1. Introduction

In the field of superconductors, bismuth superconducting wire is called first generation (1G) superconducting wire and yttrium superconducting wire is called second generation (2G) superconducting wire. This may cause some people to think that 2G wire is newer and more advanced than 1G wire, but looking back at the history of the development of superconductors proves that it is not true.

As a matter of fact, yttrium-based 2G superconductor $Y_{1}Ba_{2}Cu_{3}O_{7}$ was discovered in the United States in 1987 and it is the first superconductor whose critical temperature ($T_c$) of 90 K is higher than the boiling point of liquid nitrogen (77K, -196˚C). The reason why this type of superconductor is called the “high-temperature superconductor” is that its $T_c$ is higher than the temperature speculated from the BCS theory. In 1988, the next year of the discovery of $Y_{1}Ba_{2}Cu_{3}O_{7}$, a new superconducting material was discovered in Japan. It is $Bi_{2}Sr_{2}Ca_{2}Cu_{3}O_{10}$ and this superconductor had set the new record of $T_c = 110$ K, which is 20 K higher than that of the one discovered previous year. It would have been appropriate if $Bi_{2}Sr_{2}Ca_{2}Cu_{3}O_{10}$ had been called the “second generation” (or next generation) superconductor, but it is not called so. Instead, $Y_{1}Ba_{2}Cu_{3}O_{7}$, which is hard to be made into long wires, is called 2G. After the discovery of $Bi_{2}Sr_{2}Ca_{2}Cu_{3}O_{10}$, the development of long superconducting wire had been promoted and the trial production of such applied products as power leads, superconducting magnets, superconducting transformers and power cables had started. It was very difficult to produce long-length $Bi_{2}Sr_{2}Ca_{2}Cu_{3}O_{10}$ wire exceeding 1000 m that has a high critical current at low cost, so there are opinions that it may be difficult to break through the technical limit of $Bi_{2}Sr_{2}Ca_{2}Cu_{3}O_{10}$. Therefore, it is harder to receive governmental support for researches on $Bi_{2}Sr_{2}Ca_{2}Cu_{3}O_{10}$. Many researchers who want to receive governmental funds shifted their research focus from $Bi_{2}Sr_{2}Ca_{2}Cu_{3}O_{10}$ (BSCCO) to $Y_{1}Ba_{2}Cu_{3}O_{7}$ (YBCO). There are speculations that the reason YBCO wire discovered before BSCCO wire is called 2G wire is to raise expectations. Compared with BSCCO wire, YBCO wire has good critical current (Ic) versus magnetic field (B) characteristics and low production cost, because smaller silver amount is required in making a wire. Although the material cost for YBCO wire is less than that for BSCCO wire, the production process of YBCO wire is more complex and has not been optimized yet. Therefore, YBCO wire is more expensive than BSCCO wire. Reducing the production cost for YBCO wire to be below that for BSCCO wire is possible, but many breakthroughs need to be made first. In fact, $T_c$ and the critical magnetic field (Hc2) of BSCCO are much higher than those of YBCO, and there is a good chance that there are breakthroughs in BSCCO. Also, because YBCO wire has more variations in materials and production processes than BSCCO wire, many research institutes own many intellectual properties, presenting a serious obstacle to commercialization.

On the other hand, the development and commercialization of BSOCO wire are conducted by only a few companies in the world, one of which is Sumitomo Electric Industries, Ltd. Nowadays, reasonably priced BSOCO wires are commercially available, and trial production of superconducting equipment using such BSOCO wires is underway. It is expected that even if YBCO wire is offered commercially as the best superconducting wire in the future, the market for superconducting products is incredibly large and can be still exploited. Therefore, it is important that superconducting products using BSOCO wire are developed now. Fortunately, trial-developed YBCO wire is similar in dimensions to BSOCO wire that is now a de-facto standard for superconducting wires, so it will be easy to switch from BSOCO wire to YBCO wire. The authors expect that in the future YBCO will not drive BSOCO out of the market, but each brings out its own characteristics and coexist in the market.
2. BSCCO wire

2-1 Types of BSCCO

There are three types of bismuth-based superconducting materials: Bi$_2$Sr$_2$CuO$_6$ (Tc = around 25 K)$^{(1)}$, Bi$_2$Sr$_2$CaCu$_2$O$_8$ (Tc = around 80 K)$^{(2)}$ and Bi$_2$Sr$_2$Ca$_2$Cu$_3$O$_{10}$ (Tc = around 110 K, Fig. 1). They are named Bi2201, Bi2212 and Bi2223, respectively, after the constituent element ratio. In the early stage of development, Bi2212 was easier to synthesize than Bi2223 and Bi2212 wires had higher critical currents than Bi2223 wires at low temperatures around liquid helium temperature. However, because Bi2212 wires cannot be used at liquid nitrogen temperature and also due to the recent improvement of Bi2223 wires and the progress of applications utilizing them, the most common type of bismuth wire today is Bi2223 wires.

2-2 Fabrication process of Bi2223 wire

The crystal structure of Bi2223 has sheet-like two-dimensional CuO$_2$ square lattices at which superconductivity occurs. The CuO$_2$ planes have electricity-insulating blocking layers above and below them, forming a layer structure of CuO$_2$ planes and blocking layers superimposed on each other. This particular structure results in anisotropic transport property, which allows the current to flow along the CuO$_2$ planes while suppressing the current from straddling the blocking layers. Due to this property, the achievement of high critical currents depends on the alignment of the CuO$_2$ planes along the current path in the wire. Because cuprate superconductors are brittle ceramics, unlike ductile materials like cupper, aluminum and superconducting Nb-Ti alloy, they cannot be formed into wires by the deformation process. Therefore, cuprate superconducting wires are made by a method called either “powder-in-tube” or “silver sheath”, which consists of filling the raw material powder into a silver tube, deforming it into a wire and sintering it into a polycrystalline superconductor (Fig. 2). Bismuth cuprate has weakly bonded areas in its blocking layers that can be easily cleaved. The CuO$_2$ planes in polycrystalline bismuth cuprate can be easily aligned when formed into a tape using the powder-in-tube process including rolling and sintering, thanks to this cleavage easiness.

Fig. 2. Bismuth high-temperature superconducting wire manufacturing process

2-3 Production and marketing of Bi2223 wires

Bi2223 wire generally has a shape as shown in Fig. 3 with a thickness a little over 0.2 mm and a width a little over 4 mm. The critical current (Ic) is generally defined as the current at which 1 micro-volt per centimeter will be generated under a 1 atm atmosphere and self field. The Ic value of commercial BSCCO wire is around 90-150 A, but Sumitomo Electric reported in a published paper that its BSCCO wire had set a world record with Ic of 210 A. Nowadays, BSCCO wire is the only high-temperature superconducting wire that can be mass-produced into long wires over 1000 m in length.

In order to align crystals and increase critical current value, a tape shape is adopted. Even if the wire has a tape shape, superconducting cuprate is ceramic and therefore is brittle. The electric conductor of BSCCO wire has a multi-filamentary structure that consists of ribbon-like filaments embedded in a silver matrix, therefore it undergoes little degradation when bent.

In the case of NbTi or Nb$_3$Sn superconducting wire, it is impossible to conduct the critical current test along the entire length because the test needs to be performed in liquid helium. However, in the case of high-temperature superconductor, quality can be assured over the entire wire length by measuring the critical current for the entire wire length in liquid nitrogen.

2-4 DI-BSCCO

BSCCO wire, which became the first practical high-temperature superconducting wire, had a intrinsic prob-
Ceramic superconductor had pores through which liquid nitrogen penetrates, so when a wire was quickly warmed after liquid nitrogen cooling, liquid nitrogen inside the superconductor was gasified and caused a wire defect called “ballooning”. Some manufacturers decided to enclose the wire in a metal sheath so that wire strength is improved, but $I_c$ (the critical current density for the entire wire cross-section) decreased.

On the other hand, because the pores act as an obstacle to the improvement of critical current, some manufactures and institutes considered implementing a fundamental solution to this problem, which is to apply pressure during heat treatment, but advanced technology was needed to realize such a technique. Sumitomo Electric developed a special pressurized sintering technology called CT-OP (stands for “controlled over-pressure”), and established a mass-production facility for BSCCO wire. The company not only used this CT-OP technology but also improved the entire BSCCO wire production process from material composition to final sintering. Sumitomo Electric’s BSCCO wire is marketed under the brand name DI-BSCCO, which means “dynamically-innovative BSCCO”.

Using this new sintering process, the density of superconducting filaments was improved to almost 100% from around 85% of conventional sintering processes. As a result, the critical current and mechanical properties are improved. This type of heat treatment process is generally called “hot isostatic pressing (HIP)”, and the process is usually performed in an inert gas atmosphere to prevent the oxidation of heat-treatment chamber, but BSCCO wire needs oxygen in the sintering process and therefore special steel needs to be used. It is also necessary to control the oxygen partial pressure exhaustively and to control the temperature over 800 degrees C at an accuracy higher than that obtained by commercially-available thermo couples.

The CT-OP process not only eliminates “ballooning” but also increases the critical current and mechanical properties of DI-BSCCO. It is confirmed that DI-BSCCO recently achieved a critical current over 210 A and/or a unit length over 2000 m. However, a detailed observation of CT-OP-sintered superconducting wire indicates that much residual Bi2212 and Pb-rich phases exist in the Bi2223 superconductor. Since superconducting current path is limited in non-superconducting phases, it is expected that the reduction of these phases further increases the $I_c$ values.

### 2-5 BSCCO wire for AC applications

Although a superconductor is free from energy dissipation under a direct current, the magnetic hysteresis in the superconductor causes an energy loss called “AC loss” with an alternative current. An effective method to reduce AC loss is to make the hysteresis loops smaller by breaking up the superconductor into small pieces. However, this structure is not sufficient enough because the filaments behave as if they were a single superconducting bulk due to a coupling current induced by electromagnetic induction. To suppress the coupling current, the wire is twisted so that the filaments become spiral around the center axis of the wire and the high-resistance barrier layers are arranged between the filaments. This structure is also used in low-temperature superconductors like NbTi.

In general, a temperature rise occurs more easily at low temperatures because specific heat is smaller in low temperatures. In a superconducting device that carries a large current, Joule heat is generated when the superconducting state deteriorates as a result of temperature rise. This causes a phenomenon of steep temperature rise called “quench”. The quench phenomenon is hampering the practical use of low-temperature superconductor in AC applications despite many years of research.

The specific heat of a substance like copper increases by a hundredfold at 20 K and by a thousandfold at 77 K compared to that at 4 K. This means that temperature rise is greater at higher temperatures. Moreover, refrigeration efficiency is better in higher temperature regions. In addition, because the allowable temperature rise limit of high-temperature superconductor is high due to the large difference between the operating and critical temperatures, high-temperature superconductor can work stably in AC operations where heat is generated constantly.

It was already confirmed that a novel superconducting tape fabricated by modifying a conventional 110-A DC tape to have a narrower size and twists has a low AC loss between one-third and one-fifth those of conventional DC-use tapes. A dramatic progress can be achieved in superconductor for AC use if a low AC loss tape with a critical current around 100 A is developed using the technologies for 200 A tapes.

### 3. Applications of superconducting wire

#### 3-1 Features and applications of superconductor

There are four basic features of superconductivity: (1) Perfect zero resistance (perfect conductivity), (2) perfect diamagnetism, (3) flux quantization, and (4) Josephson effect. The examples of possible applications of superconductivity are shown in Fig. 4.
From the viewpoint of application to electric power transmission/distribution, zero resistance and high current density are the two important characteristics. Because the resistance is zero, compact conductors that feature low transmission loss and high current density can be achieved. The zero resistance characteristic also allows the realization of compact high-field magnets that provide low heat generation and high current density. The applications shown in Fig. 4 (other than electronic-related applications) are the uses of conductors or high-field magnets.

The applications of the Josephson effect include devices such as voltage standards, high-speed switching elements and superconducting quantum interference devices (SQUIDs) used for micro-magnetic field sensors, but this paper only discusses the applications of conductors and magnetic fields.

3.2 Superconducting power cable

Superconducting power cables have many advantages, which are shown in Fig. 5. Since compact-size superconducting cables can transmit large amounts of electricity, construction costs can be reduced and transmission losses are low, meaning that superconducting cables are economical. They can be used to supply low-voltage, large-current power, and because the charging current has little influence, long-distance power transmission can be achieved. As a result, the use of superconducting technology allows the elimination and simplification of intermediate substations and switching stations in urban suburbs.

Superconducting cables also have environmental advantages. They are EMI-free (superconducting shield layer prevents electromagnetic wave leakage), energy saving (low power transmission loss) and non-flammable (does not use oil that is used in oil-insulated cable).

R&D on superconducting cables is conducted all over the world. After the success of three superconducting cable projects (the Tokyo Electric Power Company Project, the Copenhagen Project and the Southwire Project) in around 2000, many demonstration projects were implemented mainly in the United States and Asia. Table 1 shows the superconducting cable projects around the world.

![Fig. 4. Superconductor Applications](image)

![Fig. 5. Features and advantages of superconducting cable](image)
(2) Albany Project

In the United States, the aging and vulnerable transmission grid is acknowledged as the cause for the Northeast Blackout of August 2003 and the upgrading of the grid calls for urgent attention. In the Energy Policy Act enacted in August 2005, the upgrading of the transmission grid is defined as an urgent issue of national importance. As one of the initiatives, the “Grid 2030” program for constructing a powerful superconducting electricity grid by 2030 is now being considered. For this purpose, three superconducting cable projects funded by the United States Department of Energy are currently under way. The first project implemented was the Albany Project in which Sumitomo Electric participates. In the project, superconducting cable was connected to the real power grid.

The project is implemented on an actual power grid extending approximately 3 kilometers between two substations (Menands and Riverside) of the power company National Grid (formerly Niagara Mohawk) in the city of Albany, the capital of New York State. In the project, a superconducting cable was applied to a 350-meter section across a freeway. The nominal voltage, current and capacity are 34.5 kV, 800 A and 48 MVA, respectively. Sumitomo Electric’s “3-in-One” superconducting cable was installed in a 350-meter-long underground conduit with an inner diameter of 6 inches (152 mm). The world’s first HTS cable-to-cable joint was placed inside a vault, and both ends of the cable were connected to overhead power transmission lines. Photo 2 shows the cable structure and Table 2 shows the cable parameters.

The cable system was connected to the actual power grid of National Grid at 21:00 on July 20, 2006 local time. About 7,000 hours (10 months) have passed since the cable system was connected to the grid, and the system transmits power to Albany without any trouble. One time the cable experienced a fault current and the breaker functioned normally, which caused the operation to suspend. The cable was deliberately checked, but no damage on the cable or the system was found and the operation was resumed. In the summer of 2007 the world’s first demonstration of the superconducting cable replacement was implemented and is going on. The 350-m cable was disconnected at the cable joint to replace the 30 m portion with a new superconducting cable.

(3) KEPCO Project

As a case study on the practical application of superconducting technology, the Korea Electric Power Corporation (KEPCO) is planning to conduct researches on the procedure for practical operation of superconducting cables, assuming a voltage of 22.9 kV, which is the power distribution level in South Korea, a current of 1,250 A, which is five times the standard capacity of 250 A, and installation in 175 mm diameter underground ducts in urban areas. The total budget for this research study project is about $6 million, 60% of which is funded by the South Korean government, and 40% by KEPCO. The main subject of the study was to procure a superconducting cable through an international public bidding and operate it at the KEPCO testing site in Gochang, South Korea. Sumitomo Electric, who has experience in participating in a joint superconducting cable project with Tokyo Electric Power Company, had submitted a tender application and successfully won the public bidding for the KEPCO project. This was the world’s first commercial order of superconducting cable.

Table 3 and Fig. 6 respectively show the parameters and configuration of the the KEPCO Project superconducting cable system. Tests such as long-term operation test and heat cycle test will be performed using this superconducting cable system to carry out technical and economical assessments.

![Photo 2. Three-cores-in-one-cryostat type Superconducting Cable Structure](image)

### Table 2. Specifications of Albany HTS Cable

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Former</td>
<td>Stranded copper wires with insulation</td>
</tr>
<tr>
<td>HTS conductor</td>
<td>Double layer of BSCCO tape</td>
</tr>
<tr>
<td>Electrical insulation</td>
<td>PPLP (thickness: 4.5 mm)</td>
</tr>
<tr>
<td>HTS shield</td>
<td>Single layer of BSCCO tape</td>
</tr>
<tr>
<td>Copper shield</td>
<td>Copper tapes</td>
</tr>
<tr>
<td>3-core stranding</td>
<td>Loose 3-cores stranding</td>
</tr>
<tr>
<td>Thermal insulation layer</td>
<td>Double-corrugated stainless steel pipe &amp;</td>
</tr>
<tr>
<td>Protective outer sheath covering</td>
<td>Polyethylene/stainless-steel-tape tension member</td>
</tr>
<tr>
<td>Cable outer diameter</td>
<td>135 mm</td>
</tr>
</tbody>
</table>

### Table 3. Cable System Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>22.9kV</td>
</tr>
<tr>
<td>Rated current</td>
<td>1250A</td>
</tr>
<tr>
<td>Rated capacity</td>
<td>49.6MVA</td>
</tr>
<tr>
<td>Cable type</td>
<td>3-in-One superconducting cable</td>
</tr>
<tr>
<td>Length</td>
<td>100m</td>
</tr>
<tr>
<td>Electrical insulation type</td>
<td>Low temperature dielectric</td>
</tr>
<tr>
<td>Termination</td>
<td>EBA (2 units)</td>
</tr>
<tr>
<td>Installation</td>
<td>Tunnel &amp; duct (30 m)</td>
</tr>
<tr>
<td>Cooling system</td>
<td>Liquid nitrogen circulation</td>
</tr>
</tbody>
</table>
3-3 Application of superconducting magnetic field

(1) Application of superconducting magnetic field

The most basic application of superconductivity is superconducting magnets that can generate a high magnetic field at a compact size. Other than superconducting magnets, superconducting magnetic field is used by transformers, motors and linear motors.

(2) High-field superconducting magnet

Superconducting magnets are used for the generation of high magnetic field which requires very large electrical power when using non-superconducting magnet. One example of commercial application of superconducting magnet is medical magnetic resonance imaging (MRI) that usually uses NbTi, a low-temperature alloy superconductor. The maximum magnetic field obtained using NbTi is around 8 T. To generate a magnetic field over 8 T, an intermetallic superconductor Nb3Sn has been used. For nuclear magnetic resonance (NMR), whose principle is the same as MRI but is used mainly for material analysis, higher field is required to have high resolution. When performing NMR at over 1GHz, a very high field of more than 23T is needed, but it is difficult to generate such high field with Nb3Sn. Therefore, superconducting magnet using BSCCO wire is under development.

As for superconducting magnet that generates a magnetic field of around 10T, those commercially available use low temperature superconductors. However, magnet using BSCCO superconductor that can be easily cooled using 20 K cryocooler has been also developed. Photo 3 shows a coolant-free 8.1 T superconducting magnet with a 200 mm room-temperature bore.

Applications of magnetic field to other magnetic resonance analysis apparatus like MRI and NMR systems are also under development, which are magnetic separation and magnetic field control of molten metals.

(3) Superconducting transformer

Superconducting transformer is considered as one of the applications of superconductivity to electric power systems. The advantages of using superconductor for transformer are low loss, compactness and light weight.

The benefits of compactness and light weight are that it can be used in movable bodies, and the application of superconductor to transformers for high-speed trains is now under consideration. For Japanese Shinkansen bullet trains, reduction of weight is an important issue, and superconducting transformer is expected as a means to achieve lighter weight. The trial 3.5-MVA-class superconducting transformer is shown in Photo 4 and the parameters are shown in Table 4. The transformer has enough capacity to be used in Shinkansen, but there remains another problem of AC loss, which influences the weight of cryocooler. Because it is important to reduce AC loss, low AC loss superconductor needs to be developed as soon as possible.

<table>
<thead>
<tr>
<th>Primary voltage</th>
<th>25,000V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary voltage (For driving)</td>
<td>1,200V (4 windings)</td>
</tr>
<tr>
<td>Tertiary voltage (For servicing)</td>
<td>770V</td>
</tr>
<tr>
<td>Dimensions (WxDxH)</td>
<td>1.2m x 0.7m x 1.9m (excluding compressor)</td>
</tr>
<tr>
<td>Weight</td>
<td>1.7 ton (excluding cryocooler and compressor)</td>
</tr>
<tr>
<td>Cooling method</td>
<td>Liquid nitrogen immersion</td>
</tr>
<tr>
<td>Wire</td>
<td>BSCCO superconducting wire</td>
</tr>
</tbody>
</table>
(4) Superconducting motor
The Japanese Maglev train using superconducting magnets had set a world record of 581 km/hour. Conventional superconducting Maglev system used NbTi superconductor and 4 K cryocooler, but a system using BSCCO superconductor is now being researched at an experimental line constructed in Yamanashi Prefecture. Because the new system uses more effective 20 K cryocooler, the stability against temperature fluctuations can be increased and overall economic efficiency can be improved.

Since powerful superconducting magnet has become available, the development of a motor with greater efficiency and higher torque is expected. The advantage of such motor is especially prominent in large motor sizes. The conventional ship propulsion system is that a diesel engine equipped with a gear and a shaft causes a propeller to rotate. On the other hand, electricity consumption in ships is increasing recently. The rotating speed of a diesel engine should be quite low even when a gear is used, so the engine is generally large. Therefore, for the purpose of maintaining the balance of a ship, the engine is set in the center of the ship and rotational force is transmitted to the propeller using a long shaft. The new mechanism is that the motor is powered by electricity generated by the diesel engine. Because rotational force is converted into electricity, the new mechanism may seem inefficient. However, the engine for power generation can operate at a higher rotation speed and therefore can be made in a smaller size compared with the engine for driving a shaft in achieving the same output power. Moreover, because electricity is transmitted by cables, the location of the engine can be determined more flexible and the space in the ship can be utilized effectively. Because the engine is small, it is easy to hydrodynamically optimize the ship’s structure and thus improve total efficiency.

In recent years, pod electrical propulsion system, which has an electrical motor installed in a pod-shaped housing with a propeller directly connected to it attached beneath the ship’s bottom, is increasingly being adopted in luxury liners and ice-breaking boats. The ship with a pod propulsion system can change its direction freely, because the pod acts as a rudder. Using superconducting motor, the pod can be made smaller and the overall propulsion efficiency will improve by around 30%.

In Japan, an industry-academic consortium consisting of Sumitomo Electric, University of Fukui, IHI and other companies are developing the axial-gap type superconducting motor for ship propulsion systems (13). (Photo 5) The most prominent feature of this superconducting motor is that the motor is cooled by liquid nitrogen as a result of the use of iron core. Conventional superconducting magnet generates a high magnetic field by utilizing the high current density of superconductor, so the idea of using an iron core whose maximum magnetic field is around 1 T was unthinkable. However, by determining the optimum location for iron core, the drawback of the BSCCO superconductor is offset and a small and lightweight motor is realized. Presently the consortium is working to develop a 400-kW-class superconducting motor. It is expected that if a contra-rotating propeller type propulsion system using two 400-kW motors is implemented in a several-hundred-ton-class ship, discharge of carbon dioxide will be reduced.

4. Future prospects and problems
By achieving the characteristics improvement and mass production of DI-BSCCO, it is expected that in the future DI-BSCCO will have about the same cost effectiveness as copper wires. For full-scale expansion of the superconductor market, the prompt development of superconducting devices is necessary.

Because power cables are one of the most important infrastructures, they are required to have a very high level of reliability over a long period of time. Through various in-grid demonstration tests like the Albany Project, data on reliability and economic efficiency are being accumulated. Recently in Japan, a new superconducting cable project led by the Ministry of Economy, Trade and Industry (METI) and the New Energy and Industrial Technology Development Organization (NEDO) had started. In this project, more data on demonstration under real operation conditions and on reliability will be collected. Demonstration of DC superconducting cable, which gets great performance out of superconductors, is also expected to be carried out in near future. Technology of DC low-voltage power transmission is applicable to transmission of renewable energies like solar power and wind power.

In the field of application of superconducting magnet, development of practical ship propulsion motor is expected. The development of MW-class motor in addition to 400-kW-class motor is planned. It is prospected that the global demand for reduction in carbon dioxide
emissions will accelerate the development of various superconductivity-applied products.

5. Conclusions

Sumitomo Electric’s dynamically innovative DI-BSCCO has pushed the limits of critical current, mechanical strength and anti-ballooning properties. DI-BSCCO is also innovative in that it may trigger the commercialization of a wide range of superconductor products. Table 5 shows the advantages and application examples of superconductor. Although various advantages are expected in different areas, superconductor must meet various requirements. By globally supplying high-performance DI-BSCCO at reasonable prices, Sumitomo Electric is determined to exploit the superconductor market together with application product developers. Sumitomo Electric will strive to act as an evangelist of high temperature superconductor in order to make the 21 century the century of superconducting technology.

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