WB3-1-INV

Recent Progress on the Development of MgB_2 superconductors at Hyper Tech

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This presentation will discuss Hyper Tech's latest progress on development of MgB_2 wire, cables, coils and applications. It will include latest improvements with regard DC and low AC loss MgB_2 wires. These wires are now being configured into coils and cables for various applications. The primary applications being pursued are MRI, NMR, SMES, FCL, rotors and stators for wind turbine generators, and high speed motors and generators for all electric aircraft.

Keywords: MgB2, superconductor, wire, coils

WB3-2-INV

Recent progress on the development of MgB_2 wires in Hitachi

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Owing to the relatively high critical temperature (~40 K) and the low manufacturing cost, MgB_2 wires are promising for liquid helium-free superconducting applications. We have been developing MgB_2 wires, using the *in situ* powder-in-tube process, in which a metallic billet filled with magnesium and boron powders are processed into a thin wire.

For the *in situ*-processed MgB_2 wires, as is well known, the use of fine boron powder, the appropriate way of carbon addition, and the increase in the filling density of powder through wire processing are effective to enhance the critical current density, J_c. Optimizing these manufacturing conditions carefully [1−3], we obtained the J_c of 10^3 A mm^{-2} at 10 K and 5.4 T, 15 K and 4.2 T, and 20 K and 2.8 T. By using a 300-meter-long MgB_2 wire with 10 filaments 1.5 mm in diameter, we fabricated a coil 120 mm, 190 mm, and 41 mm in inner- and outer-diameters and height, respectively. The coil was successfully driven in a maximum field of 2.3 T at 24 K and the longitudinal homogeneity of the wire was confirmed [4].

To further improve J_c, we have been developing the mechanical milling method. In this method, magnesium and boron powders are mixed with a planetary mill, and the characteristic precursor particles, in which boron particles are dispersed in a magnesium matrix, are formed. We demonstrated that a monofilamentary wire fabricated from the mechanically milled powder has superior J_c to wires prepared by sufficiently optimized *in situ*-process [3].

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Keywords: MgB2, wire, critical current density, mechanical milling

WB3-3-INV

Development of iron-based superconducting materials for high-field applications

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The high upper critical field and low anisotropy of iron-based superconductors (IBS) make them being particularly attractive for high-field applications, especially for the construction of next-generation nuclear magnetic resonance (NMR) spectrometers, particle accelerators and ultra-high-field magnets. Conventional powder-in-tube (PIT) method has been the most effective technique for fabricating IBS wires and tapes. The transport critical current density J_c of IBS wires and tapes has been rapidly increased in the recent years, the highest J_c values have now achieved 0.15 MA/cm^2 (I_c = 437 A) at 4.2 K and 10 T in densified and textured 122 tape samples. The transport J_c measured at 4.2 K under high magnetic fields of 27 T is still on the level of 5.5 x 10^4 A/cm^2, which is much higher than those of low-T_c superconductors such as NbTi, MgB_2 and Nb_3Sn. More recently, the world's first 100 meter-class 7-multifilamentary IBS tape was fabricated by a scalable rolling process, which demonstrates the great potential in large-scale manufacture. In this presentation, I will report recent activities of the wire processing based on 122 IBS materials. Finally, the future development and problems to be solved in this area are suggested.

WB3-4

New Internal-Sn Processed Nb_3Sn Conductors with Brass Matrix

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Nb_3Sn conductors are widely used for high-field NMR, fusion, refrigerator cooled magnet etc.. The improvement of performance of Nb_3Sn is one of the most important topics in the long term application of superconductivity. We proposed new internal tin(IT) processed Nb_3Sn using Cu-15 wt% Zn alloy(gold brass, GB) matrix[1)]. The IT process has a possibility to use different alloys as the matrix. In this study, diffusion behaviors of constituent elements in the matrix have been studied. Sn component of this study contains 1.6 wt% Ti. Then trial fabrication of multifilamentary wire using GB matrix has been performed.

Table 1 is the result of EPMA analysis for SS(single stack) 37 core wires with Cu and GB matrix, and MF(multifilamentary) 817 core wire with GB matrix after the heat treatment. The residual Sn in the matrix after the heat treatment is appreciably smaller in GB matrix wire than in Cu matrix wire. This indicates that the Sn diffusion in GB matrix is faster than in Cu matrix. Due to the solubility limit in Cu, Zn seems to push Sn to form Nb_3Sn layers around Nb cores. The Sn content in Nb_3Sn layer is a little higher in GB matrix wire than in Cu matrix wire. Zn remains homogeneously in the matrix with no reaction to other constituent elements. Since the equivalent mass value of Zn for Sn is ~0.5, residual 14%Zn in the matrix corresponds to ~7%Sn. The increase of equivalent Sn content in the matrix may improve mechanical strength as well as AC performance of Nb_3Sn wires.

Different type MF wires were fabricated through double stacking procedure. Fig.1 shows the cross-section of MF 817 core wire indicated in Table 1 [2)]. As for J_c values without Nb and Cu sheath area, MF684 core wire has recently shown J_c values of 1470A/mm^2 and 640A/mm^2 at 12T and 16T, respectively at 4.2K. Further improvement in J_c may be expected by the improvement in wire fabrication techniques as well as by the optimization of heat treatment condition.

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Table 1 Composition of matrix and Nb_3Sn layer in SS and MF 817 wires (wt%).

Wire	Temp. (°C)	Time (hr)	Matrix			Nb_3Sn layer		
			Cu	Sn	Zn	Nb	Sn	Ti
SS-Cu	700	200	95.55	4.45		74.79	24.12	1.09
SS-GB	700	200						
Inner Matrix			85.37	3.02	11.62			
Outer Matrix			85.90	2.85	11.25	73.28	25.52	1.20
MF817	700	200						
Inner Matrix			84.38	1.61	14.01			
Middle Matrix			84.45	1.81	13.74			
Outer Matrix			82.75	1.64	15.60			

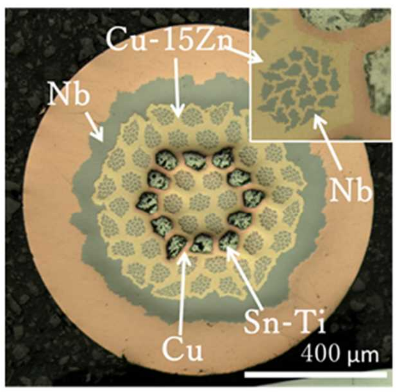

Fig.1 Cross-section of 817 core wire.

Table 1 Composition of matrix and Nb_3Sn layer in SS and MF 817 wires (wt%).
Fig.1 Cross-section of MF 817 wire.

Keywords: Nb3Sn, brass matrix, diffusion, Jc