WB2-1-INV

Recent progress in newly alloyed Nb_3Sn conductors

*Chiara Tarantini[1], Shreyas Balachandran[1], Peter J. Lee[1], Nawaraj Paudel[1], Benjamin Walker[1], William L. Starch[1], David C. Larbalestier[1]

Applied Superconductivity Center, National High Magnetic Field Laboratory, Florida State University, USA[1]

The requirements for Nb_3Sn conductor for the realization of the Future Circular Collider (FCC) are very stringent. Particularly challenging is the target non-Cu J_c -(16T, 4.2K) of at least 1500 A/mm^2. Nowadays the best commercial Nb_3Sn strands can achieve only 1300 A/mm^2, demanding a significant improvement of the high-field J_c performance. To meet the FCC J_c target we developed new Nb-Ta-Zr, Nb-Ta-Hf and other alloys to introduce additional pinning centers while maintaining a high H_{Irr} in Nb_3Sn. Although the employment of SnO_2 can lead to the formation of ZrO_2 or HfO_2 precipitates, the best performances were obtained in the oxygen-free Hf-Ta-doped Nb_3Sn thanks to its very small grain size of less than 100 nm. This approach more than doubles the maximum of F_p and shifts its peak from 4.6 T, typical of Ta-doped wires, to 5.8 T on the Hf-Ta-doped conductor. This leads to a layer J_c(16T, 4.2K) of about 3710 A/mm^2, corresponding to a potential non-Cu J_c(16T, 4.2K) of 2230 A/mm^2. The microstructural analysis suggests a correlation between grain size of the alloys and the A15 phase. In particular the presence of Hf causes an increase in the recrystallization temperature of the alloy that then leads to the formation of small-grain A15. In this presentation we will discuss the sensitivity of H_{Irr} and F_p to heat treatment with respect to standard Ta/Ti-doped conductors and we will show the most recent results on multifilamentary wires and on the optimization of the dopant content.

Keywords: Nb3Sn, Critical current density, Pinning mechanisms, High Field

WB2-2-INV

Recent Progress of Nb_3Sn Wires in Furukawa

*Hisaki Sakamoto[1], Daisuke Asami[1], Masahiro Sugimoto[1], Hideki Ii[1], Hirokazu Tsubouchi[1], Tomoya Kato[1]

Furukawa Electric Co., Ltd.[1]

Furukawa Electric Co., Ltd. (FEC) started the development of A15 superconductors such as Nb3Sn and V3Ga at early '70s and has focused on the development of multi-filamentary Nb3Sn wires through the bronze process. Since then, FEC has contributed to various fusion projects. such as MFTF-B and ITER. FEC also developed various type of Nb3Sn wires and cables collaborating with universities and national laboratories.

In this presentation, history and recent topic of Nb3Sn development at FEC are mentioned.

Keywords: Superconductor, wire, Nb3Sn, Bronze process

WB2-3-INV

Recent Progress of Nb_3Sn Wires in KSL/JASTEC

*Shinya Kawashima[1], Takao Kawarada[1], Hiroyuki Kato[2], Yukinobu Murakami[2], Kazuyoshi Saito[2], Michinaka Sugano[3], Toru Ogitsu[3], Hidetoshi Oguro[4], Satoshi Awaji[5]

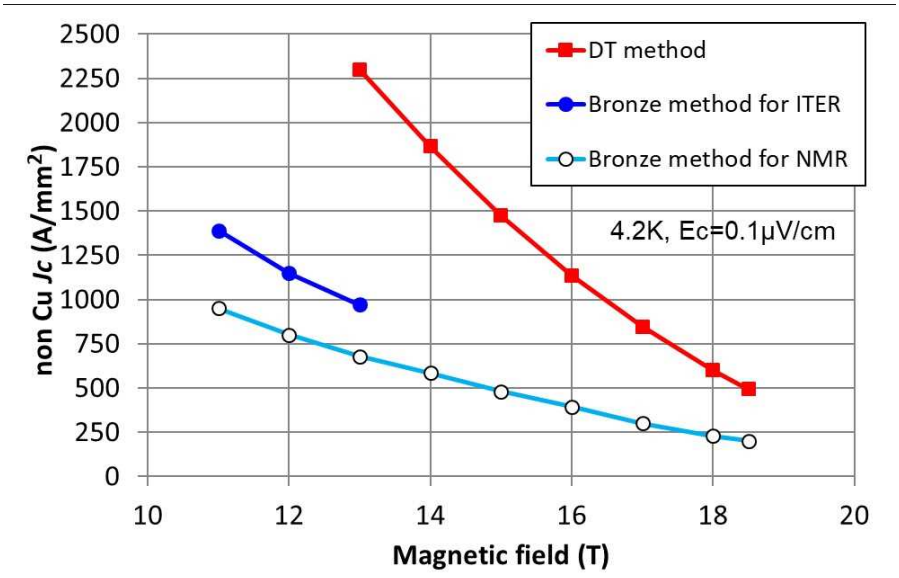
Kobe Steel, Ltd.[1]
Japan Superconductor Technology[2]
High Energy Accelerator Research Organization[3]
Tokai Universit[4]
Tohoku University[5]

Kobe Steel Ltd. (KSL) has been doing researches of Nb_3Sn wire since the 1980s. Japan Superconductor Technology, Inc. (JASTEC), which belongs to Kobe Steel Group, has been manufacturing superconducting wires and magnets. In respect of the superconducting wires, JASTEC has high production capacity in bronze-processed Nb_3Sn wires and is one of the main supplier of Nb_3Sn strands used for ITER project. To increase *Jc*, we made the filament diameter finer and improve the heat treatment, and achieved very high performance of non-Cu *Jc* = 1200A / mm^2 at 12 T, 4.2 K by the bronze method.

Recently, according to the assumed specification of the Nb_3Sn for the accelerator magnets of the FCC (Future Circular Collider) planned by CERN (European Organization for Nuclear Research), it is required to achieve extremely high *Jc*, which is unprecedented, and high RRR (Residual Resistivity Ratio) and small effective filament diameter (d_{eff}).

We have developed high performance Nb_3Sn wire via DT (Distributed Tin) method, which is a type of internal Sn method with single barrier. So far, non-Cu *Jc* of 1,100 A/mm^2 at 16 T, 4.2 K has been achieved by reducing Sn diffusion length and optimizing Ti content. The d_{eff} of these samples were approximately 30 to 60 μm. The values of RRR were approximately 350, and RRR after 10% rolling assuming deformation of the cabling were 150 to 200, and no decrease in *Jc* was observed.

From these results, The DT method has very high potential as a candidate of Nb_3Sn wire for FCC. We will continue to improve *Jc* by further increasing Nb ratio and optimizing for the Sn diffusion distance, ternary additive elements and heat treatment, etc., for targeting the FCC's specification.



Acknowledgments: This work was supported by the CERN and KEK under contract. Appendix 19 to the Agreement on Collaborative Work between CERN and KEK (ICA-JP-0103)

Keywords: Superconducting wire, Nb3Sn, Bronze method, Distributed Tin method