§19. Superconducting Properties of MgB_2 Wires Synthesized with External Mg Diffusion Process

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1. Introduction

Since the discovery of superconductivity in MgB_2 with critical temperature Tc of 39 K, developments of conductors as well as fundamental researches on the new superconductor have been performed. In particular, improvements of critical current density Jc in MgB_2 superconducting wires and tapes have gained world-wide interest for practical applications[1)-3)].

In present work, superconducting properties and structure of MgB_2 wires synthesized with external Mg diffusion process have been reported.

2. Experimental

Fig. 1 shows preparation procedure of MgB_2 wires by external Mg diffusion process. A pure Mg tube of 6/4 and 6/3.5 mm in outside/inside diameter was inserted into a pure iron tube of 12/6 mm, and then amorphous B powder mixed with 5 mol% SiC nano-sized powder addition was encased in the Mg tube to form Fe/Mg/B(powder) composite. The composite was fabricated into 1.8 mm square wire through grooved-rolling and then drawn into round wires of 1.0 and 0.8 mm in diameter without intermediate annealing. The heat-treatment was performed at 630℃ for 5 h in Ar gas atmosphere.

The critical current Ic at 4.2 K of specimens was measured by a four-probe resistive method, the criterion of the Ic measurement being 1 μV/cm. The core Jc was calculated by dividing Ic by the cross-sectional area of the MgB_2 core.

3. Results and Discussion

Fig. 2 shows SEM image taken on the fractured cross-section of MgB_2 wire of 0.8 mm. The MgB_2 superconducting core was synthesized in a center of the wire through diffusion reaction between Mg metal and B powder with SiC addition. The MgB_2 core forms denser structure without voids in comparison with conventional in-situ PIT processed wires and tapes. The residual Mg which has not reacted with B powder remains around iron sheath. According to EPMA analysis, the composition of MgB_2 core is slightly B richer compare to stoichiometric composition of 1:2.

Magnetic field dependence of core Jc at 4.2 K for the MgB_2 wires is shown in Fig. 3. The Ic at 4.2 K for the MgB_2 wire of 0.8 mm (Mg 6/4) are 187 A at 5 T and 21 A at 10 T, which Ic values correspond to core Jc of 3740 A/mm^2 and 420 A/mm^2, respectively. The Jc values are one order of magnitude higher than that of PIT processed wires. The higher Jc results from denser structure without voids synthesized by diffusion process.

1) Y. Yamada, et al. : IEEE Trans. Appl. Supercond., **22** (2012) 6200304.
2) Y. Yamada, et al. : ICEC24-ICMC2012, 15P-P09-09, 80.
3) M. Son, et al. : IUMRS-ICEM2012, B-4-O26-022.

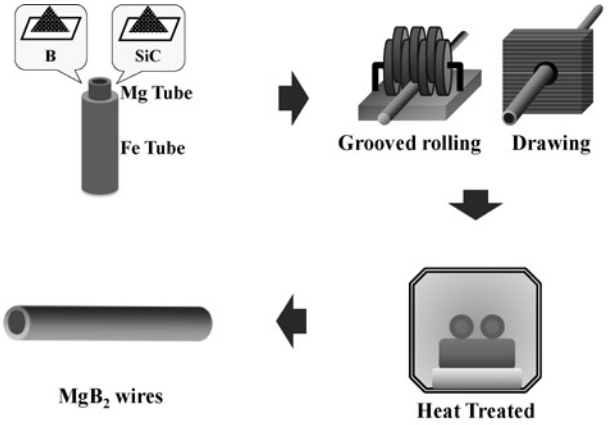

Fig. 1. Preparation procedure of MgB_2 wires by external Mg diffusion process.

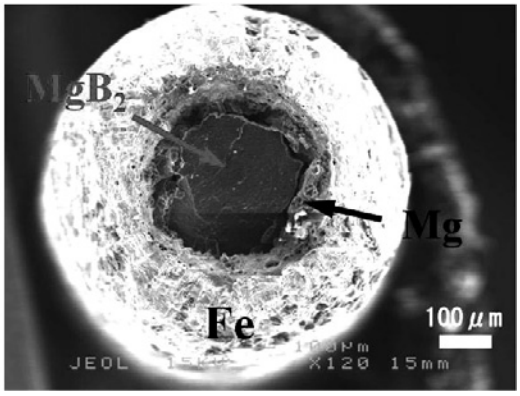

Fig. 2. SEM image of the fractured cross-section of MgB_2 wire.

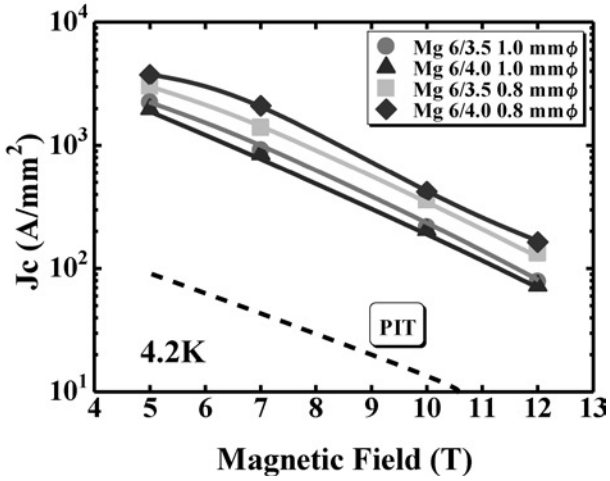

Fig. 3. Magnetic field dependence of Jc at 4.2 K for the MgB_2 wires.