§2. MgB_2 Superconducting Wires for Current Lead Application

Yamada, Y., Nitta, A., Ohki, S., Tachikawa, K. (Tokai Univ.),
Tamura, H., Mito, T.

1. Introduction

Since the discovery of superconductivity in MgB_2 with critical temperature Tc of 39 K, many researches and developments of conductors on the new superconductor have been performed. In particular, improvement of critical current density Jc in MgB_2 superconducting wires and tapes have gained world-wide interest for practical applications.

In this report, superconducting properties and workability of in-situ powder-in-tube PIT processed MgB_2 thin wires sheathed with pure iron and stainless steel have been studied.

2. Experimental

Fig. 1 shows preparation procedure of in-situ PIT processed MgB_2 wires. Magnesium hydride MgH_2 and amorphous B powders mixed with 5 mass% SiC nano-sized powder were encased into pure iron tube 8 mm in outside and 4.5 mm in inside diameter. The tube was fabricated into square rod of 1.8 mm by a grooved-rolling and then into a wire 0.5 mm in diameter by cold drawing. The wire was inserted into an austenitic stainless steel SUS304 tube (outside/inside diameter:1.6/0.6 mm) to form SUS304/Fe sheathed MgB_2 composite wires by cold drawing. The heat treatment was performed at 630℃ for 10 h in Ar gas atmosphere. The critical current Ic at 4.2 K was measured by a four-prove resistive method and magnetic field was applied perpendicular to the specimen current.

3. Result and Discussion

Fig. 2 indicates the optical micrographs of cross-sections of SUS304/Fe sheathed MgB_2 wires 0.530 mm and 0.353 mm in diameter. The wires are composed of MgB_2 core, thin pure iron and thick stainless steel with low thermal conductivity. The sheath(SUS304+Fe)/MgB_2 core ratio is about 21 in both composite wires, while the cross-sectional area of the wire of 0.353 mm in diameter decreases by 40 % compared to that of 0.530 mm.

. The reduction ratio of the thin wire of 0.353 mm in diameter is 95 %. The SUS304 stainless steel sheath with Vickers hardness Hv of 380 was hardened to around Hv 700 by the cold drawing. On the other hand, the hardness of pure iron sheath rose from Hv:210 to Hv:360 due to work hardening.

Magnetic field dependence of core Jc at 4.2 K for the MgB_2 wires is shown in Fig. 3. The Ic for the wire of 0.353 mm in diameter is 5.1 A at 1 T and 20 A at self-field(0 T), which correspond to the core Jc of 1,130 A/mm^2 and 4,440 A/mm^2, respectively. The Jc of the thinner MgB_2 wire is slightly higher than that of thick wire of 0.53 mm in diameter. SiC nano-sized powder addition to the MgB_2 core has been found to enhance the transport current properties in magnetic fields [1), 2)].

In future work, a current leads with small heat leakage using SUS304/Fe sheathed MgB_2 composite wires will be developed due to the improvement of transport current properties.

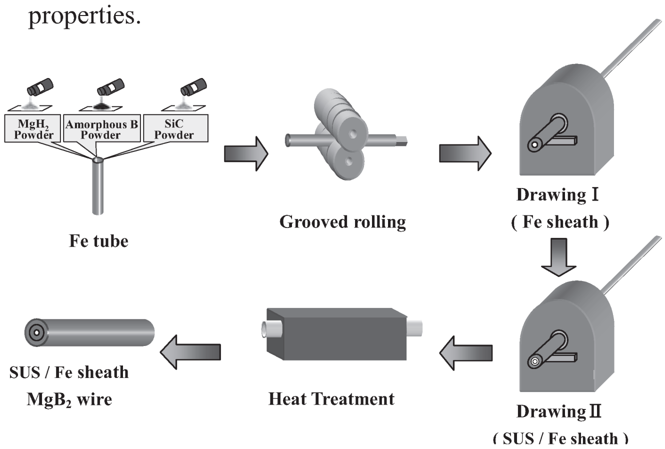

Fig. 1. Preparation procedure of in-situ powder-in-tube processed MgB_2 wires.

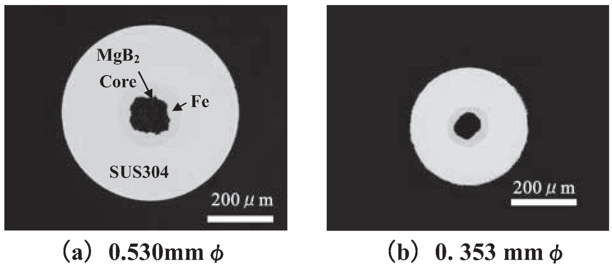

Fig. 2. Cross-section of SUS304/Fe sheathed MgB_2 wires. (a) 0.530 mm, (b) 0.353 mm in diameter.

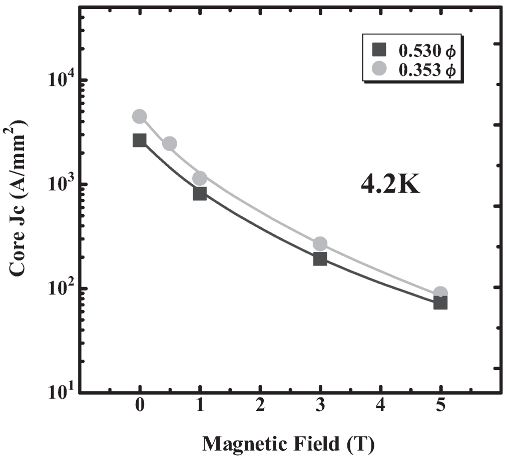

Fig. 3. Magnetic field dependence of core Jc at 4.2 K for the MgB_2 wires.

1) Yamada, Y. et al.: Adv. in Cryogenic Engineering, **52**, (2006) 631.
2) Yamada, Y. et al.: IEEE Trans. Appl. Supercond., **17**, (2007) 2911.