Superconductivity Web21

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Progress and Prospect of Development of Superconductivity Application Technology

The research and development of the high temperature superconductivity has shown a considerable progress in these several years in 15 years after the discovery thereof, and the prospect to the practical use is promising. The reasons therefor include that the Project on "Research and Development on Basic Technologies required for Superconductivity Applications" which was established in 1998 as the successor of the "Research and development of superconducting materials and devices" by Agency of Industrial Science and Technology of the Ministry of Trade and Industry which continued from 1988 to 1997 has clarified the target of the development of the applications, and promoted the development in an integrated manner with the industry. Similar tendency was present in the trend of the development in USA and EU. Briefly will be described below four issues, i.e., (1) superconducting bulk, (2) next generation wires, (3) superconducting devices, and (4) basics for superconductivity applications which were developed in the Project with stress thereon.

(1) Development of superconducting bulk

YBCO has been mainly used for the bulk material. The materials with Nd, Sm, Gd, etc. substituted for Y together with the mixed crystal thereof have been studied, and the trapped magnetic field as large as 3T was obtained at 77K in GdBCO which is three times as large as that of YBCO. What is featured in this development is that the mechanical strength has been considerably increased by performing the vacuum impregnation of the epoxy resin in the superconducting bulk, and the strength exceeding 100 MPa has been obtained. When a strong magnetic field is trapped, the strong internal stress is generated by the repulsive force between the magnetic flux, and the superconducting bulk reinforced by the resin impregnation can successfully trap a magnetic field as high as 15 T at 30K even in the case of YBCO. In addition, this resin impregnation plays a role of preventing the degradation generated when the superconducting bulk is preserved at room temperature.

As described above, the superconducting bulk has already reached the stage of the practical use. The flywheel power storage system and the highly efficient magnetic separation system have been actually developed, while the latter is applied to the water purification system, and a further development using this superconducting bulk can be expected.

(2) Development of next-generation wires

The next generation wire with YBCO as the superconductor can be expected to demonstrate the performance higher than the first generation Bi-based wires, and it is expected to be developed as soon as possible. This wire has a three-layer structure comprising the metal substrate, the intermediate oxide layer and the superconducting layer, there are many possible possibilities of each material and the combination thereof, and various kinds of challenges are made by many institutes.

The performance expected for the next generation wire is the critical current of at least 100A at 77K and at least 50A at 64K and 5T for the case of the thickness of 0.1 mm and the width of 1.0 cm. This means that the critical current density of the superconducting layer is at least 10^6 A/cm^2. In addition, the manufacturing speed is preferably at least 5 m/hour taking into consideration the price in future.

The wire is supposed to have the unit length of several hundreds meters, and the difficulty in the process for realizing the superconducting wire may lead to the loss of the value as the wire if it has even one defect somewhere. Thus, the stability and the automatic controllability of the manufacturing process must also be considered.

A wire of the length of 10 m has been trial-manufactured of the sample with GZO vapor-deposited as the intermediate layer by the so-called IBAD (Ion Beam Assisted Deposition) method on the substrate made of hastelloy of nickel alloy, and further with YBCO thereon by the PLD method, and the critical current density of the superconducting layer is about 5 x 10^5 A/cm^2 at 77K. The IBAD method is extremely excellent as the manufacturing method of the intermediate layer, and the intermediate layer of 60 m has already been made on the trial basis, and it is expected that the next generation wire of 50 m class will soon appear.

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In recent years, attention has been attracted to the TFA-MOD method for the superconducting layer. This is the system in which the trifluoro acetate salt of Y, Ba and Cu as the raw solution is applied to the intermediate layer, and the YBCO layer is grown by an appropriate heat treatment, and it can be manufactured with a simple apparatus, and its critical current density demonstrates a value as high as 10^6 A/cm^2 at 77K. If it is put in the practical use, it will be expected to contribute much to the cost reduction.

In the prospect of the results of the recent research in the world, the development of the next generation wire is also globally full-scaled, and it is expected that the full-scale wire will appear in several years.

(3) Development of superconducting device

Recently, attention has been attracted to the Single Flux Quantum Device : SFQ as the superconducting electronic device. This device utilizes the quantized magnetic flux held by small SQUID device, and is characterized by the operation speed as high as 1 pico-second (100 times higher than that of the semiconductor device) and the power consumption as low as 1 nano-watt (1/100 of that of the semiconductor device), and it is expected that the possibility as the super-high operation device will be realized if successfully integrated.

Integration of 10,000 devices is already possible with the device using Nb which is the low temperature superconductor, and integration of at least 100,000 devices will be possible depending on the future development. Though the possibility as the super-high speed operation device is high, it must be used at 4K, and its application seems to be limited to some applications to larger equipment.

On the other hand, the SFQ device using YBCO can be used even at 30K, and the application to the equipment for measurement and communication can be expected. However, there occurs a problem of the homogeneity of the Josephson junction constituting the SQUID. Fortunately, the interface modified ramp edge junction was developed in the beginning of the Project, and the variance of the critical current flowing in the junctions is not greater than 7% with 100 junctions on the trial basis, and the trial manufacture of the high-speed circuit using 10 to 20 junctions has been successfully realized. If the variance reaches not greater than 8% with 1,000 junctions, it is expected that the integrated circuit with 100 junctions (for example, the digital sampler) will appear.

(4) Basic research for superconductivity application

Though the basic research on the physical properties of the high temperature superconductors has considerably been developed except the trunk of the research, i.e., the superconductivity pairing mechanism, there are still many problems left unsolved from the viewpoint of application. For example, the influence of the impurities on the flux pinning effect is very important in the aspect of application in determining the critical current. In addition, it is also important to correctly understand the influence of the grain boundary on the superconducting current. It is an important research to manufacture pure single crystals and to examine the physical properties thereof in understanding the limit of the performance, and it is necessary to continue the fundamental research from the viewpoint on the long-term basis.

In conclusion, the prospect of the applications of the high temperature superconductivity will be rapidly developed in a few years ahead, and it can be concluded that the development of the basic technology on the applications is now in the most important period.

(Shoji Tanaka, Director General, SRL/ISTEC)

Progress Report of Superconducting bulk

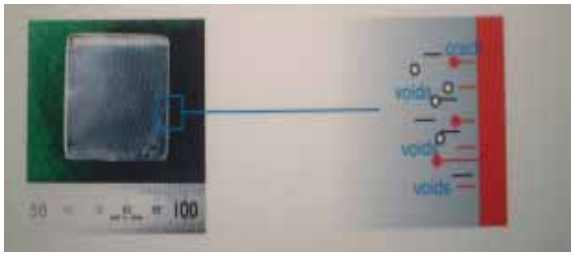
Problems of the material development of the superconducting bulk are aggregated into three items, i.e., (1) how to produce the material of the large trapped magnetic field, (2) how to increase the size, and (3) how to improve the mechanical properties of the material in recent years.

The intensity of the trapped magnetic field is proportional to the critical current density and the size of the material. The value of the critical current as high as 100,000 A/cm^2 at 77K, 2T(H//c axis) was successfully obtained by mixing several kinds of rare earth elements such as Nd, Sm, Eu and Gd. In future, the manufacture of the large superconducting bulk will be challenged using this system.

The trapped magnetic field of 3.3 T which is the world record at 77K was achieved with the Gd123 system. It is found that the trapped magnetic field up to 15T can be achieved if the temperature is dropped to 30K even with the Y123 system. It is also confirmed that this material is a new functional material.

Since the characteristics of the superconducting bulk are thus improved, and a large electromagnetic force is applied to the superconducting bulk in their applications, their mechanical characteristics become very important. The mechanical strength has already exceeded 100 MPa with the method of impregnating the epoxy resin. In addition, this method has an advantage in that the corrosion resistance is largely improved by the resin.

Since the characteristics of the superconducting bulk are considerably improved, the development of the applications has been spurred. Recent topics include a magnetic separator for water purification which was jointly developed with Hitachi, Ltd. A maintenance-free magnetic separator can be manufactured, which recovers pollution particles adhered to the filter by utilizing the large magnetic gradient of the bulk superconducting magnet.



Superconducting bulk (Epoxy resin impregnated reinforced bulk)

Development has been made on the application of the resin-impregnated Y123 superconducting bulk to the current lead of the superconducting magnet mounted on the superconducting magnetically levitated train, and since it is proved that the characteristics thereof sufficiently satisfy the required specification, the full-scale experiment is thus challenged. As described above, the material development and the application of the superconducting bulk have been advanced at the same time, and practical products are already put on the market.

(Masato Murakami, Director, Div.I & Div. III, SRL/ISTEC)

Progress Report on Development of Superconducting Wires

1. Introduction

In recent years, the development of wires using the $REBa_2Cu_3O_{7-x}$ (RE123: RE=Y, Sm, Nd, •c) superconductor has been advanced in the world, in which the improvement of the critical current density (J_c) characteristic at the liquid nitrogen temperature range (77K) is expected. In the RE123 wire, it is necessary to align the crystalline axes of the superconducting grains in the three-dimensional manner to maintain the high J_c. In addition, for the practical use, there are several issues of the increase in length of the wire, the improvement of the manufacturing speed, and the improvement of the current density (J_e) per total sectional area of the wire. In Japan, the wire technology has been developed by SRL, wire manufacturers, heavy electric machine manufacturers, and electric power companies as part of the Project on Research and Development on Basic Technologies required for Superconductivity Applications. In this Project (April 1999 to March 2003), the wire manufacturing technology has been developed on roughly three kinds of wires, i.e., the substrate textured type wire, the aligned buffer layer type wire, and the rapid-growth superconducting layer type wire aiming at the values shown in Table 1. Main results in each technology will be introduced below as the progress report of the Project.

Type of development	Length (m)	Substrate thickness (μm)	J_c (A/cm^2)	Thickness of superconducting layer (μm)	Manufac-turing speed (m/h)
Substrate orientation control type	10～100	≦100	10^5～10^6		10
Intermediate layer orientation control type	100～1000	≦100	10^4～10^5		1
Superconducting layer rapid synthesis type	1～10	≦100	10^5～10^6	≧5μm	1

Table 1 Development Target in each Type of Next Generation Wires

2. Advancement

The development group of the textured substrate type wire has developed the technology in which the metal substrate is textured by the strong working and the heat treatment. In the development of the high-strength Ni-based oriented tape mainly by The Furukawa Electric Co., Ltd., the long tape using the clad with SUS or Ni-Cr alloy as a core for high strength and low/non-magnetization was successfully developed, and the tape of 30 m long subjected to SOE (Surface Oxidation Epitaxy) is manufactured, and J_c of about 10^5 A/cm^2 is obtained with the short sample with the MgO buffer layer and the Y123 layer deposited thereon. Also in the Ag-based tape developed mainly by Toshiba Corp., the Ag-Cu alloy clad tape as long as 100 m long of high strength with the Ni-based alloy as a core was successfully developed, and J_c exceeding 1.2 x 10^5 A/cm^2 is obtained using the wire of 1 m long was obtained with the Y123 layer deposited directly thereon.

The development group of the aligned buffer layer type wire has developed the process for obtaining the superconducting phase by orientating the intermediate layer on a non-oriented high-strength metal substrate, and extracted problems, in particular, in the increase in the wire length. By the method using the ISD (Inclined Substrate Deposition) method mainly developed by Sumitomo Electric Industries, Ltd. and The Tokyo Electric Power Co., Ltd., the stable deposition for a long time and at high speed has been obtained by the introduction of the high-power industrial laser. As a result, the deposition speed of the buffer layer can be doubled compared with the conventional value while maintaining the orientation of the same degree as the conventional value, and J_c exceeding 1.2 x 10^5 A/cm^2 is obtained using Y123 deposited thereon. In addition, the deposition rate of the superconducting layer has also been increased, and demonstration of the film deposition of the long wire at high speed is expected by introducing a new film deposition chamber for increasing the wire length. On the other hand, Fujikura Ltd. and Chubu Electric Power Co., Inc. have developed the wire by the IBAD (Ion Beam Assisted Deposition) method. This group has succeeded in the high orientation and the high-speed film deposition by combining the large IBAD system with the $Gd_2Zr_2O_7$ intermediate layer. As a result, the highly oriented intermediate layer of the FWHM $\Delta\phi$ =10.7° showing the index of the crystalline orientation with the wire length of 10 m was realized, and the high characteristic of J_c = 1.2 MA/cm^2 (I_c=140A) was obtained with the wire length of 8 cm, and J_c = 0.42 MA/cm^2 (I_c = 50A) was obtained with the 10 m long wire using the intermediate layer of $\Delta\phi$ =18° . In addition, the intermediate layer as long as 60 m is now deposited.

The development group of the rapid-growth superconducting layer type wire aims at the development of the high-speed synthesis process of the superconducting thick film for developing the high J_e wire. The MOD (Metal Organic Deposition) method with TFA (trifluoro acetate) salt as a raw material which has been developed by Showa Electric Wire & Cable Co., Ltd. and SRL, is a non-vacuum process, and attracts considerable attention because J_c exceeding 1 MA/cm^2 can be obtained in a relatively easy manner. It has been pointed out that the increase in the film thickness with maintaining the high J_c is difficult. A method of increasing the film thickness while maintaining the high characteristic by the multi-depositioning application of the

solution has been developed to obtain J_c of 1.6 MA/cm^2 using the Y123 film of about 1 mm in thickness on the CeO_2/YSZ(IBAD) hastelloy substrate though it is short. The increase in length using a long calcination furnace will be expected in future. The LPE (Liquid Phase Epitaxy) method developed mainly by SRL has been positioned as the high J_e process since the film deposition speed is high and the high J_c can be maintained. However, the suppression of the reaction with the metal substrate raise a serious problem. The film deposition on the metal substrate has been successful by the decrease in the film deposition temperature and the development of the reaction-suppressive intermediate layer structure, and J_c exceeding 1 MA/cm^2 is obtained with Y123 deposited on the IBAD substrate by the low temperature LPE method. Higher characteristics will be expected by the continuous film deposition.

3. Conclusion

The progress report of the coated conductor development project is outlined above, and each method has been steadily and successfully developed toward the achievement of the target. However, similar development projects have been advanced in USA and Europe, taking on an aspect of the development competition between Japan, USA and Europe. At the present, Japan takes a slight lead. However, in USA, the development has been energetically advanced mainly by the national institutes, and we must not be negligent. It is expected in this phase that the technology for increasing the wire length of 100 m class is established as soon as possible to appeal the potential of the coated conductor, and the high J_c and the high-speed film deposition process by the integrated process aiming at the practical use is developed. This work is supported by the New Energy and Industrial Technology Development Organization (NEDO) as the Collaborative Research and Development of Fundamental Technologies for superconductivity applications.

(Yuichi Nakamura, Div. IV and Yuh Shiohara, Director, Div. IV, SRL/ISTEC)

Progress Report of Research of High-temperature Superconducting Mechanism

Regarding the studies of the interlayer conduction mechanism and the pseudogap phenomenon among the anomalous normal state properties challenged aiming at the elucidation of the high temperature superconductivity mechanism, the unified understanding has been advanced as the nature specific to the materials with the strong electron correlation and the two-dimensional electronic state. On the other hand, however, there appeared a possibility that these anomalous phenomena are unrelated to the superconductivity pairing. Though the experimental data has been accumulated on the stripe-like order and the non-uniformity of the charge distribution, it is not sufficient yet. Though these have been regarded as the phenomena specific to only a part of the high temperature superconductors in the beginning, there is a possibility that these are the nature common to the high temperature superconductors, and the pairing accordingly. It is proved that most of the pairing breaking phenomena can be understood by taking into consideration the d-wave symmetry of the superconductivity and the short superconducting coherence length.

There leaves much to be done for elucidating the superconducting mechanism itself. However, a finding is obtained, in that the composition area of the low carrier dope indicating the “anomalous normal state” is very unstable in the electronic state, and must be avoided in the practical applications without question. Combined with the characteristic of the d-wave superconductor that the superconductivity is also easily degraded even by the non-magnetic impurities and the lattice defects this finding indicates how strictly we should control the composition of the high temperature superconductor which is required in the stage of the practical applications. In that sense, these findings contributed much to the improvement of the superconducting characteristic.

The problems to be solved in the remaining Project period include further pursuing the problems of the stripe order and the charge inhomogeneity, and the establishment of the unified picture is aimed through the experiments on the measurements of the optical spectra, the magnetization, the tunnel spectra, and the neutron scattering. The electronic state of the materials having many copper-oxygen planes in a unit cell will be studied in detail by the photo-emission spectroscopy and the Raman scattering spectroscopy, and the causes for the high superconductivity transition temperature of these materials will be searched.

On the other hand, regarding the material search, on a basis of the classification of the homologous series new superconductors were successfully developed by using the high pressure synthesis method while the superconductivity transition temperature was not considerably raised. It can be concluded that the material search of the copper oxide high temperature superconductor has been substantially completed. The characteristics of the existing high temperature superconductors can further be improved. It is proved that the high purity of the material and the precise control of the doping concentration contribute much more to the improvement of the characteristics than expected, and a guideline of developing the high performance materials is obtained.

In addition, the non-copper materials were also studied, and several novel non-copper superconductors which seem to have different superconductivity mechanisms from that of the copper oxides could be synthesized while no superconductors of a higher or possibly higher transition temperature than those of the copper oxides has ever been found. For the organic materials, the parameters important for the superconductivity could be grasped to some extent, and a way for the superconductivity by a new method could be found.

The characteristics will be further improved by the element substitution in future, and the details of the guideline of the development the materials with the high critical field and the high critical current will be established.

(Setsuko Tajima, Director, Div. II, SRL/ISTEC)

Progress Report on Research and Development of Superconducting Device

The Project on Research and Development of Fundamental Technologies for Superconductivity Applications, aims at the establishment of the basic technologies of the high temperature superconducting digital integrated circuit using the SFQ (Single Flux Quantum) device which is expected for the applications to the future information processing network equipment of super-high speed and lower power consumption type and the super-high speed measurement system. The magnetic flux penetrating the loop formed of the superconductor becomes the integer multiple of the magnetic flux quantum (f^3_0=2.07 x 10^{-5} Wb) which is the minimum unit of the magnetic flux, and only one magnetic flux quantum is stably present if the size of the loop is about several micron. The SFQ device and circuit transmit this magnetic flux quantum to a large number of superconducting loops connected to each other one after another to implement the logical and storage operation, and the control of the feed/supply of the magnetic flux quantum to/from the superconducting loop is implemented by the Josephson junction corresponding to the semiconductor transistor. Though the SFQ device and circuit have been developed mainly by using the low temperature superconductor Nb with which the integrated circuit process technology has been advanced advantages such as much increase in the speed of the device and the expansion of the range of applications with the use of the cryocooler can be expected by employing high temperature superconductors. On the other hand, the most serious technical problem is the development of the manufacturing technology of the integrated circuit including a large number of Josephson junctions. The target of this Project is to develop the technology for designing and evaluating the SFQ integrated circuit which is a common problem to the low-temperature circuit in addition to the integrated circuit manufacturing technology, and to demonstrate the operation of the small scale circuit of the high temperature superconducting SFQ at the high speed and with the small power consumption.

Fig. 1 shows the summary of the basic technologies and the problems for development in order to realize the high temperature superconducting SFQ integrated circuit. The most important items include the epitaxial technology of the superconducting thin film/insulating thin film including at least three layers of superconducting layers and the manufacturing technology of the Josephson junction with the small spread in the characteristics such as the critical current value I_c. In addition thereto, however, it is necessary to establish the manufacturing technology of the devices such as the superconducting contact, the superconducting wiring crossover, and the resistor. The lowest superconducting layer is referred to as the ground plane, and plays important functions of reducing the inductance of the superconducting loop by the magnetic shielding effect, and enabling the holding and transfer of the single flux quantum. This ground plane is requested to satisfy the conditions such as the excellent flatness, crystallinity and superconducting characteristic. In particular, SRL has developed the RE-123 liquid phase epitaxy (LPE) thick film which is the pseudo single crystalline film more excellent than the thin film by the vapor phase method and the development of the technology for depositing a thin film thereon. Recently, a (Y, Yb)-123 large-area LPE film having the diameter of 50 mm was successfully grown. In addition, the thin film lamination technology for forming the Josephson junction on the LPE film or the thin film by the vapor phase method via the insulation layer formed of CeO_2, Sr_2AlTaO_6(SAT), $(La, Sr)_2AlTaO_6$(LSAT), etc. which are low in permittivity and excellent in the lattice matching with the RE-123 material is substantially established, and the technology for forming the circuits such as the superconducting contact and the resistor is also developed.

The target of the Josephson junction manufacturing technology to the final fiscal year of the Project is the value of 8% for the standard deviation σ of I_c to 1,000 junctions on the ground plane. The key for determining the junction properties is the technology for forming the non-superconducting barrier of the thickness of several nm. In the Project, the development has been focused not on the

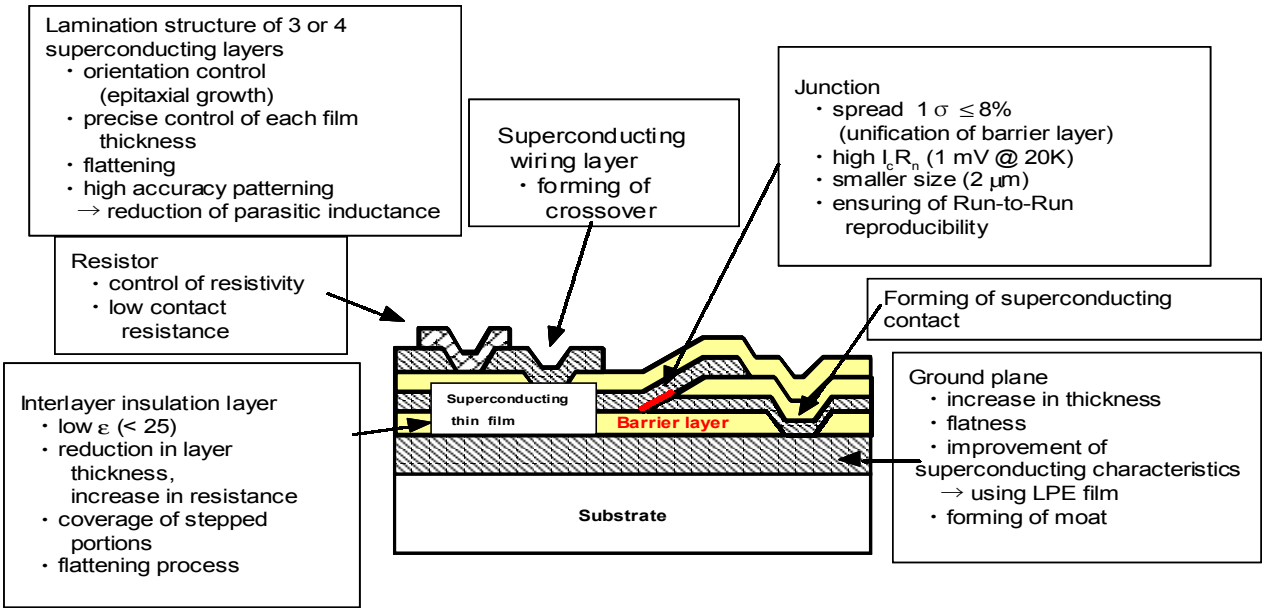


Fig. 1 Basic technology and problems for development for realizing the high temperature superconducting SFQ integrated circuit

conventional method for depositing the non-superconducting thin film, but a method in which a thin amorphous layer is once formed on the surface of the lower superconducting layer by ion irradiation, and crystallized during depositing the upper superconducting film, a so-called ramp edge junction method having the interface modified barrier. NEC group has first reported the small spread in the characteristics using this kind of junctions. However, similar junctions with high quality can be obtained now by a plurality of companies including Hitachi, Toshiba and SRL participating in the Project. The composition, structure and formation mechanism of the interface modified barrier are elucidated, and the causes for the spread in the characteristics are clarified, and the value of 7.9% is obtained for 100 junctions on the ground plane, or the value between 5 and 7% is obtained without any grand plane for the top data of the standard deviation σ of Ic, and the achievement of the target is almost near at hand. In addition, the technology of applying the material such as Yb-123 which can be deposited at the lower substrate temperature without any influence on the lower layer as the upper superconducting thin film is also developed.

The SFQ circuit design has been developed in order to establish the design technology of the medium-scale circuit including thousands of junctions. The AD converter which seems necessary for the next generation mobile communication base station, and is capable of converting the radio signal different in the frequency or the system into the digital signal at a high speed over the extensive band was selected as the specific circuit target, the designed circuit was manufactured on the trial basis by the Nb process of NEC so as to demonstrate the design technology in their policy. It is demonstrated that the front end circuit for converting the analog radio signal into the high-speed digital signal is operated in a substantially theoretical manner, and the digital filter including about 500 junctions (the logical circuit for processing the signal to connect the high-speed digital signal to the semi conductor processor) is successfully operated. Future problems include the expansion of the scale of the digital filter from 2,000 junctions to 3,000 junctions, and achievement of the high bit accuracy by improving the front end circuit.

The trial manufacture of the high temperature superconducting SFQ circuit has been advanced using the developed junction technology. Fig. 2 shows a photo of the front end circuit of the AD converter recently developed by Hitachi. It is confirmed that this circuit including eleven interface modified barrier ramp edge junctions is operated at the clock frequency of 100 GHz at 20K. The trial manufacture of the small scale basic circuits such as the ring oscillator, the interface circuit, and the sampler circuit used for observing the high-speed signal waveform is advanced, and the demonstration of the high-speed operation of the circuit including about 100 junctions and the low power consumption has been planned.
(Keiichi Tanabe, Director, Div. VI, SRL/ISTEC)

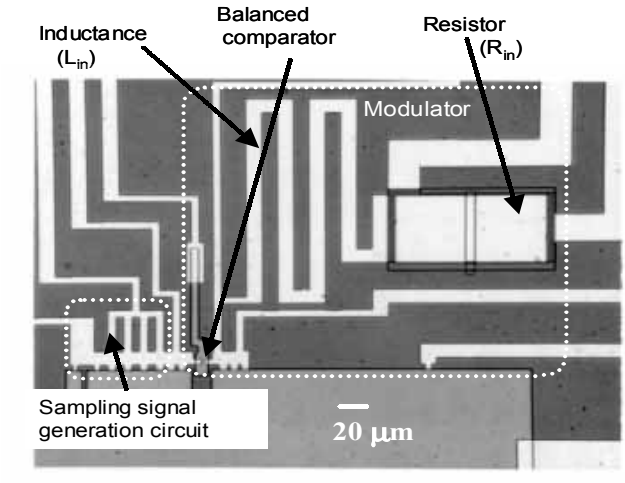


Fig. 2 High temperature superconducting AD converter front end circuit

Target of Super-ACE (Research and Development on Basic Technologies required for AC Superconducting Power Equipment)

Kiyotaka Ueda, Managing Director and General Manager of Department of Technology, Superconductive Generation Equipment and Materials (Super-GM)

Fifteen years have passed since the Bi and Y high temperature superconductor materials were discovered in the second half of 1980, and a part of these materials have been put into practical use, and served for the research and development of the power appliances such as the cable, the fault current limiter (FCL), the transformer and the rotating machine. Compared with the power applications of the low temperature superconductor using NbTi from 1970, the high temperature superconductor power appliances such as the cable, the FCL, transformer and motor been extensively researched and developed in many countries, resulting in the great results.

The Bureau of Industry, Technology and Environment of the Ministry of Economy, Trade and Industry established the five-year Project “Research and Development on Basic Technologies required for AC Superconducting Power Equipment (Super-ACE)” Project from 2000. The Superconducting Generation Equipment and Materials (Super-GM) was entrusted this Project from NEDO, and started the research and development aiming at the early introduction of the AC superconducting technology to the field of the power transmission and transformation.

In this Project, the low loss and the reduction in size and weight of the AC transmission and transformation equipment will be performed through the superconductivity, realizing the energy saving which is difficult with the present system. The core of the Project is the development of the superconducting cable (SC-cable), the S/N transition type FCL (SC-FCL) and the AC superconducting magnet (SC-magnet).

The SC-cable can easily increase the power transmission capacity by utilizing the existing piping system to cope with the future information-oriented system and the rapid increase in the local power demand in urban areas by the environmental countermeasures. It also simplifies the multi voltage classes of 500/275/154/66 kV in the power system in the suburbs of cities into two classes of 500/66 kV, omitting many transforming stations. The FCL suppresses the fault current, and the present circuit breakers need not be replaced even when a large number of independent power sources are introduced, and the fault current in the power transmission cable is increased. In addition, the maximum value of the transient current during a failure can be reduced. This leads to reduction of the lifetime damages

of the existing machines to prolong the service life of the equipment, and mitigates the overload design condition of the new machines to reduce the manufacturing cost thereof. The SC-magnet realizes the large-current and low-voltage type transformer and the reactor type SC-FCL necessary for the two-voltage class.

The superconductor capable of conducting the alternating current of several kA using the wire of high current density of tens of thousand A/cm^2 and the highly efficient cooling technology for maintaining the superconductivity state are required for putting these AC power equipment in practical use. In particular, it is important to suppress the cooling loss to a minimum by reducing the AC loss generated in the superconductor by the AC energization and the heat invasion from the outside.

Regarding the cooling system with liquid nitrogen, the present Stirling engine system and the GM system have been improved, and a new magnetic cooling and the pulse tube cooling are studied. In the present situation, the cooling power of 20-30W is required for maintaining the liquid nitrogen temperature of 77K for the loss heat of 1 W in the superconducting space, which is the cooling loss. For the energy-saving effect, it is necessary and essential to develop the heat insulation structure of small heat invasion and the superconductor of small AC loss.

Super-GM aims at the solution of these problems in research by racking the brains of the industrial, governmental and academic brains, putting the AC superconducting power equipment taking the initiative in the world, and establishing the new energy industry. We hope this AC superconducting project will be the source of the vitality of young engineers and sweep away the future anxiety of Japan as the engineering nation.

Latest Developments of Superconducting Power Cables

Yoshihiro Wachi, AC Equipment Engineering Department, Engineering Research Association for Superconductive Generation Equipment and Materials (Super-GM)

In the "Leading Fundamental Research and Development of AC Superconducting Power Apparatuses" (chaired by Professor Masada of Science University of Tokyo), it is predicated that the superconducting power equipments will be put into practical use around 2015. To cope with this prediction, the plan for the development of cables, fault current limiters and magnets for AC power applications which are competitive with the present equipments or add the values thereto was started in 2000 FY at the New Energy and Industrial Technology Development Organization (NEDO). Super-GM consigned this research and development from NEDO, and started the five-year research (to 2004 FY) with four themes including the analysis of the power system and test method of superconducting power apparatuses.

Many countries including USA, Europe and Japan have energetically performed the development of the superconducting power apparatuses using the high temperature superconductors under the support of the national budget and the power industries. Table 1 shows the representative researches. In particular, regarding the cable development, the Southwire Company have been starting the service of the power supply in their plant using a single Bi cable of 30 m long as part of the US SPI Project, and succeeded in the continuous test (1.25kA/12.5kV) already exceeding 8,000 hours. In Japan, the long-term current/voltage test (1kA/66kV) during one year has been doing using a Bi cable of 100 m long having the magnetic

Target			
	Phase 1: Execution of the research and development on basic technologies required for the power equipment introduced in the actual system (from 2000 FY to 2004 FY)		
	・Development of the conductor of 3 kA class under 1W/m AC loss for cable ・Development of the cooling technology of the long cable of 500 m class	・Development of the superconducting thin film and SC-FCL (size : 30 mm x 100 mm, Critical current density : at least 1 million A/cm^2) ・Development of high voltage FCL (6.6kV class) ・Development of large current FCL (1 kA class)	・Development of the technology of the SC-magnet for transformer Voltage : 66 kV, Current : 800A ・Development of the technology of the SC-magnet for FCL Voltage : 66 kV, Current : 500A
	Execution of equipment development supposing the system introduction based on the evaluation of Phase 1		
	Development of the cable of 500 m class Maximum conduction capacity : 5-10 kA, 3-core integrated type	Development of the current limiter of 6.6 kV/2 kA class	Development of the transformer of 66 kV/30 MVA class Development of the reactor of 66 kV/3 kA

Table 1 Target of the plan of Super-ACE

shield with three core that is the first challenge in the world through the joint research of Tokyo Electric Power Co., Sumitomo Electric Industries, Ltd. and Central Research Institute of Electric Power Industry. Thanks to the recent discovery of a new superconductor (MgB_2), the research for the practical use using the high temperature superconductor has been spurred.

Main part in the cable development in "Research and development of fundamental technologies for superconducting AC power equipments" is to establish a cable cooling technology with the single unit length of exceeding 500 m in order to utilize the existing under ground piping system as it is. Many basic characteristics including the initial cooling, the heat removal, mechanical properties during the cooling (such as the thermal contraction) and the flow characteristics have been collecting in this study. And challenges have been made to the countermeasures for various problems in the installation (introduction into the pipes, the difference in level and the terminal connection, etc.), and the development of the cooling system as the important points.

	Country	Company	Main specification
Power Cable	Japan	Tokyo Electric Power Co., And Sumitomo Electric Industries, Ltd.	100m 66kV 1kA (3-phase collective)
	USA	Detroit Edison	120m 24kV 2.4kA (3-phase,1,000MVA)
		EPRI/Pirelli	50m 115kV 2kA (insulated at normal temperature)
		Southwire Co.	30m 12.5kV 1.25kA (3-phase, 27 MVA)
	Germany	Siemens AG	100m 110kV (3-phase,400 MVA)
	Italy	Pirelli Interna	100m 110kV 2kA
	France	EdF/Pirelli	50m 90kV 2.6kA
	Denmark	NKT Research	30m 36kV 2kA (3-phase)
Fault current limiter	Japan	Super-GM	100A 400V
	USA	General Atomic	1.2kA 12.5kV (18MVA)
	UK	EA Technology	400A 11kV
	Germany	Siemens AG	135A 765kV
	Switzerland	ABB Research	70A 10.5kV
	Israel	Bengrion Univ.	50A 1kV
Transfor -mer	Japan	Kyushu Univ./ Fuji Electric Co., Ltd.	1MVA 22/6.9kV 45/145A
	USA	WES	1MVA 13.8/6.9kV 72.5/145A
	Switzerland and USA	ABB/DOE	630kVA 1.87/0.42kV 12/866A

Table 1 Representative studies on AC superconductive power applications

Reference ;
Kiyotaka Ueda, "Status and prospect of superconducting power applications" ENERGY 2000-11

Topical Development of Superconducting Transformer and Superconducting Current Limiter

Kazuo Funaki, Professor, Research Institute of Superconductivity, Kyushu University

Advantages of the superconducting transformer are expected, including the high efficiency, compact and lightweight structure, non-combustibility, addition of current-limiting function, cost reduction of the life cycle by making use of the low loss of the superconducting winding and the excellent cooling and electric insulating characteristic by liquid nitrogen. Since long BSCCO tapes with high current density wire have been produced, the research and development aiming at the timely practical use has been challenged in Japan, Europe and USA, taking into consideration the replacement of the present system and the system setup with other superconducting facilities. The group of ABB Research in Switzerland developed the 3-phase 630 kA transformer (18.72 kV/420V) using the Bi-2223 tape, and carried out the field test for one year (1997-1998) after the transformer unit test (AC withstand voltage, impulse voltage, short-circuit test, etc.).

The group of Kyushu University developed the single phase 1 MVA transformer (22 kV/36.9 kV, 1999) with the capacity of the short-circuit excess current (5 times the rating, 2 seconds) and the resistance against the lightning impulse (100kV in peak), and carried out the field test with the cooling system by the subcooled liquid nitrogen using the refrigerator. (The photo shows the 1 MVA HTS transformer under the field test by Kyushu Electric Power Co., Inc.).

The 1 MVA transformer using the Bi-2212 tape has been developed in the SPI Program. In each case, the research and development has been planned targeting the application to the transformer for the power distribution of tens of MVA class.

The current limiter has the function of suppressing the excess current induced when a short circuit accident occurs in the power system, reduces the rated capacity of the circuit breakers of the system, and the effect of improving the reliability of the power supply such as the system configuration and the flexible operation is expected. Various kinds of test apparatuses have been developed in Japan and overseas, including the magnetic shield type with the superconducting cylinder disposed as the secondary coil via an iron core, the rectifier type with the rectifying coil and the DC power source built in the diode bridge circuit, and

the SN transition resistance type utilizing the high resistance during the normal conducting transition. The field tests have been already carried out on the magnetic shield type (Bi-2212 bulk cylinder, 10.5 kV/70 A, 1996) by ABB Research in Switzerland, the rectifier type (2.4 kV/80 A, 1995) by SPI Program in USA, etc. As for the SN transition resistance type, the current-limiting element using the YBCO thin film has been developed by Siemens AG in Germany. In Japan, the basic technological development project (such as Super-GM) for realizing the SN transition resistance type using the YBCO thin film current-limiting element and the rectifier type current limiter using the BSCCO large pulse coil has been advanced through the development of the SN transition resistance type (6.6 kV/2 kA, 1993) utilizing the metal-based superconductor wire by The Tokyo Electric Power Co., Ltd. and Toshiba Corp. and the rectifier type of the Bi-2212 thick film cylinder (6.6 kV/400 A, 1996) by Electric Power Research Institute.

Outline of Technical Development of SMES (Superconducting Magnetic Energy Storage) System

SMES (Superconducting Magnetic Energy Storage) is a system capable of storing the electric energy as the magnetic energy by allowing the current to continuously flow in the superconducting coil making use of the absence of the electric resistance in the superconductivity, and supplying/storing its energy rapidly.

In this SMES, the storage efficiency is 80 to 90% which is higher than that of a conventional energy storage system, the energy can be supplied/stored at a very high speed of below 20 msec. which has never been experienced, and the SMES is characteristic in that the active power and the reactive power can be controlled independently. When the SMES with such an excellent function is once introduced in the power system, the high performance can be demonstrated in not only the energy storage but also the stabilization of the power system and the maintenance of the power quality, and an extensive effect can be expected in sophistication of the system control. In addition, the improvement in the efficiency of the energy utilization will contribute much to the global environmental countermeasures, and the results of the technical development obtained in the present project will greatly affect other superconductivity applied technology with much expectation.

The project is targeted on the SMES for controlling the power system on the small scale with the practical applications expected following the previous phase of the development of the basic technology necessary for realizing the 100 kWh superconducting Magnetic Energy Storage (SMES) pilot plant, and aims at the development of the basic technology aiming at the low cost for the practical applications and the possibility of realizing the high temperature superconducting SMES, taking into consideration the competitiveness in the cost with other technologies which are already employed or recently developed in the power system.

Establishment of the economy has been confirmed, and the design of the optimum conductor-coil system intended for the practical application of the metal-based SMES is now in the progress, and the establishment of the cost-reduced basic technology is clearly prospected in this project.

In the future prospect, it is expected that the technology as the practical superconducting power appliance will be established through the development of the pilot system aiming at the verification of the entire system including the peripheral appliances necessary for the practical applications of the SMES system such as AC-DC converter and the cooling system, taking into consideration the result of the development of the cost-reducing technology for the SMES for controlling the power system in the project. It is also expected that the technology of the high temperature SMES will be further developed for the practical application through the development of the basic technology.

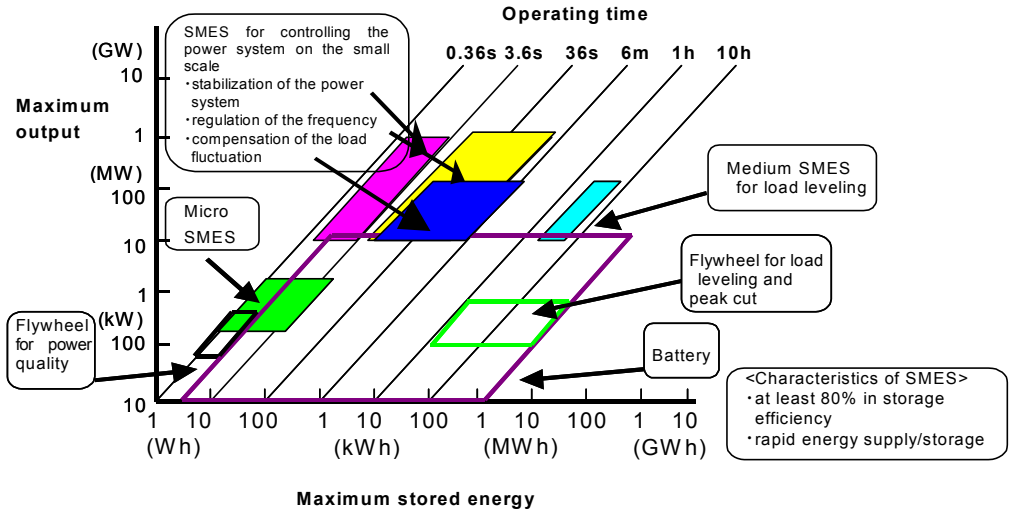
This project is commissioned by the New Energy and Industrial Technology Development Organization (NEDO), and performed by the International Superconducting Technology Center (ISTEC) in the plan from 1999 to 2003.

(Yoshinori Tatsuta, Managing Director, ISTEC)

Prospect for Practical Applications of SMES

Satoshi Morozumi, Senior Staff Researcher
Energy Technology Research Dept.
Mitsubishi Research Institute, Inc.

SMES (Superconducting Magnetic Energy Storage) is a superconductivity applied product which appeared on the market actually as a commodity of the micro SMES around the same time with a filter for magnetic separation and cellular phone station next to MRI. The chance of the micro SMES appearing on the market is not unrelated to the IT-orientation in recent years. In an early stage, Europe and America has paid attention to the technology of avoiding the influences such as generation of troubles in manufacturing the semi conductor and stops of computers caused by the abnormal voltage phenomena in a very short time within one second which is referred to the voltage sag. Damages attributable to the voltage sag has been told to reach several trillion yen annually in USA, and estimated to reach several tens to hundreds of billion yen annually in Japan though they are not publicly disclosed. It is told among customers in the semiconductor industry sensible to the power quality that the economy can be sufficiently established



even at the present cost of the micro SMES.

Establishment of the economy of the SMES for controlling the power system such as the stabilization of the system and the frequency control has been prospected through the study in the first half of the second phase of the national project. In addition, in Japan after 2010 in which the increase in the natural (regenerative) energy power generation and nuclear power generation difficult in output change will be expected, the needs for the SMES of large capacity such as the frequency control and the load shift seem to be gradually increased. Improvement of the power transmission capacity of 100 MW class has made a big benefit together with the development for the liberalization in the overseas system in the Northwest part of the U.S.A. and Canada with problems of stabilization mainly on the hydroelectric power generation system, and the SMES can be introduced in these systems earlier than expected.

Present Status of Low Temperature Superconductor Technology for SMES

Katsuya Tsutsumi*[1], Shigeo Nagaya*[2]
Group Leader of Power Storage Technology, Research Laboratory Kyushu Electric Power Co., Inc. *[1]
Team Leader of Superconductivity and New Material, Power Group Institute of Power Technology, Chubu Electric Power Co., Inc.*[2]

In the second-phase Superconducting Magnetic Energy Storage (SMES) System Technology Development Project started in 1999 FY, the basic technology development for reducing the cost mainly comprising the superconducting coil much accounting for the system cost and its peripheral equipment has been challenged aiming at the practical use of the SMES system for the power system stabilization, the load fluctuation compensation, and the frequency regulation.

When designing the superconductor and the coil for SMES, for the power system stabilization the high rate of change in the current is rather requested compared with the reduction of the AC loss because the output power is high, and the high withstand voltage and the high frequency of the coil are requested. For the load fluctuation compensation and the frequency regulation, the large storage capacity, and the size reduction of the coil and the reduction in the AC loss are requested because of the continuous pulse operation.

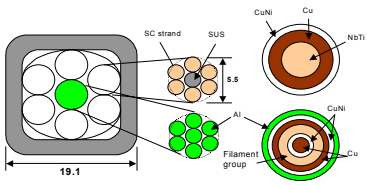
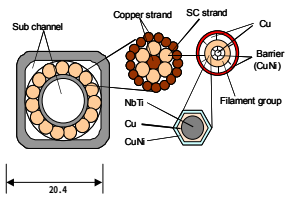
On the other hand, in order to reduce the manufacturing cost of the conductor and the coil, it is required to reduce the amount of the superconductor and the stabilizer, to reduce the manufacturing man hour by simplifying the structure and improving the fabricability, and to reduce the material cost by using inexpensive materials, and it is also important to reduce the operational cost by suppressing the cooling power as much as possible.

In the Project, four kinds of systems capable of expecting the cost reduction were set for the applications taking into consideration the possibility of satisfying the performances requested for the conductor and the coil and of reducing various factors relating to the cost, and the detailed design, the trial calculation and analysis were executed.

In addition, in order to verify the manufacturing ability and the design performance of the conductor based on the results of the detailed design, a short conductor of about 1 m length was manufactured on the trial basis, and the critical current, the stability and the AC loss were evaluated. The results so far obtained confirm the validity of the technology in which the NbTi forced cooling CIC conductor for the stabilized copper isolation which is on the top level in the world in the reduction of the AC loss has been developed, the CIC conductor having the high stability has been developed by covering the aluminum stabilizer on the superconducting strand of about 1 mm diameter, and the capacity is increased by increasing the energy density using the Nb_3Sn strand, reducing the size of the coil, and connecting a plurality of coils to each other in parallel.

The table below shows the optimum conductor system in reducing the cost selected based on the conductor performance evaluation test and the results of the trial calculation of the system cost.

The result of the trial calculation of the cost of the selected conductor is 3.3 yen/Am (5.66 T) for the power system stabilization, 2.3 yen/Am (4.8 T) for the load fluctuation compensation and the frequency regulation, and the cost can be reduced to about 1/5 in comparison with the estimated cost of 14 yen/Am (5.6 T) of the conductor developed in the first-phase SMES Basic Technology Development project.

Applications		for power system stabilization	for load fluctuation compensation and frequency regulation
Conductor system		 Surface-oxide aluminum stabilization NbTi forced cooling CIC conductor	 External stabilized isolated copper NbTi forced cooling CIC conductor
Particulars of conductor	Rated current	9.6kA	9.65kA
	Critical current	28.9kA（at 5.66T，4.5K）	>10.1kA（at 6.4T，4.5K）
	Al:Cu + CuNi :NbTi ratio	4.4 : 2 : 1	2.08 : 1.12 : 1
	Stabilization margin	380kJ／m^3	1,860kJ／m^3
	AC loss	30,090mJ／m	151mJ／m

(Note) The above values on the critical current, the stabilization margin and the AC loss show the results of measurement with the short conductors.

Detailed parameters of selected superconductors

Present Status of High Temperature Superconductor Technology for SMES

Shirabe Akita
Senior Research Scientist,Director
Electrical Physics Department,Komae Research Laboratory
Central Research Institute of Electric Power Industry

The SMES technology development has been advanced using the low temperature superconductor formed of the metal superconductor. This is because only two or three years have passed since the large current conductor of the high temperature superconductor is realized for SMES though the large current capacity conductor of at least 1 kA class is essential in order to input/output the energy at the coil terminal voltage up to several to tens of kV in which the electric insulation is not difficult.

In the Superconducting Magnetic Energy Storage System Technology Development Project started at ISTEC in 1999 FY, the examination of the technology for the HTS SMES has been started in addition to the research and development for reducing the cost of SMES using the low temperature superconductor. This is because the possibility of the further cost reduction can be expected including the size reduction of the coil by the higher magnetic field and the improvement of the operational efficiency by the increase of the operational temperature by using the high temperature superconductor.

In the research up to 2000 FY, the reduction characteristic of the critical current caused by the tensile strain of the strand, the proof stress to the tensile stress of the Ratherford conductor, and the AC loss were examined on the Ratherford conductor formed of the Bi2212 round strands of which the large current capacity conductor has already been realized. As a result, it is clarified that the Bi2212 Ratherford conductor has the mechanical characteristic applicable to SMES including the mechanical proof stress of not less than 200 MPa.

In addition, regarding five kinds of Bi HTS strands (including three kinds of Bi2212 wires and two kinds of Bi2223 wires) which are applicable to the large current capacity conductor, the HTS coil for evaluating the wire characteristic by the refrigerator conduction cooling having the self magnetic field of 0.5 T with the diameter of 14 cm class was manufactured on the trial basis, and the characteristic of each wire was evaluated. As a result, it was verified that the conduction cooling operation is sufficiently possible with the Bi2212 wire at 20K, and the conduction cooling operation is sufficiently possible with the Bi2223 wire up to 50K. It was clarified that the coil formed of any wire can withstand the hoop stress up to the mechanical proof stress of the wire against the electromagnetic force, and the applicability to the HTS SMES was demonstrated.

Since 2001 FY, a small model coil of the current capacity of 3 kA class for verifying the possibility of the conduction cooling of the HTS SMES as the coil for evaluation, and a large current capacity conductor model for verifying the possibility of the larger current in the Bi2223 wire were manufactured on the trial basis, and the examination thereof will be continued.

The 14th International Symposium on Superconductivity (ISS2001)

The ISS2001 was held from September 25 (Tuesday) to 27 (Thursday) at the International Conference Center Kobe with about 100 participants from overseas, and about 500 participants from domestic region. More than 600 researchers and engineers discussed and exchanged the most advanced information on the current superconductivity science, technology, and industrial aspects.

In the ISS2001 conference this year, about 390 technical programs were presented both in oral and poster sessions. Although lecturers from the US Government or institutions had been prohibited to travel outside USA in a little while after the unexpected terrorist attacks in USA, the modifications of the conference program resulted in a minor extend through the participants' co-operations.

On the first day, master of the opening ceremony, Mr.S. Saito (Senior Managing Director, ISTEC), declared the opening of the symposium starting with the expression of the regrets to victims by the terrorism in New York. Prof. S. Tanaka (Director General, SRL/ISTEC) gave a well-come speech as the symposium organizing committee chairperson. Congratulatory addresses were also given from the Ministry of Economy, Trade and Industry, the Hyogo Prefecture and Kobe City, and those in the related industries followed by the special plenary lectures and the plenary lectures.

The special plenary lectures and plenary lectures were given by the authorities under the co-chair of Prof. Kobayashi (Osaka University) and Prof. Salama (University of Houston), the co-chairs of the ISS2001 program committee.

Prof. Yoichi Kaya (RITE) gave the first special plenary lecture with the title of "Long Term Strategy for Mitigating Global Warming". The second special plenary lecture was given by Dr. P. Grant (EPRI) with the title of "Advances in Power Applications of Superconductivity in the United States: Ⅰ. Status of the Government/ Industry Superconductivity Partnership Initiative, and Ⅱ.The Future Promise of MgB_2 for Power Applications".

The first plenary lecture was given by Prof. Jun Akimitsu (Aoyama Gakuin University), the discoverer of superconductivity in MgB_2 and Prof. D. K. Finnemore (Iowa State University) on "Current superconductor of magnesium boride (MgB_2)", which is in the state of worldwide development competitions. In all the lectures, the most recent progress were reviewed.

In addition, the plenary lectures were given by Dr. S. Berkowitz (Conductus) on the "Current State of HTS for Wireless Applications and Future Needs", Dr. Akio Seki (Central Japan Railway Company) made a lecture on "Remarkable Progress in the JR-Maglev". He presented the most recent remarkable progress in the magnetic levitation technology at Central Japan Railway Company with many photos of the superconductor linear motor cars. Dr. X. Obradors (ICMAB-CSIC) presented "Bulk Superconductors with Tuned Properties for Fault Current Limiters" on the application to the current limiter by bulk superconductors, and by Dr. Naoki Koshizuka (SRL/ISTEC) "Present Status of R&D of Superconducting Bearings of Flywheel Energy Storage" discussing the present status and the future of the power storage technology.

In the first day evening, the well-come banquet was held with about 200 attendants, resulting to a very informative opportunity for international information exchange and

creating new friendships between researchers and engineers from various different countries.

On and after the second day, active discussions were made dividing the presentations into 5 technical fields, i.e., Physics & Chemistry, Vortex Physics, Bulk/System Applications, Wires & Tapes/System Applications, and Films & Junctions/Electronic Devices. In the Physics and Chemistry session, especially, two mini-symposiums were held. One is “New superconductors”, focused on magnesium boride. This new superconducting material has been placed in a keen competitive state of development, after the discovery by Prof. J. Akimitsu in Japan. The other mini-symposium was “Electronic State revealed by Different Energy Scale Probes” for the deep understanding of characteristic electronic states in superconductors.

In the Closing Address Session on the final day, the summary of this Conference and the future prospects were discussed by four presenters, Prof. Yamada (Kyoto University) for the Session on Physics & Chemistry, Dr. G. J. Schmitz (Access.eV) on Bulk/System applications, Dr. Suenaga (Brookhaven National Laboratory) on Wires and Tapes/System Applications, and Dr. Seidel (Friedrich-Schiller-Universitaet Jena) on Films & Junctions / Electronic Devices.

Each presenter stated the steady technical progress including the progress in the basic understanding of the superconductivity, the new superconductors including MgB_2, the film deposition technology, the wire and TFA-MOD manufacturing technology, and the device and system applications.

As the end of the conference, the announcement of the forthcoming ISS2002 at Yokohama in 2002 FY, the hope for the further progress in the research, development, and application fields, giving rise to the growth of superconductivity industry, were stated as the closing address by Prof. S.Tanaka (Director General, SRL/ISTEC).

ISS 2001 Exhibition: Superconductivity Technology Fair
International Frontier Industry Messe 2001
Superconductivity Technology Fair

The “ISS2001 Exhibition; Superconductivity Technology Fair” with the sponsorship of ISTEC was included in the exhibition of “International Frontier Industry Messe 2001” which had been held at Kobe International Exhibition Hall from 26 September to 28 September.

The ISS2001 Exhibition was reported in the newspapers and TV broadcasting news reports calling special attentions to many persons of various technical and non-technical fields. The superconductivity technology booth was opened as a part in the Kobe International Industrial Fair. Many non-specialists visited the exhibition.

Exhibition and Highlight

The exhibition items were as follows; the superconductor bulk materials, superconductor wires and cables. The displayed applications include the high temperature superconductors wires, the superconductor cables, the superconducting flywheel power storage system, the high temperature superconducting magnetic bearing for the flywheel, the superconducting permanent magnet, and etc. The high-energy electron storage ring for synchrotron orbital radiation facility using superconducting wiggler magnets was presented as one of the industrial application fields.

New measurement and evaluation equipments for system applications were proposed in the exhibition including the high temperature superconducting SQUID magnetic field sensors, SQUID microscopes, high speed signal waveform monitoring sampler systems using high temperature superconductor, as the applications of superconducting magnet to the magnetic separator in water purifying systems and the measurement equipments in relation to the environmental technology. In the field of electronic devices and information systems, the present status of the HTS filter and the system, and the AD converter for the software radio system applications, which have been commercialized for the mobile communication station. In addition, the exhibition of the superconductivity-related technology includes the exhibition of the production and evaluation devices and the system such as the refrigerator, the laser ablation film deposition apparatus, and the critical current measurement apparatus for thin films. In this exhibition, all-round superconductivity technology, covering from the fundamental research field to the industrial technology field were displayed, evoking much interest and expectations for non-specialized persons not only as the future technology but also the present practical technologies.

The lists of Exhibitors (inconsecutively listed)
Cryodevice Inc.
Dowa Mining Co., Ltd.
E. I. Dupont de Nemours & Company
IMRA MATERIAL R&D CO., LTD.
Kawasaki Heavy Industries, Ltd.
K & R Creation Co., Ltd.
Leybold Vacuum Japan Co., Ltd.
Mitsubishi Heavy Industries, Ltd. (and Chubu Electric Power Co., Inc.)
NEC Corporation
Nippon Steel Corporation
Osaka University
Quantum Design Japan Inc.
Seiko Instruments Inc.
Showa Electric Wire & Cable Co., Ltd. (and Chubu Electric Power Co., Inc.)
Sumitomo Electric Hightechs Co., Ltd.
Sumitomo Electric Industries, Ltd.
TYK Corporation
Superconductivity Research Laboratory/ISTEC

(Nobuaki Shohata, Research & Planning Department, ISTEC)

A scenery of Superconductivity Technology Fair at Kobe

ISS2001 Topics 1: Physics & Chemistry

In the Mini-Symposium focusing its theme to the "new superconductor", the current topics on the new superconductors including MgB_2 discovered in the beginning of this year were announced. It can be concluded that the physical properties of MgB_2 are now considerably understood except the problem on the number of superconducting gaps. The material development required for the practical applications is remained as the future problems to be solved. On the other hand, Iwasa (Tohoku University) made an interesting review on C_{60} (Tc = 117K) superconductorized by applying the high electric field of at least 100V to the insulator by Bell. In his conclusion, it is not clarified yet what occurs under the high electric field, and what is essential to the superconductivity though the comparison with the superconductivity by the chemical substitution from various viewpoints. In response to the question from the audience, an information was given that Tc = 80K is obtained also by introducing holes in the copper oxide insulator $CaCuO_2$ in the same method by the same group. (Later, this result was published in Nature.)

(Setsuko Tajima, Director, Div. II, SRL/ISTEC)

ISS2001 Topics 2: Bulks/System Applications

In Bulks/System Applications Session, a big progress was reported in the application and the process. Firstly, Wang (Southwest Jiaotong University) introduced the present situation of the development of the bulk superconducting levitation MAGLEV using a permanent magnet rail. The traveling height of this 5-occupant vehicle is about 2 cm, and the line manufacture of 2km length is now planned. He showed the intention of using this system in the inter-urban traffic. Chairman Jian Zemin made a trial ride, and expressed the support to the development. Sawa (Keio University) showed that the superconducting current flows only by facing the resin-impregnated bulk superconductors facing each other and mechanically pressing them against each other. He suggest that the PCS development will be is expected in future.

Regarding the process, Nariki (SRL/ISTEC) reported that the bulk having the strong trapped magnetic field of 3T class even at the temperature of liquid nitrogen is developed. Sawamura et al. (Nippon Steel Corporation) introduced for the first time the technology of manufacturing a large bulk superconductor using a multi-seeding technique. In this technology, the superconducting portion is divided into two layers, the RE123 phase of high melting point is formed on the upper portion forming the polycrystal while the lower RE123 phase forms a single domain taking over only the crystal orientation. This technology is believed promising in increasing the size in future. Iida and Yoshioka et al. (SRL/ISTEC) introduced the large bulk joining technology. It is clarified that the segregation normally generated in the junction can be suppressed by setting the orientation of the joining surface to be parallel to (110) plane. It will be an important technology in joining the large bulk.

(Masato Murakami, Director, Div. I & Div. III, SRL/ISTEC)

ISS2001 Topics 3: Films & Junctions/Electronic Devices

Topics in Films & Junctions/Electronic Devices Session are introduced briefly. Regarding HTS SQUID, the magnetocardiographic measurement in the unshielded environment is now possible by the noise canceling technology using the gradiometer and electronics. Attention was attracted to the technology (by NEC) for detecting the defects in the pn junction with the spatial resolution of 1 μm from the disturbance in the magnetic field produced by the induced current. Regarding the microwave application, the present situation of the receiver system using the superconducting filter for the mobile communication base station was reported from Conductus and DuPont in USA, and Cryodevice and Toshiba Corporation in Japan. Advantages such as elimination of non-traffic areas and suppression of the interference with adjacent bands have been sufficiently demonstrated due to the high sensitivity. However, motivations such as the changes in the communication circumstances and the social situations in addition to the cost reduction are seemingly required for the introduction on a large scale in the base stations. Regarding the digital applications, attention was attracted to the results of the design and the trial manufacture of the SFQ chips (including 66,000 Nb junctions) by SUNY and TRW, and the tests will be carried out in September or later. Also in Japan, the SFQ circuit (2 x 2 switches, NEC) including 2,400 junctions is now operable due to the progress in the technology such as the cell-based design. Also regarding the HTS SFQ circuit, the 100 GHz operation (by Hitachi) of the front end circuit of the AD converter is demonstrated by the improvement of the characteristic uniformity of the ramp edge junction having the interface modified barrier. Attention is attracted to the challenges (by Toshiba Corporation and SRL) of combining the RE-123 materials other than Y-123 for the thin film material suitable for the integration process.

(Keiichi Tanabe, Director, Div. VI, SRL/ISTEC)

ISS2001 Topics 4: Wires & Tapes/System Applications

In the field of Wires & Tapes/System Applications, the presentation of the research on the MgB_2 wire which was just discovered in last winter was introduced in addition to the YBCO wire, the Bi-based wire and Nb-Ti wire which have been the conventional items. The trend of the field will be described from the number of the presentations.

22 presentations on the YBCO film deposition process and those related thereto were included in the YBCO wire, 8 presentations were given on the manufacturing methods of the substrate and the intermediate layer, and 4 presentations were given on the characteristics of J_c and pinning. The breakdown of the reports on the YBCO film deposition methods is 9 presentations on the metal and metal-organic deposition method using the precursor containing fluorine, 8 presentations on the liquid phase epitaxial method, 4 presentations on the electron beam vapor deposition method, and 1 presentation on the pulsed laser method. It is shown here that the research is focused on the establishment of the YBCO film deposition method.

Regarding the Bi-based wires, 13 presentations were given on the manufacturing methods, while 10 presentations and 6 presentations were given on AC loss

and applications, respectively. This indicates that the research has been steadily changed from the wire forming stage to the manufacture and applications.

8 presentations on MgB_2 were made on the technology of manufacturing the wire and the evaluation of the superconductivity thereof though it has not been long after the discovery of MgB_2. It seems that the methods developed in the conventional metal-based superconductors and Bi-based superconductors have contributed to the rapid development of the research. It is also expected that the possibility of replacement of the conventional metal-based superconductor by this MgB_2 will be evaluated relatively soon.

(Yasuji Yamada, Div. V, SRL/ISTEC)

Oxide Superconducting Wires under Development

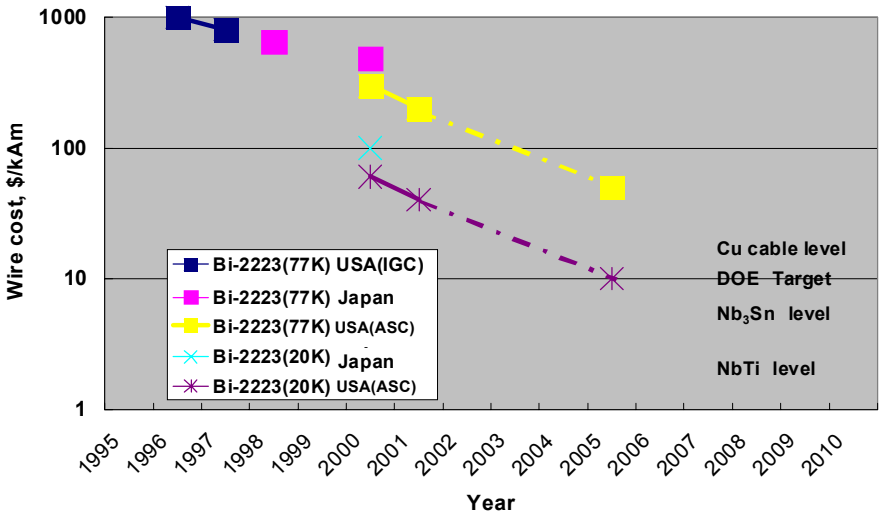
The Bi-based silver-sheathed wire and Y-based coated wire, the objectives for development of the representative practical oxide superconducting wires, have acquired the considerable result of development in these several years.

Above all, the development of the Bi-based silver-sheathed wire in these five years has demonstrated the remarkable progress in the critical current density, the critical current, the mechanical property, the wire length, the variance of characteristics, the manufacturing capacity, the cost, etc. For example, the critical current density of the long wire at 77K with the zero magnetic field has been improved four times from 8 kA/cm^2 to 33 kA/cm^2, the critical current has been improved 5.2 times from 25A to 130A, the mechanical strength has been improved 7.5 times from 40 MPa to 300 MPa, and the cost of the wire applicable to the condition at 77K with 0T has been reduced to 1/5 times from \$1000 /kAm to \$200/kA

coil for the silicon single crystal growth pulling apparatus. Based on these results, American Superconductor Corporation (ASC) declares that the cost of the Bi-based silver-sheathed wire of \$50/kAm ready for the condition at 77K with 0T, and \$20/kAm ready for the condition at 20K will be achieved, respectively, within 3 to 5 years by the improvement of the critical current density, the mass production effect by increasing the capacity of the manufacturing facilities, and the promotional sales activities.

On the other hand, the development of the Y-based coated wire which has been expected as the next generation wire to the Bi-based silver-sheathed wire has been advanced at a high pace. In particular, remarkable progresses have been reported since 2000 by SRL/ISTEC, etc., including the improvement by 20 times of the manufacturing speed of the intermediate layer tape, the manufacture of the wire of 10m length and 1 MA/cm^2 class (Fujikura Ltd. and Chubu Electric Power Co., Inc.), and the TFA-MOD method which is the non-vacuum process of the superconducting layer. The interest on the Y-based coated wire has been focused on two points, i.e., when and at which price the wire will be supplied.

Firstly, regarding the timing for the supply, Intermagnetics General Corporation (IGC) group has announced the plan for supplying the Y-based coated wire in 6 to 7 years. The cost of \$50/kAm equivalent to that of the Bi-based silver-sheathed wire already achieved ready for the condition at 20K will be achieved in the first stage. The cost thereof will further exceed \$10/kAm which is often referred to as a limit for the Bi-based silver-sheathed wire in the second stage, and it seems that strenuous efforts will be made for reaching the same level as the cost level of the metal-based Nb_3Sn wire ready for the condition at 4.2K.



Transition of the cost of oxide superconducting wire

As the requests have been increased from the development of the prototype equipment including the power cable, the motor, the transformer, and the silicon single crystal growth pulling apparatus, the manufacturing length of the wire and the manufacturing capacity have been actively increased. For example, it is reported that, in the power cable projects by Detroit Edison, and The Tokyo Electric Power Co., Ltd. & Sumitomo Electric Industries, Ltd., the cable length was increased to about 29 km and about 35 km from 120 m and 100 m, respectively, and the wire of about 80 km length was manufactured using the

The scenario of predicting the level on the cost in this report was introduced by P. M. Grant of EPRI, USA at ASC Conference in 1996 as the DOE target. It seems that the competition will be more active in the international market as this scenario is realized. We hope the development for the technology and the application of the oxide superconductor wire for practical use will be further promoted in future.

(Yasuzo Tanaka, Editor)

World Record in Characteristic with TFA-MOD Superconducting Film on Metallic Substrate

On September 19, 2001, Superconductivity Research Laboratory, Fujikura Ltd., and Chubu Electric Power Co., Inc. announced the success in development of the technology of forming the wire of the Y-based oxide superconductor which can reduce the cost.

The main stream of manufacturing the Y-based superconducting wire (tape type) is to manufacture the wire in vacuum by the method referred to as the pulsed laser method. The method of manufacturing the wire announced this time is to manufacture the superconducting wire by the method referred to as the TFA-MOD method by applying the film in the non-vacuum atmosphere. In this method, the current carrying in the wire cannot be high because the thickness of the film cannot be increased though the current density can be high. The highest current value has been 71A obtained in USA. However, the current value as high as 150A or more can be successfully obtained this time by repeating the film application to increase the film thickness without decreasing the current density. Since the wire is manufactured in the non-vacuum atmosphere, the manufacturing cost can be reduced to 1/10 of the conventional cost, enjoying the great result for gaining the momentum to the development of the Y-based superconducting wire.

This time, the superconducting thick film was successfully manufactured without reducing the current density by the above-described TFA-MOD method with the following specific technical devices on the intermediate layer metal tape manufactured by the IBAD method developed by Fujikura Ltd. which is the original technology of Japan.

(1) The uniform and dense precursor was successfully manufactured by the multi-coating method by repeating the thin film coating and the calcination.

(2) The baking condition was optimized for generating the superconducting layer by using the precursor. More specifically, the thick film of the high quality crystal was grown through the baking under the condition of the low steam partial pressure.

(3) The above technical development was applied to the highly oriented intermediate layer using the metal substrate by the IBAD method, and the high critical current characteristic was realized thereby.

Realization of the thick film crystal maintaining the high critical current density characteristic on the metallic substrate by this technical development means a large advancement in the Y-based superconductor wire process under the continuous competition in development between Japan and USA.

This technical development plays a technical role together with the vapor phase method (PLD method) in the Project on "Research and Development on Basic Technologies required for Superconductivity Applications" which has been in progress since 1999 in Japan. This result can be positioned as a step of the approach to $30-50/kAm which is the target for the practical cost essential for the practical use of the oxide superconductor wire. Another technical issue, i.e., the technical development for the increase in length is further advanced and the contribution thereof to the application development of cables and magnets is strongly expected.

This research was entrusted by the New Energy and Industrial Technology Development Organization (NEDO), and announced at ISS2001 held at Kobe International Conference on September 25 (Tuesday) through September 27 (Thursday).

(Yasuzo Tanaka, Editor)

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

Power Applications

American Superconductor Corporation (November 28, 2001)

American Superconductor Corporation has signed an agreement with KISWIRE, Ltd., of Korea naming KISWIRE as the exclusive distributor of American Superconductor Corporation's HTS wire in Korea. As part of the agreement, KISWIRE will distribute American Superconductor Corporation's HTS wire to companies involved in Korea's New Frontier Program, a US$200 million initiative to develop and commercialize HTS motors, generators, and power cables.

News Source:

"American Superconductor Announces HTS Wire Distribution Agreement with Leading Korean Wire Manufacturer"
(American Superconductor Corporation Press Release; November 28, 2001)
http://www.amsuper.com/

MRI and Sensors

Intermagnetics General Corporation (November 14, 2001)

Intermagnetics General Corporation announced that it is increasing its internal net operating asset target from 35% to 50% and improving its internal working capital efficiency target from 20% to 15%. In addition, Intermagnetics also announced the recent completion, testing and delivery of a series of new high-field open MRI magnets with lightweight, active magnetic shielding and a magnetic field strength of 1.0 Tesla. The advanced design removes the need for heavy and expensive iron shielding, required by several other competing magnet systems. The new magnet will be utilized in Phillips Medical Systems' "Panorama 1.0 T" MRI system. Commercial shipments of a 3.0 Tesla magnet forming the core of Phillips Medical Systems' "Intera 3.0 T" MRI system have also begun. The Intera 3.0 T MRI system is intended for use in research and high-end clinical applications in the fields of neurology, orthopedics, and cardiology and is the only compact, ultra high-field MRI system on the market. The shipment of these two magnets has begun to produce incremental revenue, with further increases expected in the next 12 to 18 months.

News Source:

"Intermagnetics Announces New Performance Targets, Updates Progress On Major Development Programs"
(Intermagnetics General Corporation Press Release; November 14, 2001)
http://www.igc.com/

Material

Superconductive Components, Inc. (October 4, 2001)

Superconductive Components, Inc. has been awarded a US patent for a new process that utilizes a melt processing technique to join two individual strongly linked superconductors. The technique enables crystals to be grown that have both the properties of a single crystal and complex shapes and geometries, removing the size and shape limitations of currently available superconductors. The technique also addresses the current-carrying issues that have hindered the widespread application of HTS devices. Key commercial applications for this patented process include motor generators, magnets (including flux trap magnets), frictionless bearings, and HTS fault current limiters.

News Source:

"Superconductive Components, Inc. Awarded Patent for Superconducting Process"
(Superconductive Components. Inc. Press Release; October 4, 2001)
http://www.superconductivecomp.com/

Superconductive Components, Inc. (November 15, 2001)

Superconductive Components, Inc. (SCCI), reported income applicable to common shares of $22,407 for the three months ended September 30, 2001 compared to a net loss of $54,522 for the same period in the previous year. In addition, revenues rose 12.2% to $891,813 for third quarter 2001. A 20.7% increase in product sales was partially offset by lower contract research revenue. Revenues for the 2001 improved 24.5% to $2,857,064 from $2,294,392 in 2000. Product sales benefited from increased shipments to an expanding customer base and higher tantalum sales, which were partially offset by a 17.1% decline in contract research revenues last year.

Due to an increase in gross margin from higher sales, a more favorable product mix, and improved utilization of production capacity, gross margin rose to $336,194, or 37.7% of revenue, for the three months ended September 30, 2001 versus $185,860 or 23.4% of total revenue a year ago. Gross margin for the first nine months of 2001 was $1,005,350, or 35.2% of revenues, compared with $487,542, or 21.2% of revenues, in 2000.

Also due to staff additions and expenses related to the Company's listing on the Nasdaq, general and administrative expenses increased to $244,708 and $652,320, respectively. Sales and promotional expenses were $52,249 for the third quarter versus $86,896 a year ago, and totaled $178,344 for the 2001 year-to-date.

News Source:

"Superconductive Components, Inc. Reports Improved Third Quarter Results."
(Superconductive Components, Inc. Press Release; November 15, 2001)
http://www.superconductivecomp.com/

Telecommunications

ISCO International, Inc. (November 2, 2001)

ISCO International, Inc. (ISCO) announced today that it is consolidating its research and development facilities as part of a strategic plan to streamline the company. ISCO•fs Canadian engineering group located in Toronto, which has been responsible for the research and development of ISCO•fs patented Adaptive Notch Filter (ANF™) will be merged with the R&D activities in ISCO's Mount Prospect, Illinois headquarters. The ANF is used by wireless carriers to dynamically reduce in-band interference, preventing dropped calls and increasing cell capacity.

Roger Boivin, President, said that merging these resources into one facility would decrease costs, improve communications and speed up product development.

News Source:

"ISCO International Transfers Toronto-Based Research & Development Programs To Illinois Headquarters"
(ISCO International, Inc. Press Release. November 2, 2001)
http://www.iscointl.com/

Superconductor Technologies Inc. and Comarco Inc. (November 6, 2001)

Superconductor Technologies Inc. (STI) and Comaraco Inc., a leading provider of advanced technology tools and engineering services to the wireless communications industry, announced that they intend to include STI's SuperFilter (R) System in the options available to Comaraco customers using EDX SignalPro (R) for their wireless network planning. SignalPro (R) is an advanced software package consisting of a complete set of planning tools for wireless communication systems from 30 MHz to 60 GHz. Optional modules are available to provide specialized capabilities. The SuperFilter (R) option is expected to be available before the end of 2001 and will enable customers to virtually verify the benefits afforded by STI's filters, which utilize high-temperature superconducting technology to enhance filter performance.

News Source:

"Superconductor Technologies and Comarco Announce Plan to Add High Temperature Superconducting to Wireless Optimization Software"
(Superconductor Technologies Inc. Press Release; November 6, 2001)
http://www.suptech.com/

ISCO International, Inc. (November 7, 2001)

Thanks to new financing provided by Elliott Associates, L.P. and Alexander Finance, L.P., ISCO International, Inc. (ISCO), announced today that it has raised $9.425 million of new capital and has settled for $4.925 million with the previously announced $6.5 million judgment obtained against ISCO by Craig Siegler. The financing takes the form of non-convertible secured notes due March 2003, bearing interest at 14% per annum.

ISCO's Chief Executive Officer, Dr. George Calhoun said that he was "gratified by the continuing financial support of our leading investors." He added, "These are challenging times in the capital markets, so we are fortunate to enjoy the confidence of two major financial institutions, with billions of dollars of capital." He also expressed pleasure that the Craig Siegler matter was over.

News Source:

: "ISCO International Raises Capital, Settles Contract Suit"
(ISCO International Press Release; November 7, 2001)
http://www.iscointl.com/

ISCO International Inc. (November 12, 2001)

ISCO International Inc. announced the consolidation of its thin-film development activities into its Illinois headquarters. The company has closed its Louisville, Colorado facility, laying off 19 employees. The Colorado facility was responsible for R&D leading to ISCO's patented tower mounted Cryogenic Front-End product line, which includes both thin-films and thick-films in tower-mounted and indoor configurations. The consolidation of ISCO's facilities is

expected to reduce costs, improve communication within the company, and accelerate product development, especially of hybrid products.

News Source:

"ISCO International Consolidates Thin-film/Tower Mount Development to Illinois Headquarters"
(ISCO International Inc. Press Release; November 12, 2001)
http://www.iscointl.com/

Conductus Inc. (November 13, 2001)

Conductus Inc. has received a subcontract from General Dynamics Advanced Information Systems to develop advanced filter systems for airborne intelligence applications. The subcontract is part of a delivery order received by General Dynamics from the Defense Microelectronics Activity (DMEA), in collaboration with the Defense Advanced Research Projects Agency (DARPA), and includes the development, delivery for product testing, and ultimate deployment of the filter systems. The primary goal of the project is to develop fixed-frequency-filter-based, high-performance subsystems for military aircraft. In addition, the program also aims to complete the technology development required for practical tunable superconducting filters to be used in future enhanced subsystems. The subcontract is currently valued at US$ 2.1 million for Conductus, with the initial work being performed under a US$1.3 million increment. General Dynamics is negotiating with DMEA and DARPA to increase the scope of efforts and project funding.

News Source:

"CONDUCTUS RECEIVES CONTRACT TO DEVELOP ADVANCED AIRBORNE WIRELESS FILTER SYSTEMS"
(Conductus Inc. Press Release; November 13, 2001)
http://www.conductus.com/

Conductus, Inc. (November 13, 2001)

Conductus, Inc. (CDTS), today announced that revenues for the third quarter of 2001 were $1,873,000; this represents an increase of 218% from the same period in 2000. In addition, product revenues increased by 266% to $703,000. Also, contract revenues increased by 195% to $1,170,000. For the first nine months of 2001, revenues totaled $4,851,000, which represents an increase of 316%. Product revenues for the first nine months of 2001 increased by 513% to $1,997,000 compared to product revenues of $326,000 reported for the first nine months of 2000. Contract revenues increased by 240% to $2,854,000. The increase in product revenues was mainly due to increased unit shipments of both commercial and government wireless products during the comparison periods.

President and Chief Executive Officer, Charles Shalvoy expressed pleasure with the significant growth in revenue from the previous year in both our commercial wireless and government business in the Third Quarter. He made five key points:

That they have corporate sponsored field trials in progress with three of the top ten wireless carriers in the U.S., which they expect to complete this year.

Their ClearSite® systems, installed in 11 CDMA cell sites at one of their existing customers, showed an average 43% increase in minutes of use after installation.

They shipped a new system to a Japanese OEM for testing and potential deployment in Japanese 3G networks. In addition, they began work with a second Japanese OEM on a similar program.

They have been awarded a subcontract on a $2.1 million program (with the initial work being performed under a $1.3 million funding increment) with General Dynamics to develop multiple super conducting wireless systems for military aircraft.

Furthermore, recent world events have resulted in an increased emphasis on advanced technologies by government customers and may accelerate the growth of this part of their business.

News Source:

"Conductus Reports Third-Quarter Results"
(Conductus, Inc. Press Release; November 13, 2001)
http://www.conductus.com/

ISCO International Inc. (November 14, 2001)

ISCO International Inc. has received an additional purchase order from a major wireless operator for nine tri-sector cryogenic front-end (CRFE) systems and 66 single-sector Adaptive Notch Filter (ANF™) systems for immediate deployment. The order is valued at over US$ 1 million and is the fifth that ISCO International has received over the last 12 months from this particular customer.

News Source:

"ISCO International Receives $1 Million Follow-on Order From a Major Customer Covering 93 Base Stations Sectors"
(ISCO International Inc. Press Release; November 14, 2001)
http://www.iscointl.com/

ISCO International (November 14, 2001)

ISCO International, Inc. (ISCO), today reported consolidated net revenues of $90,000 for the quarter ending September 30, 2001, compared to $22,000 during the equivalent period in 2000. For the nine-month period ending September 30, 2001, consolidated net revenues were $1,976,000, versus $209,000 during the first nine months of 2000. The consolidated net loss was $10,689,000 and $20,965,000 for the three and nine month periods ending September 30, 2001, respectively, versus $5,284,000 and $11,497,000 during the same periods in 2000. The increase in net loss in the third quarter was largely due to the $4.925 million settlement of a lawsuit against ISCO.

ISCO's Chairman, Dr. George Calhoun said, "Coming off of a relatively strong second quarter, third quarter revenues reflect the present 'lumpiness' in orders." However, he added, "Events subsequent to the third quarter give us reason for optimism. First, ISCO now has a $1.1 MM backlog derived from significant follow-on orders of both cryogenic front-end and ANF™ systems. Second, in October we took decisive action to reduce our annual overhead by approximately $7.6 MM. Third, in October we brought on board our new President and Chief Operating Officer, Roger Boivin, a veteran of the wireless equipment industry. Roger has already taken dramatic steps to focus our sales effort and streamline our organization. Finally, we have reduced the production costs of our products to a point where every sale contributes positively to the Company's profitability."

News Source:

"ISCO International Reports 3rd Quarter Results"
(ISCO International Press Release; November 14, 2001)
http://www.iscointl.com/

Superconductor Technologies Inc. (November 28, 2001)

Superconductor Technologies Inc. announced two major milestones: the sale of its 1,000th SuperFilter ® system, and the accumulation of more than 10 million hours of deployed unit operation. M. Peter Thomas, president and CEO of Superconductor Technologies, commented that "These milestones mark significant steps in the growth and evolution of our company. STI has met the challenge of

introducing cutting-edge technology into the marketplace and has clearly established itself as the market leader."

News Source:

"Superconductor Technologies Inc. Sells 1,000th SuperFilter ® System and Tops 10 Million Hours of Field Operation" (Superconductor Technologies Inc. Press Release; November 28, 2001)

http://www.suptech.com/

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

Patent information

September

Publication system of unexamined application was introduced in U.S.

At the strong request of Japan and Europe, the patent applications for the United States Patent and Trademark Office on and after November 29, 2000 will be published without examination, in principle, in 18 months from the date of the first application.

The system for preventing generation of so-called submarine patents, which have been pointed out, is now established thereby. At the same time, the details of the patents applied to only the USA as well as the US patent strategy of the companies outside the USA (integration, division, claims, etc.) can be known in an early stage.

Also, in promoting the research and development, the published patent information of the USA should be utilized for constructing the strategy for the research and development, considering that our own applications will be published in 18 months in the USA with the keenest technical development in the world.

Finally, it is noted that, even in the new US system, all patents are not always published, because there is room for applying for the non-publication shown below. "Patent whose application has no will of making a foreign patent application to a nation having the publication system, and applies for the non-publication"

Octomber

Introduction of obtained patents
The recently registered Japanese patent of ISTEC is introduced below.

"Thin film superconductor and its production"

: Japanese Publication No. 08-133896 (filed in 1994)

This is the pioneer patent on the composition and the characteristic of the NdBCO thin film superconductor, and the manufacturing method thereof. In the application of the superconductor to the field of electronic devices, it is essential to realize the multi-layered thin film. However, it cannot be avoided that some different materials from YBCO-123 crystal system will be generated in the well-known YBCO-123 thin film deposition, and it is therefore difficult to conclude that the YBCO thin film is optimum for construction of multi-layered structure. The point of this invention is that the mutual substitution between Nd and Ba to some degree is permitted in the NdBCO-123 crystal system, and can extremely suppress the generation of unfavorable materials. In addition, when the Ba element with strong activity is substituted by Ba element, the surface of the thin film is more chemically stable and thus, the NdBCO thin film has excellent characteristics suitable for the multi-layered structure such as the improvement in smoothness.

This invention will be extensively applied for fabrication of the Nd123 thin film for the superconducting filter and the superconducting integrated circuit.

November

Published unexamined patents in the second quarter in 2001 FY

The patents applied for by ISTEC and published between July and September 2001 FY are introduced below.

For details, please refer to the patent data in the Industrial Property Digital Library in the Japan Patent Office home page.

1) Japanese Unexamined Patent Application Publication No. 2001-223400 "SINCFILTER": This circuit system is a kind of digital filter circuit for the superconductive IC, and counts pulses in the Single Flux Quantum (SFQ) pulse train at high speed.

2) Japanese Publication No. 2001-251177 "Dynamic Single Flux Quantum Logical Circuit": This circuit system prevents the interference with the adjacent junction caused by the leakage of the bias current in the SFQ circuit, and has the automatic resetting function.

3) Japanese Publication No. 2001-251178 "Single Flux Quantum Logical Circuit": Generally, the SFQ circuit can easily trap unnecessary magnetic flux. This invention provides a new circuit system, which can eliminate the unnecessary magnetic flux by the resetting function of the SFQ.

4) Japanese Publication No. 2001-251179 "Single Flux Quantum Logical Circuit": This circuit system prevents the interference with the adjacent junction caused by the leakage of the bias current in the SFQ circuit.

(Katsuo Nakazato, Director, Research and Development Div., SRL/ISTEC)

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