIDs other than those summarized here, including many presentations by other researchers utilizing HTS-SQUIDs fabricated by ISTEC. This clearly highlighted the pivotal and important role that ISTEC plays in superconductor applications.

In the digital category, Prof. Febvre from Savoie University reported on a digital circuit application employing SNIS junctions. An Nb/Al-AlOx/Nb structure, with the thickness of Al ranging from 30 to 100 nm, displayed no hysteresis and self-shunt pattern current-voltage properties. The lack of a non-shunt resistance reduces the integrated area of the device to ¼ that of a conventional device.

Prof. Kitayama, from Nagoya University reported on the ultra-low power consumption of SFQ circuits by reducing the dynamic power. The group investigated reducing either the current or voltage, and for the same power consumption concluded that reducing the current is the better alternative due to non-speed deceleration.

Prof. Dorenbos, from Delft Institute of Technology detected a single electron by employing a superconducting single photon detector (SSPD) made up of NiTiN. By setting up the SSPD in an electron microscope they successfully detected an electron from the electron beam source, as well as successfully detecting both α and β particles.

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Feature Article: ISS2011 Topics
- Large Scale System Applications

Takeshi Ohkuma, Director
Electric Power Equipment Division
SRL/ISTEC

At ISS2011 there were a total of 119 presentation entries for large scale system application fields, which were made up of 28 oral sessions, including plenary lectures, and 91 poster sessions. Categorizing the presentations: 15 were related to rotating machines, 15 for cables, 13 for fault current limiters, 11 for SMES, 5 for transformers, 19 for magnets, 9 for magnet applications and 25 for other applications. Recent years have seen many presentations regarding applications for rotating machines, cables, fault current limiters and SMES, with an increasing trend of presentations related to rotating machines.

At the plenary lecture, Dr. M. Noe (KIT: PL-5) presented a development status of power application equipment such as cables, rotating machines, transformers, SMES and fault current limiters in the world. In particular, a brief account regarding a new project being undertaken in Germany (September 2011 – August 2015), involving the development of 40MVA/10kV/1km-class AC cable with a current limiting function. Dr H. Hayashi, (Kyushu Electric Power Co., Inc.: PL-6) presented “Development of Y-based superconducting power transformer” under the ”Material & Power Applications of Coated Conductors (M-PACC)” project. The presentation reported the reduction of AC loss and the current limiting test results of a 400 kVA-class transformer model with a current limiting function. The group plans to undertake system verification tests combining a 2 MVA-class transformer model with a refrigerator.

Oral sessions related to NMR and MRI applications included, Dr. S.B. Kim, (Okayama University: SA-8) who reported the development of NMR magnets that utilize REBCO thin films and Dr. M. Sekino, (The University of Tokyo: SA-28), investigating NMR applications, reported the results of the magnetic field homogeneity in a bulk magnet with given slits.

Regarding rotating machines, Dr. S.K. Baik, (KERI: SA-16), reported the development of synchronous motors in Korea, and introduced the effect of HTS wires, along with the developmental status of 100HP/380V(1800 rpm) and also 1MW/3.3kV(3600 rpm) HTS motors utilizing Bi2223 superconductors. Furthermore, Dr. J. Gannon, (AMSC:SA-18) and Dr. G.H. Kim, (Changwon National University: SA-19) presented design outcomes of HTS generators utilizing 2G wires for 10 MW-class wind power generators in USA and Korea, respectively.

Regarding fault current limiters, Dr. A. Morandi, (University of Bologna: SA-12) introduced the effectiveness of fault current limiters in electric power systems. Dr. Y. Shirai, (Kyoto University: SA-13) reported the design and their experimental results of a 3-phase, tri-axial transformer type superconducting fault current limiter utilizing HTS (Bi2223) wires. Dr. W. Gong, (Innpower, China: SA-14) presented test results at their factory for their fabricated 220kV/300MVA class statured iron-core superconducting fault current limiter and disclosed their three-year grid connection tests planned for Tianjin.

For the cable development, the outcomes from “Development of Y-based Superconducting Power Cable” in Japan’s M-PACC project were presented. Dr. M. Ohya, (Sumitomo Electric Industries, Ltd.: SA-25) reported the development status of the 66kV/5kA/15m class HTS cable, and Dr. M. Yagi, (Furukawa Electric Co., Ltd.: SA-26) reported on the development status of 275kV/3kA/30m class HTS cable. Both groups disclosed that they were planning system verification tests in 2012.

Dr. M. Park, (Changwon National University: SA-24) reported about the projects currently being undertaken in Korea. One such project is the GENI project, which is planned for a grid connection test for a 22.9kV/50MVA/500m HTS AC cable and a 22.9 kV-class fault current limiter. In addition to this project are a series of smart grid tests at Jeju Island, involving grid connection tests for a 80kV/60MVA/500m HTS DC cable and a fault current limiter for wind power transmission applications.

Dr. L. Xiao, (Chinese Academy of Sciences: SA-10) presented the projects being undertaken in China. Verification tests for a 1.3kV/10kA/360m HTS DC cable launched in October 2011, with the development of a 110kV/2~3kA/1km class HTS AC cable undertaken. Tests involving a 10kV/1.5kA/75m HTS power cable, 10kV/400V/630kVA HTS transformer, 1MJ/0.5MVA SMES and a 10kV HTS fault current limiter at 10 kV-class superconducting substation have been reported.

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Feature Articles: Superconducting Microwave/Terahertz Wave Device Technology
- Recent Trends in Superconducting Microwave/Optical Device Technology

Shigetoshi Ohshima, Professor
Graduate School of Science and Engineering, Yamagata University

The changes in the numbers of presentations given at international conferences could be a good indicator to learn of the shifting research trends in superconducting devices. Amongst recent conferences, the EUCAS-ISEC-ICMC symposium, held last September, is an appropriate place in which to determine such research trends. The symposium commemorated 100 years since the discovery of superconductivity with many presentations, including more than 300 device-related presentations. The presentation categories associated with superconducting electronics can be roughly divided as shown in Figure 1. Whilst the majority of presentations were on SQUIDs and Josephson Junctions, there were many presentations on microwave/optical devices, which can be divided into categories such as filters, terahertz waves, TES/bolometer etc as shown in Figure 1. The author now attempts to provide a summary of recent active research themes related to microwave/optical devices, as well as provide an introduction to the author's areas of interest.

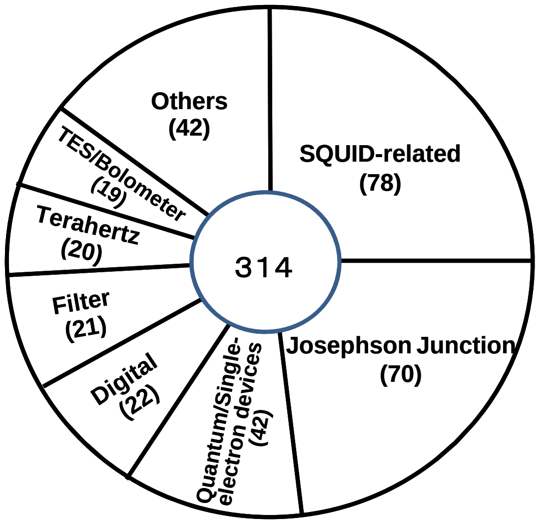

Fig.1 The number of device-related academic reports presented at EUCAS-ISEC-ICMC

1. Microwave field

Superconducting microwave bandpass filters are actively being investigated at present. Amongst these filters, the following lists three types of filters that have been at the forefront of research studies:

. Dual bandpass filter (DBPF)
. Ultra-wide band (UWB) bandpass filter
. Bandpass filter with enhanced power durability

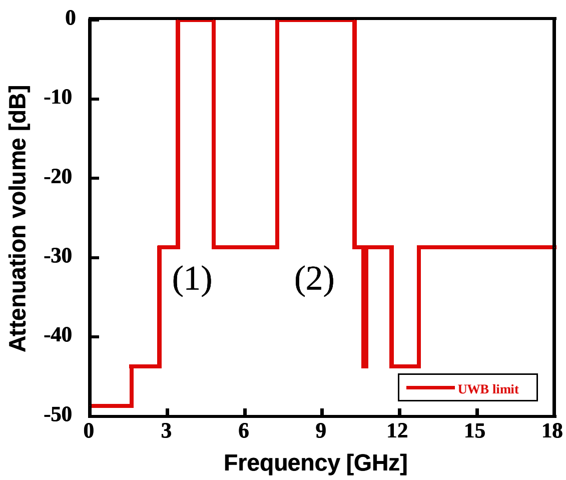

Fig. 2 Japan's frequency spectral masks for UWB communications (1) 3.4~4.8 GHZ, (2) 7.25-10.25 GHZ

Since Dr. Narabayashi provides details on a DBPF filter in a feature article in this issue, further information is not provided here. DBPF is a dual bandpass filter originally designed to solve A-B problems usually

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associated with frequency band allocation for mobile phones in USA[1]. There are however several recent reports regarding favourable characteristics of DBPF being used for other purposes. In particular, Professor Cao and his group at Tsinghua University in China[2], and Professor He and his group at the Chinese Academy of Science[3], are proposing DBPF for new applications. In Japan, Dr. Sato and his group at NTT DoCoMo are realizing DBPF using their unique resonator shape[4]. Additionally, multi-band pass filters (MBPF) with more than three bands have recently been proposed.

UWB technology is utilized for transmitting information that is spread over an extremely large frequency bandwidth, and has been developed for use in ultra-high speed communications at short distances. In Japan, two UWB frequency bands of 3.4~4.8 GHz and 7.25~10.25 GHz have been proposed by the Ministry of Public Management, Home Affairs, Posts and Telecommunications (Figure 2). Superconducting bandpass filters offer excellent advantages such as small insertion losses, an ultra-wide bandwidth (1~3 GHz) and steep rejection characteristics. Our research group[5] and researchers based at National Taiwan University[6], as well as Professor Cao and his group at Tsinghua University in China[7], all report favourable performance attributes of superconducting UWB filters.

Studies into superconducting bandpass filters with enhanced power durability can be largely divided into three methods: 1) Filters employing a peculiar resonator shape, 2) Filters using bulk resonators, 3) Hybrid filters. Further information relating to point 3 is not expanded upon here as Dr. Kayano discusses this further in a feature article in this issue. For point 1 however, the research group led by Professor Cao based at Tsinghua University in China, and our research group are currently investigating this. Our initials findings have confirmed that a thin sliced microstrip line reduced the current concentration at the outer edges, thereby improving the electric power durability[8]. Furthermore, Professor Cao and his group focused their attention to the fact that the current flowing in the individual resonators were different, and successfully improved the electric power durability by changing the width of each resonator[9]. Our group reports on enhancing electric power durability by utilizing a bulk resonator.

2. Terahertz field

Research in this field is focused on both terahertz wave oscillation and receiving devices. Japan is currently the world leader in both theoretical studies and experimental work into terahertz wave oscillation devices. It was a Japanese research group who experimentally discovered for the first time a strong terahertz wave oscillation from a mesa structure in a Bi-based Josephson Junction. Excellent research outcomes in this field have been reported by Professor Kadowaki and his research group at University of Tsukuba[10] and Dr. Wang and his group at NIMS[11]. Additionally, many investigations into highly sensitive terahertz receivers have been ongoing, with previous studies employing tunnel junctions, and recent experimental studies employing microwave kinetic inductance devices (MKIDs) gaining attention. A Terahertz wave irradiating a microwave resonator causes a shift in the resonant frequency, which MKIDs are able to detect. Since the devices are more compact the realization of future applications is highly anticipated.

3. Light/X-ray field

A Transition-Edge Sensor (TES) is the mainstream superconducting device for detecting light/X-rays. Several reports regarding this field were presented at EUCAS2011[12]. Various elaborate efforts to enhance high-energy resolution and improve the detection of high-energy particles have been attempted. For a detailed explanation of TES, please refer to the book by Dr. K. D. Irwin and Dr. G. C. Hilton[13].

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Feature Articles: Superconducting Microwave/Terahertz Wave Device Technology
- Development of a Microwave/Millmeter wave-band Noise Source using a Superconducting Tunnel Junction

Hirofumi Inoue
Institute of Astronomy, The University of Tokyo

A superconducting tunnel junction (hitherto SIS) has been employed in a radio-astronomy receiver in order to detect faint astronomical signals. This receiver is cooled to 4.2 K, well below the transition temperature of SIS junction materials such as Nb, and appears to minimize noise to the theoretical limit of quantum noise. The SIS junction is ultra-sensitive and in cases where large input signals are present, the output signal exhibits non-linear behaviour leading to saturation. Without a linear output, adjustments in strength lead to problems associated with incorrectly estimating astronomical signal strengths and imprecise astrophysical results. Thus, linear behaviour of the SIS junction is desired, which can be investigated by using a white-noise source that continuously transforms the power strength output. However, there are not many devices that output both millimetre waves and white noise. To evaluate characteristics of a potential receiver for use in radio astronomy the most common method involves a wave absorber soaked at both room and liquid nitrogen temperatures, to be used as the source of thermal noise.

A tunnel current results when a voltage is applied to the SIS-like structures where two conductors are separated by an insulator several nm thick. The tunnel current is attributed to an electrical charge that moves independently or randomly, giving rise to shot noise. By modifying the bias to the junction the shot noise can be used to control the output strength and thus potentially can be used to address saturation issues. Although shot noise tests have already been undertaken at microwave frequencies there is no evidence of shot noise at millimetre wave frequencies exceeding 100 GHz. First of all our research group have attempted the detection of shot noise in the SIS junction at 100 GHz.

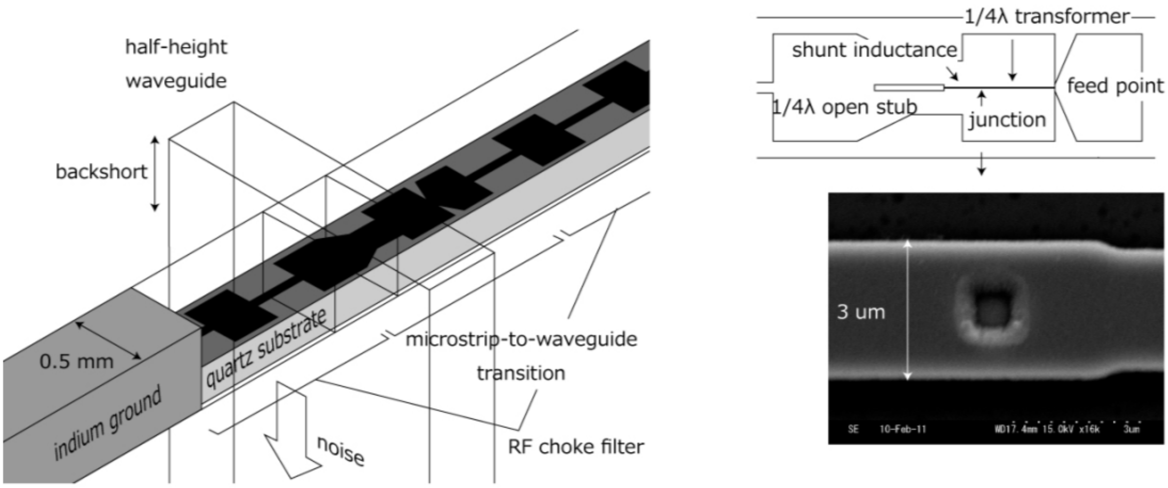

Fig. 1 The fabricated 100 GHz SIS noise source (left), Junction, Tuning circuit, Impedance converter circuit (above right), The enlarged photo of the junction (bottom right)

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The fabricated SIS noise source consists of a chip and cabinet, as shown in Figure 1. The chip comprises of a tunnel junction, matching circuit and a choke filter, which mimics the role of a bias circuit, and a microstrip-to-waveguide transition. The noise emanates from the waveguide. At such high millimetre wave frequencies the geometrical capacitance of the SIS junction itself cannot be ignored. Here the matching circuit is required in order to eliminate the junction capacity and in our studies consists of an inductance placed parallel to the junction. After optimizing the matching circuit design it was left operating at broadband frequencies, with a measured SIS noise source reflection coefficient of -20 dB at 90-110 GHz.

Figure 2 shows the world's first results from our SIS junction, able to detect the output from a SIS noise source. As expected the SIS noise source output increased monotonically with increases in bias voltage. In order to estimate the equivalent temperature output from the SIS noise source its response was compared with an existing thermal noise source. The results confirmed the ability of the SIS to detect an equivalent temperature to almost 80 % of the value forecasted theoretically.

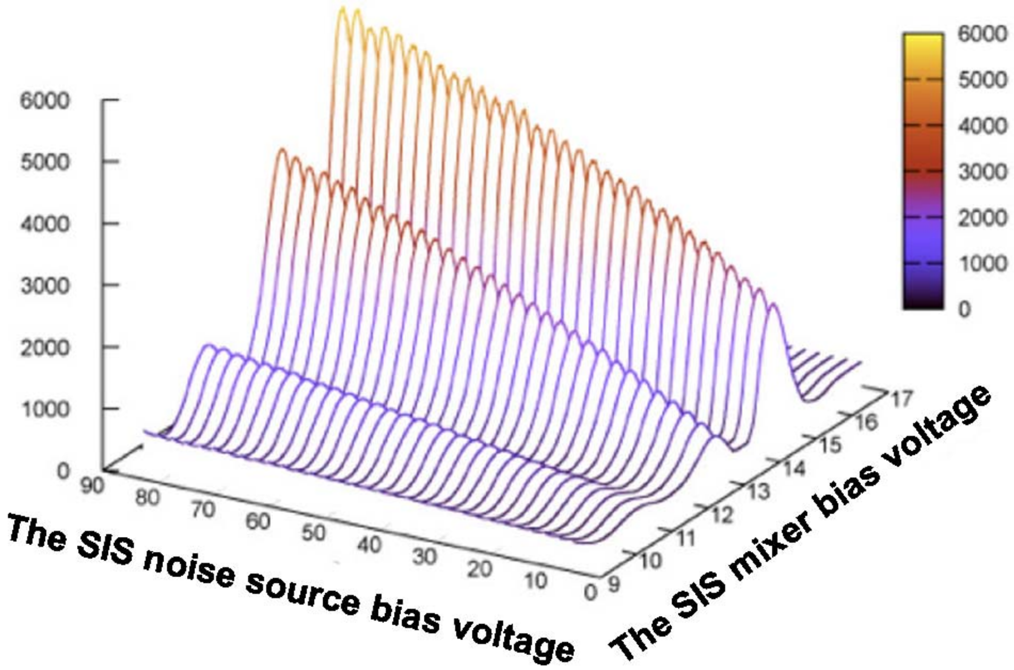

Fig. 2 Measured shot noise of the SIS junction at 100GHz. Monotonic increases with the SIS noise source bias voltage.

Employing the above-mentioned SIS noise source, our future efforts will be focused in an unprecedented research area such as directly evaluating the linear behaviour of the SIS junction, as well as planning further broadband and higher power output of SIS noise source itself.

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Feature Articles: Superconducting Microwave/Terahertz Wave Device Technology

- Narrow-band Transmission Hybrid Filter Technology for Weather Radar Applications

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Functional Materials Laboratory, Research and Development Center
Toshiba Corporation

Fig.1 Weather radar image

In recent years the use of radio-wave devices such as digital televisions, wireless LANs and mobile phones, in particular the use of smart phones has increased. Such trends have heightened the expectation for future high-speed communication networks, which are being met by both effectively using the allocated radio wave frequency bands, and by appropriately protecting the environment for radio wave use.

Attention is also focusing on employing radio wave-based control measures to guard against floods caused by localized downpours, commonly known by torrential downpours. One such measure that is gaining attention involves the installation of high-performance weather radars that are designed to observe further detailed rainfall data. However, simply incorporating greater numbers of weather radars into current systems increases the frequency bandwidth requirements. To circumvent this issue our group has focused its research and development on the design of narrow-band weather radar applications that would operate within current allocated frequency bands thereby allowing greater numbers of weather radars to be installed without compromising performance. Figure 1, shows that mutual interference arises as the allocated frequency band for individual weather radars are narrowed but can be overcome by electric power durable/narrow-band filters, which minimize such noise.

A narrow-band filter that is able to completely reduce mutual interference can only be realized with a superconducting filter. However, since the signal power passing through the transmission filter is large, a serious concern arises for superconductors, which have critical current density characteristics. In order to overcome this issue our research group has developed a transmission hybrid-superconducting filter that utilizes a 3.5 kW solid-state amplifier designed for 5 GHz-band weather radar applications[1)]. Current weather radar systems utilize either 5 GHz or 9 GHz bands. Aiming to further broaden the applicable band, we have successfully developed a transmission hybrid-superconducting filter operating at 9 GHz by employing a 100 kW Klystron amplifier[2]. By combining a cavity resonator with a superconducting resonator, a hybrid filter was able to realize greater power handling capability than conventional superconducting filters, achieving both high power handling capability of 100 kW, with narrow bandwidth characteristics of 0.08 % of the fractional bandwidth. A simple principle of operation is shown in Figure 2. A picture of the filter unit developed is shown in Figure 3. The narrow bandwidth characteristics of this filter have reduced the noise caused by mutual interference to less than 1/100. Thus, this technological development makes it possible to operate and install greater numbers of weather radars all over Japan in order to observe the earliest possible data of potential torrential downpours.

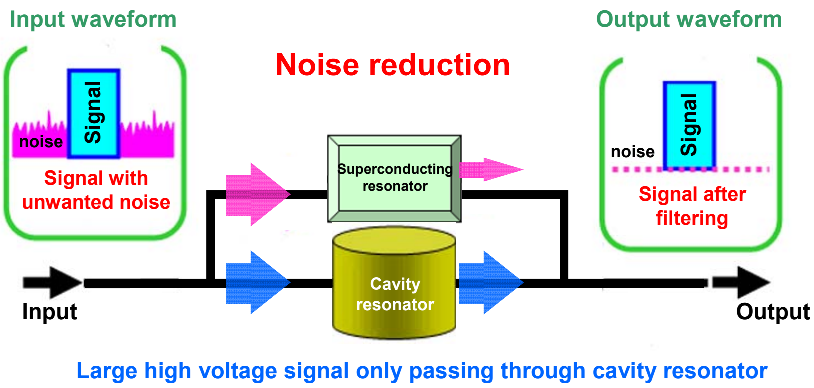

Fig. 2 The principle of operation of a hybrid transmission filter

Fig. 3 Superconducting hybrid filter unit for 9 GHz band weather radar applications

This research study is from the outcomes of "FY2009 Investigative Commission related to the Effective Frequency Utilization Technology using 5GHz or 9GHz band radar" undertaken by the Office of Ministry of Internal Affairs and Communications.

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Feature Articles: Superconducting Microwave/Terahertz Wave Device Technology
- Carrier Aggregation and Multi-band Bandpass Filters

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RF Technology Research Group, Research Laboratories
NTT DOCOMO, INC.

"Carrier Aggregation" (CA)[1)] uses several fundamental frequency blocks simultaneously, in so-called component carrier (CC) communication technology, has been gathering attention in recent years as the component technology to improve transmission speeds for next-generation mobile communication systems (Refer to Figure 1). Figure 2 provides scenarios of CA where a low-loss broadband filters and low-loss multiple bandpass filters (multi-band filters) are playing important roles for intra-band CA and non-contiguous intra-band CA, respectively.

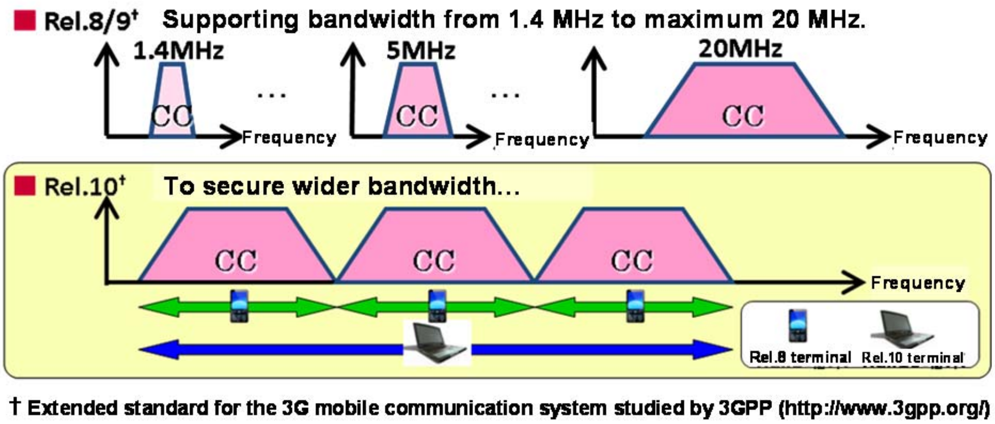

Fig. 1 Carrier Aggregation (CA)

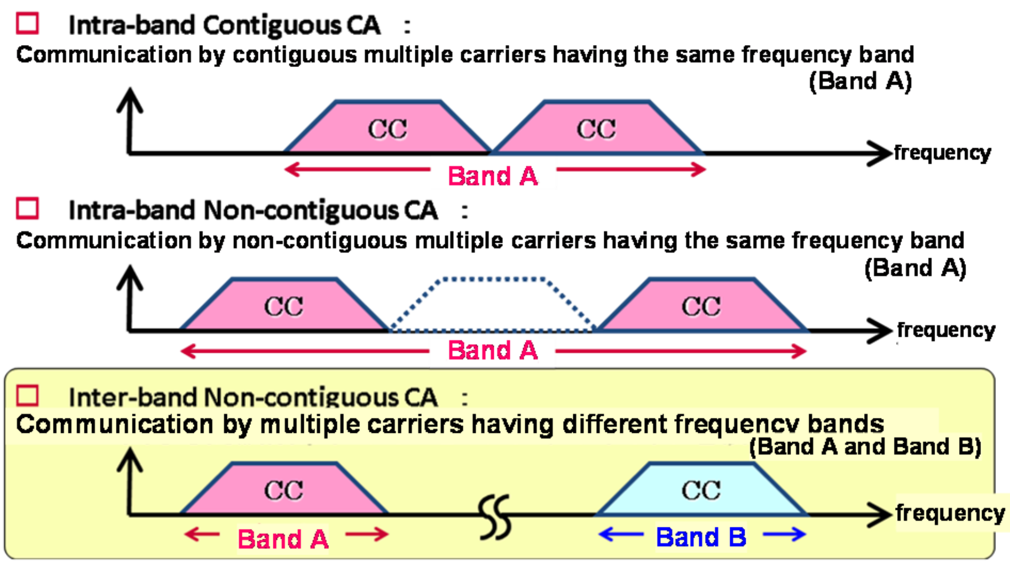

Fig. 2 Example scenarios of CA

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It is generally the case that the specification required for wireless communication systems depends on not only the communication system specification itself, but also on relationships with other system parameters, (transmitting power, frequency band detuning intervals of each system, etc). Therefore, it is desirable that multi-band filters have steep filter skirt characteristics and large stopband attenuation at the required pass bands in addition to low insertion loss. High-temperature superconducting (HTS) filters are considered to be potential candidates for such multi-band filters.

An initial research study involving a multi-band filter has been undertaken at NTT DOCOMO, advancing construction methods for a HTS dual-band bandpass filter (HTS-DBPF)[2]. Aiming for multi-staged HTS-DBPF, the coupling factor between each resonator in the HTS-DBPF can easily be adjusted at each pass band with the structure, i.e. the central conductor and the open stub of the coplanar ¼ wavelength resonator located closely to each other. The filter operates as a dual-band resonator because of the odd and even mode resonations between the central conductor and the open stub (Refer to Figure 3). Furthermore, since the areas of current concentration, which are due to the magnetic field coupling between the resonators, are different for each mode, the filter characteristics make adjustments to the coupling factors for each mode much easier (Refer to Figure 4).

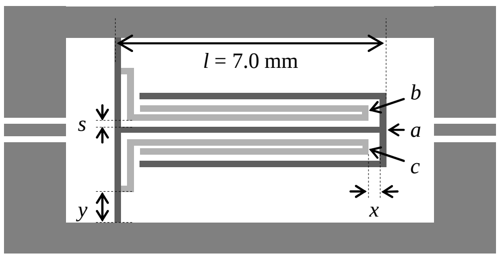

Fig. 3 A dual band resonator

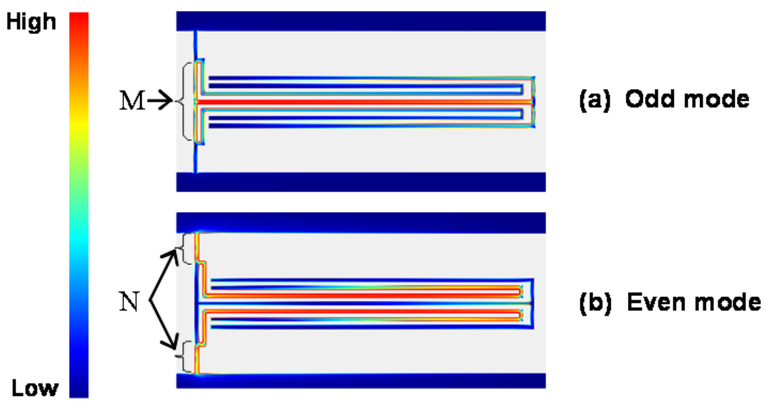

Fig. 4 Current density distributions at each mode of the dual band resonator

A Chebyshev type 4-pole 2.0/3.5 GHz band HTS-DBPF has been fabricated in order to confirm the effectiveness of this filter construction. The frequency characteristics of this filter are shown in Figure 5. This filter has two bandpass regions, each having different fractional bandwidths but almost equivalent characteristics to conventional single-band bandpass filters.

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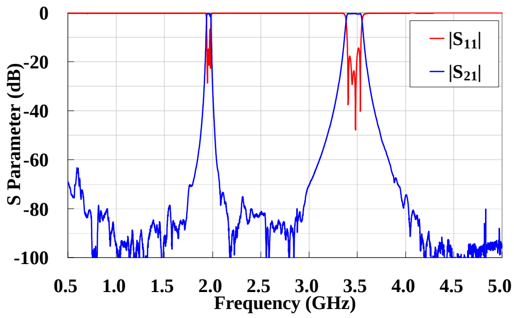
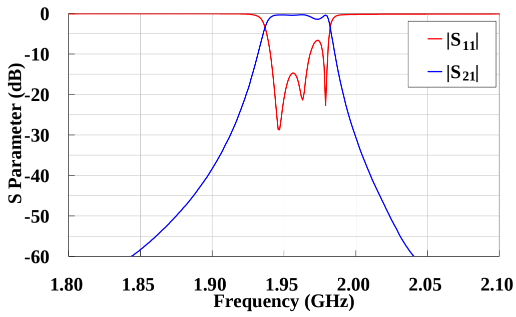
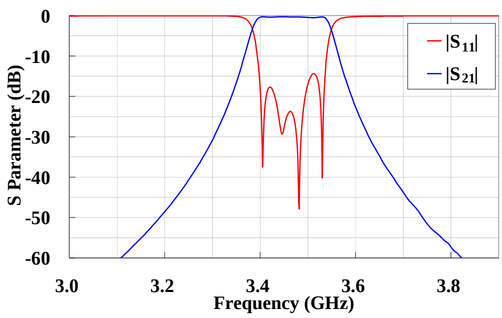


(a) 2.0/3.5 GHz Band



(b) 3.5 GHz Band



(c) 2.0 GHz Band

Fig. 5 Frequency characteristics of a Chebyshev type 4-pole 2.0/3.5 GHz band HTS-DBPF

Current investigations include the progression towards enhancing the high-Q for each resonating mode, extending the input and output coupling design freedom and the fabrication of a multi-band filter having more than three bandpass regions.

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Feature Articles: Superconducting Microwave/Terahertz Wave Device Technology
- High Speed Quantum Distribution System using SSPD

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Nano ICT Laboratory, Advanced ICT Research Institute
National Institute of Information and Communications Technology

The reassurance of a safe communication network is an important attribute in a society where networks are developing rapidly. This is where the distribution of a quantum key has gained attention, which theoretically enables the sharing of random numbers between two parties, whatever the technology, without an eavesdropping threat. The technology allows secure information exchange between two parties by performing an exclusive OR operation on every bit of information. Up until now, with installed optical fibre, quantum key distribution systems developed by the US Department of Defence and the European Union have limited voice encryption capabilities and restricted transmission distances of up to 10km. In Japan, since 2001, under a cooperative project involving academia, industry and the Government, the National Institute of Information and Communications Technology (NICT) has undertook a research and development programme for the world's fastest quantum key distribution technology that would possibly allow for entire encryption of a TV conference in a metropolitan area. A single photon detector is the key device behind influencing quantum key distribution performance. An InGaAs-based avalanche photodiode (APD) used conventionally in gated Geiger-mode, was previously employed as a single photon detector at fibre communication wavelengths. However, employing a superconducting single photon detector (SSPD) for quantum key distribution tests reveals superior performance characteristics such as low jitter, low noise and greater high-speed operation compared to a conventional InGaAs APDs. This article introduces the Tokyo Quantum Key Distribution (QKD) network, which started test operations in October 2010, and a SSPD system utilized for this developed quantum key distribution.

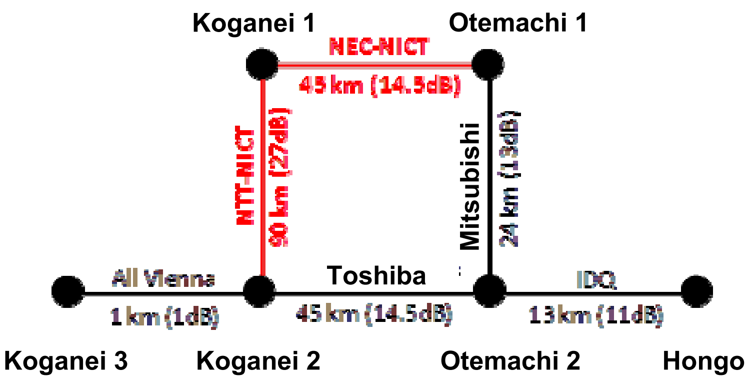

Fig. 1 The Tokyo QKD network layout

Tokyo QKD network makes use of JGN2plus, which represents an open test bed network that provides a platform for NICT R&D activities. It connects four operation centres of the JGN2plus based in Otemachi, Koganei, Hakusan, and Hongo. The network layout of the Tokyo QKD Network is shown in Figure 1[1]. The systems for each research group involved (NEC, Mitsubishi, NTT, Toshiba, IDQ, All Vienna) are located opposite each other and grouped together with six nodes. Amongst those, the NTT-NICT and NEC-NICT nodes housed the SSPD system for evaluation studies. The NTT-NICT node employed a differential phase shift quantum key distribution (DPS-QKD) system developed by NTT, with 15 kbps of shift-keying data rate successfully transmitted between the links (transmission loss 27-28 dB) over a total distance of 90 km[2]. The DPS-QKD required two SSPDs. At the NEC-NICT node, a QKD system utilizing a multiplexed decoy pulse method, BB84 protocol, has been employed, successfully creating cryptograph keys that exceed 200 kbps over a 45 km distance[3]. Here, three wavelengths are multiplexed using an avalanche photodiode for λ_1 and SSPDs (8 in total) for λ_2 and λ_3 during testing. A live demonstration of the Tokyo QKD network was presented at the "Updating Quantum Cryptography and Communications 2010" conference held on 18th-20th October 2010, where a quantum key distribution videoconference between Koganei and Otemachi, in Tokyo, took place (Figure 2). Full details of the performance and images can be found on the website[4].

Fig. 2 Video-conferencing at the "Updating Quantum Cryptography and Communications 2010" conference.

An outline view of the SSPD system used at the Tokyo QKD network is shown in Figure 3. A mechanical driven-type GM cryocooler operating at AC100V enables continuous system operation without requiring additional liquid refrigerant or an additional high voltage supply. Furthermore, it is possible to install a maximum of six superconducting single photon detectors (SSPD) into a single refrigeration unit, allowing quantum key distribution using multiple SSPDs. Each SSPD element is equipped with an optical cavity structure that effectively absorbs incident photons in the 1550nm wavelength band. A packaging technology to realize effective coupling between the SSPD elements and incident photons was developed. With this technology, the results were successful and showed maximum enhanced detection efficiencies of around 30%, leading to the rapid progress in the detection efficiency of the SSPD system[5]. Even though the SSPD system is in the middle of development, future systems performance improvements will benefit not only quantum key distribution systems, but also the development of various other research fields including quantum optics and bio-medical imaging.

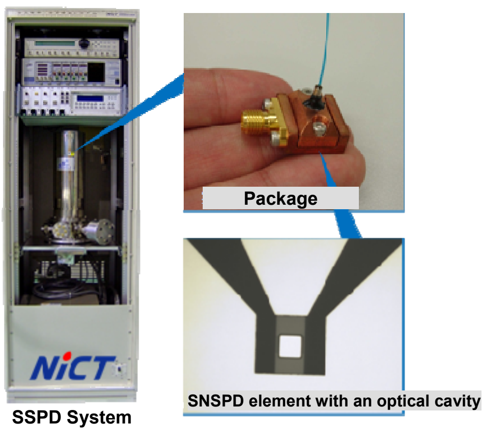

Fig. 3 Photo of the SSPD System

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Feature Articles: Superconducting Microwave/Terahertz Wave Device Technology

- The Progress of Terahertz Imaging Technology

Chiko Otani, Team leader
Terahertz Sensing and Imaging Team, Terahertz-wave Research Group,
Extreme Photonics Department, RIKEN Advanced Science Institute

Terahertz (THz) waves span 0.1-10 THz (wavelength 3 mm-30 μm) of the electromagnetic region, lying between infrared light and radio waves with both characteristics. THz waves can transmit through many soft materials. They range at the shortest end in the wavelength region with such a transmission characteristics, and the spatial resolution in imaging can reach down to a sub-mm order. From these benefits, various non-destructive inspections inside industrial products have been proposed[1)-5)]. In particular, due to the heightened terrorism activities and security breaches in recent years, the safe and secure body scanners have been extensively developed (Figure 1) [6)]. Furthermore, it is possible by THz waves to identify the crystalline materials within a package by utilizing their characteristic spectral absorption features (fingerprint spectra).[7,8)] Moreover, wireless communication technologies reaching several 10 Gbps over short distances have been achieved [9)-11)].

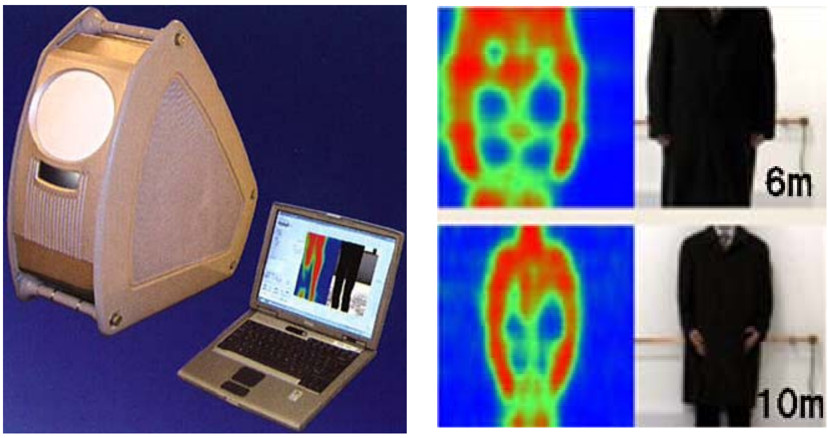

Fig. 1 ThruVision's T4000 THz Imaging System. A THz image and a visible image [6)], (A concealed purse, mobile phone, and four bags of drugs hidden under a coat).

Until now, the most of THz imaging systems has reproduced THz images by scanning the samples or the detectors. Recently, NEC Cooperation has commercialized a room-temperature THz camera by using a bolometer type two-dimensional THz sensor array. It is developed by modifying the 10 μm-band infrared camera (Figure 2) [12)]. This type of camera has been developed worldwide with the strong demand, and the demand is still expected to be stronger in the near future. Furthermore, Advantest Laboratories Ltd. has recently released a 3D-THz tomographic imaging system, and thus the 3D imaging also entered the arena of the commertcialization[13)]. As one of the other THz imaging applications, Dr. Fukunaga and her colleagues at National Institute of Information and Communications Technology (NICT) has extensively promoted non-destructive inspection of cultural heritages[14)]. It is worth noting that THz imaging technology is currently utilized at famous museums and historical temples or shrines such as Louvre Museum and

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Kiyomizu Temple. Another example of THz imaging was demonstrated by Dr. Song at the University of Seoul and his colleagues. They had demonstrated a cancer imaging of mice with THz waves and IR light by utilizing the concentration of gold nanoparticles in cancer cells[15].

Fig. 2 The NEC bolometer-type THz Camera[12].

In superconducting detector fields, the progress of imaging technology is also accelerating in the space science. Microwave kinetic inductance detectors (MKIDs) are growing importance in astronomical observations as a new type of extremely sensitive detectors. In operation as a detector, the resonant spectral features in microwave range in GHz frequency change by the absorption of millimetre waves (MMW) or THz waves. Therefore, when one designs a series of devices with different resonant frequencies, the change in each element can be read by one microwave transmission line, realizing the simultaneous readouts of 100-1,000 pixels[16]. Thus, MKIDs enable large-scale arrays with a small number of readout lines and the cryogenic detectors with one million pixels will be certainly realized within several years. This trend has also provided a sense of urgency to the groups currently developing superconducting transition-edge sensors (TES) with 1,000 pixel-class elements. Thus, it is expected that the development of a parallel readout technology of TES will also be accelerated. Because an MKID can operate as a detector by patterning transmission lines on a superconducting film, the fabrication process is amazingly easy and it is a great advantage in the rapid development. In Japan, the research and development of MKIDs was started in 2008 at KEK, Okayama University and National Astronomical Observatory of Japan, and now RIKEN, Saitama University and Yamagata University have joined the development, too. Thus, it is worth noting to watch for the development and applications of MKIDs in the near future (Figure 3).

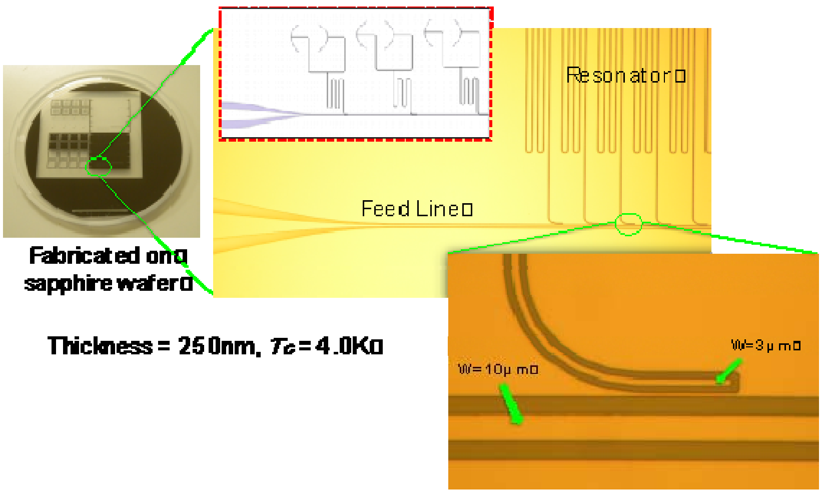

Fig. 3 Fabricated MKIDs utilizing TiN thin films[17]

Focusing the possibile applications of superconducting devices in industry, the demand of sensitive THz imaging have been remarkably heightened as expanding THz applications and cryogenic detectors can play an role in the fields because the sensitivity of room temperature systems is limited. At the current moment, the sensitivity of detectors for space has reached down to NEP<10^{-19}W/√Hz(@0.1K). However, because one requires only NEP~10^{-14}W/√Hz for the detectors for the ground use due to 300 K blackbody radiation, it will beome important to develop compact, convenient and cheap systems that operate at the temperature realized by a mechanical refrigerator.

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Feature Articles: Superconducting Microwave/Terahertz Wave Device Technology
- Mass Production of the Band-10 SIS Receiver for the Atacama Large Millimeter/submillimeter Array (ALMA)

Yoshinori Uzawa
Advanced Technology Center
National Astronomical Observatory of Japan

Fig. 1 ALMA telescope under construction. Photograph courtesy of the Joint ALMA Observatory.

Currently, construction of the Atacama Large Millimeter/submillimeter Array (ALMA) telescope located in the Atacama desert, 5000m above sea level in Chile, South America, is progressing at a high pace in a joint project involving East Asia, North America and Europe (Figure 1). The "Early Science observations (Cycle 0)" was launched at the end of September last year and will be the very first scientific observation for the ALMA telescope. Utilizing 16 units of high-precision parabolic antennas measuring 12m in diameter, it is already producing remarkable results[1]. The plan for ALMA is to be composed of 66-unit antennas for full operation, each antenna collecting and composing astronomical radio wave images using an aperture synthesis method. This is truly a state-of-art ground-based radio-astronomical telescope, with superior sensitivity to more than 1 order of magnitude in both resolution and granularity compared to the performance of existing telescopes. This telescope is expected to solve important issues in astrophysics, astronomy and planetary science, e.g. how stars and planetary systems are born, the formation of stars and galaxies in the early universe, understanding active galactic nuclei, and how the universe formed the materials that led to life.

ALMA is a ground-based radio telescope designed to observe all possible astronomical signals through atmospheric windows in the millimeter and submillimeter wavelengths. The current plan is to observe the frequency range between 31.5 GHz to 950 GHz which is divided into 10 frequency bands, and utilize an ultra sensitive heterodyne receiver to detect and capture astronomical signals from each frequency band as "waves", which can then be converted and amplified to an intermediate frequency (IF) microwave band, whilst maintaining the phase information. Band-10 covers the 787-950 GHz frequency, the highest frequency band of ALMA, and the most difficult obstacle in receiver technology. With the cooperation of National Institute for Information and Communications Technology, a SIS mixer composed of niobium-titanium nitride, with a gap frequency of more than 1 THz has been successfully developed[2] and recently tested, with the results confirming the performance sensitivity be world-leading[3]. However, even with this level of performance it barely meets ALMA specifications (less than 5 times quantum noise), which are required for astronomy. Apart from this specification, there are additional specifications required for mechanical strength as well as many electrical specifications such as incident optical characteristics, polarization characteristics, oscillation and phase stabilities, and gain characteristics. These specifications are required because the structure has to endure the mechanical overload associated with the transport of the receiver and the installation of the antenna. A total of 73 units of such high level receivers (66 units for antenna installation and 7 units spare) need to be supplied to the ALMA project.

Through the establishment of performance verification procedures at the terahertz frequencies, mechanical structural analysis and vibration tests etc., several receivers satisfying the ALMA specifications have been completed, finally reaching the stage for mass production. Figure 2 shows a photograph of 6 units of Band-10 receivers produced thus far. Amongst those, one unit has already passed preliminary performance tests for shipment and has been sent to the integration centre located in North America, last December. The integration centre will equip the unit with a cryostat and then will undergo various performance verification trials. If successful, the Band-10 receiver unit will be then sent to Chile to see the first light. This will form an important milestone, but we cannot rest on our laurels as yet. In order to achieve our international responsibility to get full operation of the ALMA telescope two years from now, we plan to make steady progress towards mass production. Victory or defeat all depends on our efforts from now.

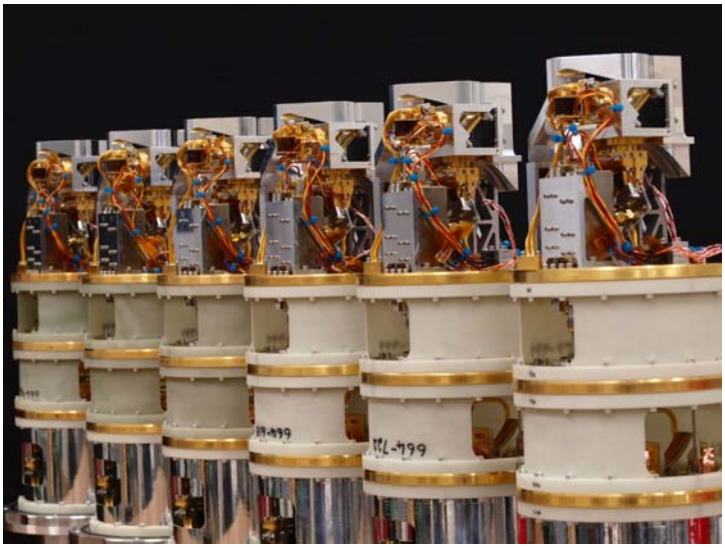

Fig. 2 6 units of ALMA Band-10 receivers fabricated thus far. The plan is to fabricate 73 units in total.

The advancements in this research and development have been possible by not only the ALMA group of National Astronomical Observatory of Japan, but also through the efforts of cooperation and support from Japanese and overseas researchers, the National Institute of Information and Communications Technology,

Osaka Prefecture University, Purple Mountain Observatory and etc. The author would like to take this occasion to thank those researchers involved.

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Standardization Activities

Topics in December 2011

- Reporting on the "Thomas A. Edison Award"

Ken-ichi Sato, Fellow
Sumitomo Electric Industries, Ltd.

The "Thomas A. Edison Award"
Commemorative Medal

I was the recipient of the "Thomas A. Edison Award" at the Standardization Management Board (SMB) of the IEC held in Melbourne, Australia on 24th October. The SMB Chair, J. E. Matthews (IEC Vice President) gave the reasoning behind the award, and presented me with a letter of commendation along with a commemorative medal. I made my award speech for about a minute.

This year marks my 23rd year of service with the IEC and looking back over my history, when back in 1988, I was posted as an international secretary to the special WG directly reporting to the IEC board. Then in 1989 the TC90 was established at the IEC General meeting held in Brighton, and since then I have been working as an international secretary of TC90. I would like to take this occasion to thank the support of the Ministry of Economy, Trade and Industry, the Japan IEC/TC90 Committee and ISTEC.

The Thomas A. Edison Award recognizes exceptional achievement, dedicated service and significant contributions to the IEC through the effective management of each of their committees. The first such award was held at the IEC General meeting in Seattle in 2010.

This year 11 representatives were nominated for this award. With 15 SMB members' votes, and with at least 9 members support votes required in order to fulfil the award criteria, a maximum of 7 nominees could stand. On this occasion the voting finally selected 4 nominees.

IEC standardization activities in the superconductivity field have reached a development period towards further enhancing test methods for materials characteristics, as well as encompassing components and products. I appreciate your continued cooperation under the established collaboration relationship with IEC/TC20 and also with CIGRE.

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Standardization Activities

Topics in December 2011
- A Report on the "9th Panel Discussion on the International Standardization of Superconductivity Technology"

Teruo Matsushita, Professor Emeritus
Faculty of Computer Science and Systems Engineering
Kyushu Institute of Technology

During the 24th International Symposium on Superconductivity in 2011, the 9th Panel Discussion on the International Standardization of Superconductivity Technology was held in room number 303 at Funabori Tower Hall (same venue as the symposium), from 7pm on the 25th October (Tue). Although the symposium poster sessions were taking place during this time, there were still a total 37 participants who attended the panel discussion from six countries, Japan, USA, China, Korea, Germany and Spain.

The author opened the discussion by summarizing the previous 8th panel discussion. Following this the Chair of the committee, Osamura (Research Institute of Applied Sciences) reported on a draft of the General and Guidance of "Practical Superconducting wires", which was the most pending issue discussed by the Working Group 13 of TC90, on Superconductivity of International Electro-technical Commission (IEC) during the last panel discussion. In particular, details reflecting the Working Group discussions held in USA in July 2011, for the necessity of having a breakdown structure such as "Categorization" and "Methods for testing properties", were explained. This year, under the "Categorization" structure, essential discussions on the content labelling of products at the time of shipping, as well as items under "Methods for testing properties" were discussed. The Chair, Osamura, also requested the participation of experts in order to achieve greater fruitful discussions in the future. Masuda (Sumitomo Electric Industries, Ltd.), reported on the current status of the Working Group B1.31, CIGRE, which discusses superconducting power cables as well as the current position of Working Group D1.38, CIGRE, which involves superconducting power equipments. Following this a discussion took place, raising quires as to why superconducting DC cables were excluded as testing subjects, and why temperature-increase cable load tests were excluded whilst voltage tests were included.

After that superconducting power equipment applications from around the world were introduced. Dr. Selvamanickam (University of Houston, USA) reported on the current status of wire production in USA. His report showed that the volume of wire shipments have been increasing rapidly, and presently research has advanced in the wires' artificial pinning centres in order to improve wire characteristics. Professor Noe (Karlsruhe Institute of Technology, Germany) reported on the activity of Working Group D1.38, CIGRE, where he himself is the Chair, and introduced his group's intense focus on fault current limiters. Dr. Xiao (Chinese Academy of Sciences) reported on YBCO-coated conductors, recently developed by Shanghai Jiao Tong University, as well as the present development status of existing Bi-based tapes and wires as well as metal-based superconducting wires for practical use. Research activities for new MgB_2 wires and wiring processes utilizing iron based superconductors were introduced as well. Dr. Park (Changwon National University, Korea) reported on the development up to now of a national project involving superconducting power equipments, clarifying the target values required for each superconducting power equipment developed for future national projects to be undertaken at Jeju Island, Korea. A general discussion followed after the above-mentioned current status of each country, highlighting the fact that fault current limiters are highly expected to be the next potential candidates for standardization, and although the Working Group D1.38, CIGRE discusses this, there are currently no discussions held at IEC/TC90 to reflect this. From this point of view, the questions then were, whether IEC/TC90 group is suited to discuss the standardization of the fault current limiter. However, if its operation pertains to superconductivity, then the IEC/TC90 would attend to this issue. Therefore, regarding this matter, the meeting recognized the necessity to urgently seek a collaborative relationship between IEC/TC90 and CIGRE.

Lastly, the Chair of ad-hoc4 group, Okubo (National Institute of Advanced Industrial Science and Technology), introduced the current status of superconducting sensors worldwide and reported on future activities. He also pointed out that there were cases where integration was difficult because of the various types of terminologies used.

Due to the numbers of reports and discussion items the panel discussion closed at 21:10, just after the planned closing time.

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