WB4-1-INV

Development and production of 2G HTS wires for moderate and strong magnetic field application at SuperOx

*Valery Petrykin[1], Marat Gaifullin[1], Maki Okube[1], Naoyuki Hirata[1], Vladimir Vyatkin[1], Miyuki Nakamura[1], Juhyun Chung[1], Tatsunori Okada[3], Satoshi Awaji[3], Alexander Molodyk[2], Sergey Samoilenkov[2], Sergey Lee[1]

SuperOx Japan LLC, Japan[1]
SuperOx, Russia[2]
Tohoku University, Japan[3]

Installation of the new manufacturing equipment at SuperOx Japan allowed for increasing HTS wire production capacity from 150 km/year (in terms of 4 mm wire) in 2018 to almost 400 km in 2020. At the same time, current demand for the standard 2G HTS wires based on GdBaCuO manufactured by SuperOx was almost satisfied, and development of new wires with improved Ic-B characteristics is necessary to expand the presence of SuperOx in the market.
Considering the prospective operating conditions of the future 2G HTS wires, we identified four target areas of interest for the development of the new HTS wires: 1) superconducting rotating machines (1-3T and 65-77K); 2) accelerator magnets and coils for levitating devices (3-5T, 30-40K), 3) superconducting magnets for fusion reactors (10-20T, 20K) and 4) high-filed NMR (30T, 4.2K).
To obtain such a new 2G HTS wire or a set of wires, which will possess considerably higher Je under the specified operating conditions, we employed the following development strategies:
- Optimizing the overall superconducting material stoichiometry;
- Variation of chemical composition by substitution into RE-site;
- Introduction of artificial pinning centers in the PLD process;
- Heavy ion irradiation of the HTS wires to create columnar defects;
- Fabrication of multilayered superconductor structures;

Extensive R&D yielded two prospective materials compositions for the production of wires with increased Je by the factor of two. Their Ic-B properties are optimized for medium and high magnetic field range application. Launch of the production of new 2G HTS wires was successfully accomplished in the 3rd quarter of 2019, and we expect to reach a benchmark of 300 km/year by the end of 2019 of the wires for the application in a high magnetic field.

Keywords: coated conductors, PLD, 2G HTS tapes, pinning

WB4-2-INV

Production and Development of REBCO (2G-HTS) Conductors

*Paul Brownsey[1], Satoshi Yamano[1], Drew Hazelton[1], Yifei Zhang[1], Aarthi Sundaram[1], Shinya Yasunaga[1], Gene Carota[1], Hiroshi Kuraseko[2], Toru Fukushima[1], Hisaki Sakamoto[2], Akinobu Nakai[2]

SuperPower Inc. United States[1]
Furukawa Electric Co., Ltd. Japan[2]

The potential applications of Rare-Earth Barium Cupper Oxide (REBCO), Second-Generation High-Temperature Superconductors (2G-HTS), have been demonstrated in many projects for the last several years. This indicates the REBCO conductor is now being considered a robust and feasible solution for advanced devices and systems for a wide range of technologies. Efforts have focused on stabilizing and controlling processes to meet the requirements of high performance and large scale deployments.

This paper describes recent approaches to produce accomplished REBCO conductors with better performance and quality for industrial applications. Recent production improvements have delivered longer and more consistent conductor. Targeting in-field performance based on specific industry requirements and monitoring run to run consistency. Routine Ic-B-T-Θ performance and mechanical measurements benchmark process stability and control. Ongoing work to understand and requirements beyond 77K SF Ic to enhance processes for excellent performance and consistency across all critical demands conductor must meet.

Keywords: REBCO, HTS, SuperPower, Furukawa

WB4-3-INV

Present status of superconducting wire development in China: RE-123 CCs and related applications

*Yutaka Yamada[1,2], Yue Zhao[1,2], Zhiyong Hong[1,2], Zhijian Jin[2]

Shanghai Superconductor Technology Co. Ltd.[1]
Shanghai Jiao Tong University[2]

The activity of RE-123 Coated Conductor (CC) at Shanghai Superconductor Technology Co. Ltd (SST) and related applications will be presented.

SST coated conductor is progressing with focusing on the large market such as electric power applications and fusion such that 30 micron thin Hastelloy substrate tape was successfully produced in mass-production system. Furthermore, high Je at 4K and high fields was achieved at above 220kA/mm2 at 4K, 12T with Ic of 570A.

Recently we have many HTS projects in China including cable, FCL, accelerator, high field magnet and so on. Typical examples of these projects used SST tape will be introduced such as Shanghai Cable Project: 1.2km long REBCO cable installed in the center of Shanghai downtown.

Keywords: Coated Conductor, large scale production, high critical current, applications in China

WB4-4-INV

BMO Doped REBCO Coated Conductors with Uniform in-Field Performance and High Growth Rate by Hot-wall PLD Process

*Yasuhiro Iijima[1], Kazuomi Kakimoto[1], Shinji Fujita[1,2], Shogo Muto[1], Tomo Yoshida[1], Wataru Hirata[1], Yutaka Adachi[1], Satoru Hanyu[1], Ryo Kikutake[1], Masanori Daibo[1], Satoshi Awaji[2], Takanobu Kiss[3]

Fujikura Ltd., Japan[1]
Tohoku University, Japan[2]
Kyusyu University, Japan[3]

Recent years we have participated in a 3 year program led by NEDO, MITI, to improve in-field transport performance and longitudinal uniformity of REBCO wires designed for 3-T class compact whole-body MRI magnet, without spoiling wire productivity. In this program, we concentrated on optimization of growth conditions for BMO-doped REBCO wires and found a high-growth rate deposition conditions of several 10s nm/sec, by using hot-wall type PLD process, which realized homogeneous crystalline growth conditions for REBCO by furnace-like substrate heating. In-field J_c properties of ~2-times bigger than non-doped ones were eventually obtained in low temperature range below 40 K. Those samples had a scattered short length BMO nano-rod structure, and a random pinning like scaling behavior was observed for the pinning forces in wide temperature range.

In-field J_c uniformity were characterized by Hall-probe magnetization measurement at 77K below 2.0T. Slight field dependent J_c enhancement and/or deviation were observed in several % length of measured samples, but quite good agreement observed for longitudinal J_c variations normalized by maximum J_c point up to 2.0 T. Furthermore, transport tests of 4-layered pancake coils have conducted by using a 34 meters long BMO-doped REBCO wire. The I-V characteristics of the coils agreed very well with numerical engineering estimations of angular dependent in-field J_c for BMO-doped REBCO wires.

Commercial shipment of the BMO-doped wire has started with production samples of 300-600m long and test samples of 1km long class also produced with good I_c uniformity comparable to non-doped REBCO wires. Mechanical reliability of those BMO-doped REBCO wires were also surveyed and the improvement od delamination strength were observed by total process refinement compared to past non-doped production wires. A part of this work is based on results obtained from a project subsidized by the New Energy and Industrial Technology Development Organization (NEDO).

Keywords: REBCO, Coated Conductors, Hot-Wall PLD

WB4-5-INV

Recent progress on the development of MgB_2 wires in Hitachi

*Hideki Tanaka[1], Motomune Kodama[1], Takaaki Suzuki[1]

Hitachi, Ltd.[1]

MgB_2 wires and coils have great potentials for helium free superconducting magnet. We have been concentrated on improving the longitudinal homogeneity of MgB_2 wire, and it was confirmed by making the magnet for klystron use by Wind & React method.
We will talk about how to bend the sintered MgB_2 wires without Ic degradation for React & Wind method. Three approaches can be thought for making the critical-bending-radius of MgB_2 wire smaller. First one is increasing the pre-compressive strain on MgB_2 filaments by raising heat treatment temperature. Second one is reducing tensile strain on MgB_2 filaments by moving the neutral axis of bending from the center of the wire. Last one is reducing tensile strain on MgB_2 filaments by arranging positions of MgB_2 filaments into center part of the wire. In this presentation, the results of improving the bending radius of the MgB_2 wire with the first and second approaches will be presented.

Keywords: MgB2 wire, Wind & React, React & Wind, bending radius