» Company Profile

Introduction of SuperPower Inc. and High Temperature Superconducting Wire

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1. INTRODUCTION

SuperPower Inc. (SPI) is located in Schenectady, NY, USA and develops and manufactures the second-generation high-temperature superconducting (HTS) wire materials. The predecessor of SPI was the Technology Development Organization (TDO) of Intermagnetics General Corporation (IGC) which was heavily focused on HTS research. SPI was formed in 2000 as a wholly-owned subsidiary of IGC, and ultimately became a member of the Furukawa Electric Group (local corporation, 100% invested) in 2012.

Figure 1 Manufacturing and corporate facility of SuperPower Inc.

Since our inception, we, at SPI, have been recognized as a leading company in the high-temperature superconductor field with our unique technological capabilities and facility development know-how. We will make further contributions to the superconducting technology of the Furukawa Electric Group and in new business creation in the future, as a member of “One Furukawa”.

While focusing on improvement of performance and development of mass-production techniques for high-temperature superconducting wire materials, the present business activity of SPI is selling the wire materials, which are obtained as a by-product of our research, to the R&D departments of multiple domestic and overseas national institutes, universities, and companies. Based on the results of the verification tests and the experimental work of such end users, we continuously improve our performance and quality.

The second-generation high-temperature superconducting wire materials which SPI develops are based on the Rare Earth-Barium-Copper-Oxide (REBCO) superconducting compounds. With excellent high-current properties in magnetic field, they are suitable as winding wires for electromagnetic coils which generate high magnetic field for application in energy, transportation, medical or advanced scientific analysis devices. The HTS conductors continue to be used for various verification tests in multiple national projects worldwide. The HTS conductors are expected to be essential wire materials for the future businesses of Furukawa Electric. In addition, the applicability of HTS to power cables, which is the original product of Furukawa Electric Group, is well advanced and it is expected that they will make a decisive contribution to the realization of zero electrical resistance, a dream for a lossless electrical transmission and low carbon society in the future.

2. Characteristic of SPI’s high-temperature superconducting wire materials

SPI’s high-temperature superconducting conductors are fabricated using multilayered thin-films. The superconducting film is deposited on a buffered high strength metal substrate forming a flexible thin tape (see Figure 2). The thin-film of the high-temperature superconducting $REBa_2Cu_3O_{7-\delta}$ (RE: Rare Earth, Barium, Copper-Oxide) material has electrical conducting properties depending on the crystal orientation of the film. It is critical to have precise orientation control of the crystal growth to achieve optimal performance. At SPI, the multilayered buffer stack has an aligned crystal orientation in the direction of the substrate surface. The buffer stack is formed by sputtering and Ion Beam Assisted Deposition (IBAD) of the buffer layers on the metal substrate which is initially smoothed by electrolytic polishing. By growing the REBCO superconducting thin-film on this aligned buffer stack using Metal Organic Chemical Vapor Deposition (MOCVD), we can achieve control of the crystal orienta-

* SuperPower Inc.

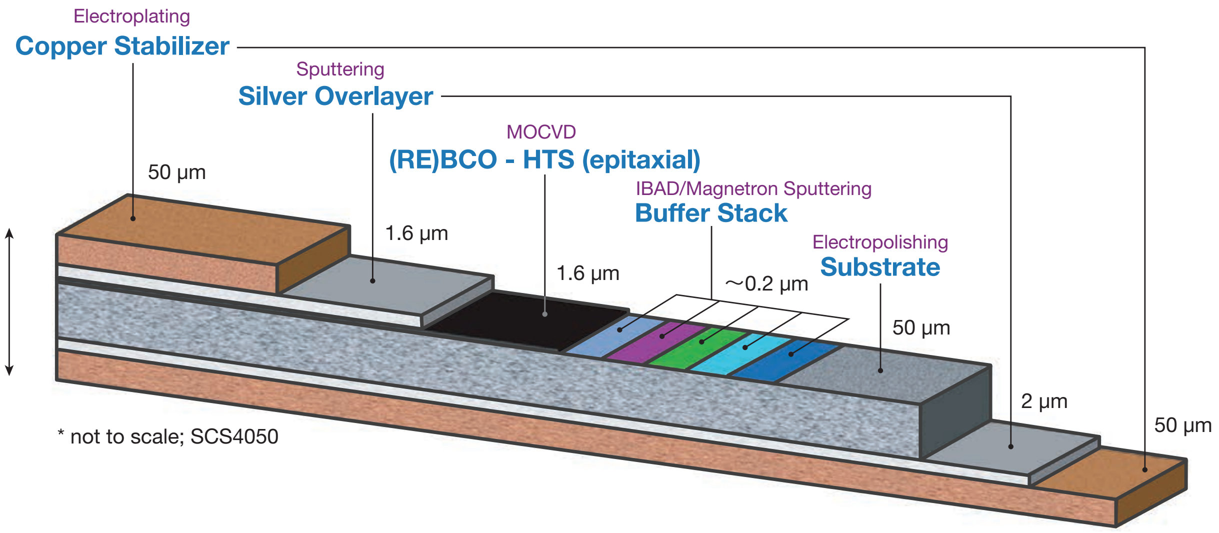

Figure 2 Structure of the high-temperature superconductor produced by SPI.

tion of the superconducting thin-film with precision. After growing the superconducting layer, a silver stabilization layer is formed on around the outside of the conductor. An additional Cu stabilization layer can also be formed around the conductor if required by the customer. The wire materials are subjected to examinations such as measurement of the critical current value (Ic) and visual appearance inspection and are then delivered.

The conductor configuration shown in Figure 2 is, a wire material in a thin tape shape with a wire width of 4 mm, metal substrate thickness of 50 μm, Cu stabilization layer thickness per side of 20 μm or 40 μm total and a total thickness of less than 0.1mm. According to the customer's requests, it is possible to fabricate conductor in several wire widths (2, 3, 4, 6, and 12 mm) and several substrate thicknesses (30, 50, and 100 μm). We have been continuing the improvement and homogenization of the manufacturing process and the wire material lengths of several hundred meters are available.

3. Configuration and use of SPI's high-temperature superconducting wire materials

SPI's high-temperature superconducting wire materials have two product types sold for several different applications. One is the cable formulation of the HTS film suitable for power cable and other utility applications and performs appropriately in the operating environment of temperature of more than 65 K (K: Kelvin, absolute temperature) and in magnetic fields of less than 1 T (T: Tesla, a unit of magnetic flux density). The other is an Advanced Pinning (AP) formulation of the HTS film. This is the formulation suitable for the use at middle temperature (20-65 K) / middle magnetic field (1-8 T) or at low temperature (4-20 K) / high magnetic field (>8 T). This formulation has an artificial columnar pinning structure in the HTS film which has the effect of increasing the critical current value in magnetic field and it is the wire material that SPI excels at.

Making full use of the characteristics mentioned above, SPI receives favorable reviews such as "we could make electromagnetic coils which are light weight, compact, and can generate super-high magnetic field" or "we became successful in the development of high current cables which have extremely thin outer diameters and are compact" from many customers who utilize our products. SPI's wire materials are suitable for middle and high magnetic field applications (next-generation MRI, high performance NMR, particle accelerator, plasma nuclear fusion reactor, etc.) and many other proposed applications, not only in the US but also in Japan, Europe, and Asia (Figure 3 and Figure 4).

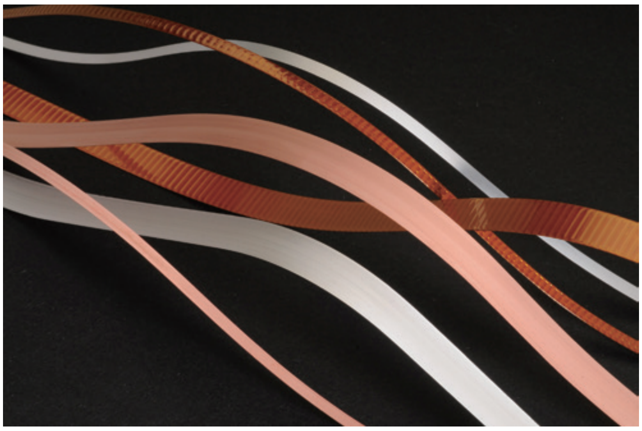

Figure 3 Various configurations of the superconductors produced by SPI.

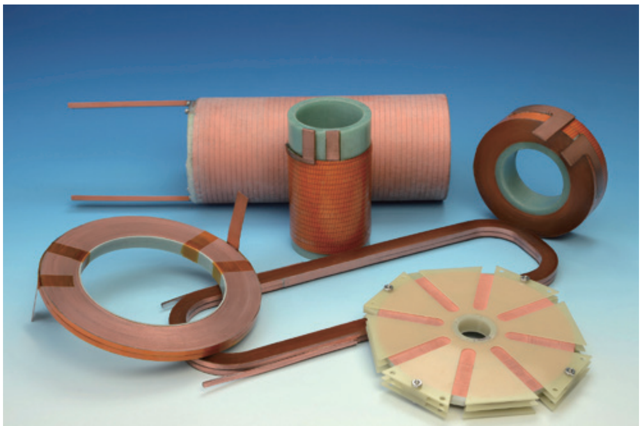

Figure 4 Examples of the coil-forms using the SPI's superconductors.

Figure 5 A scene from "Tool-box Meeting".

4. Present state of manufacture and development of production technology

Schenectady, NY, where SPI is located, is the birthplace of the General Electric Co. which was founded by Mr. Thomas Edison, and is the home of large factories for electric power equipment. The central research laboratory where basic technologies are developed is located nearby. For over 100 years, Schenectady has a history as a city of R&D up to the present date. The neighboring town of Albany, the capital of NY State, has aggressively developed centers of excellence in nanotechnology and semiconductor-associated fields and is an area where research institutes of companies and universities gather.

In such a background, the engineers and technicians who have the DNA of R&D and manufacturing gather in the factory of SPI. They focus on the research and development to improve the yield rate in the manufacturing processes to establish robust manufacturing techniques of high-temperature superconducting wire materials. We follow the fundamental principles and perform design, fabrication and improve the process and facilities by ourselves. All members participate in continuous improvement activities calling it "Quality & Consistency". All employees are always conscious that "safety takes top priority" and improve and establish a safety mindset by weekly patrols in which managers participate. All of us shout the slogan, "Be Safe! Let's Go Safe!", at the "Gemba Meeting (Tool-box Meeting)" and the factory space is vibrant.

5. CONCLUSION

SuperPower Inc. continues to give consideration to the voice and requests of our customers and continues the improvement of the characteristics of our high-temperature superconducting wire materials and the development of new products. Contributing to the progress of advanced equipment and being contributors to the well-being of future society are and will continue to be goals of all members in SPI.