

§19. Superconducting Properties of MgB₂ Wires Synthesized with External Mg Diffusion Process

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1. Introduction

Since the discovery of superconductivity in MgB₂ with critical temperature T_c 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 J_c in MgB₂ superconducting wires and tapes have gained world-wide interest for practical applications¹⁾⁻³⁾.

In present work, superconducting properties and structure of MgB₂ wires synthesized with external Mg diffusion process have been reported.

2. Experimental

Fig. 1 shows preparation procedure of MgB₂ 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°C for 5 h in Ar gas atmosphere.

The critical current I_c at 4.2 K of specimens was measured by a four-probe resistive method, the criterion of the I_c measurement being 1 μV/cm. The core J_c was calculated by dividing I_c by the cross-sectional area of the MgB₂ core.

3. Results and Discussion

Fig. 2 shows SEM image taken on the fractured cross-section of MgB₂ wire of 0.8 mm. The MgB₂ superconducting core was synthesized in a center of the wire through diffusion reaction between Mg metal and B powder with SiC addition. The MgB₂ 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 MgB₂ core is slightly B richer compare to stoichiometric composition of 1:2.

Magnetic field dependence of core J_c at 4.2 K for the MgB₂ wires is shown in Fig. 3. The I_c at 4.2 K for the MgB₂ wire of 0.8 mm (Mg 6/4) are 187 A at 5 T and 21 A at 10 T, which I_c values correspond to core J_c of 3740 A/mm² and 420 A/mm², respectively. The J_c values are one order of magnitude higher than that of PIT processed wires. The higher J_c 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.

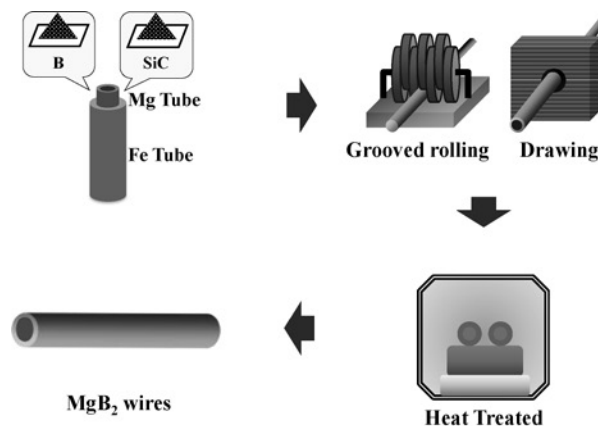


Fig. 1. Preparation procedure of MgB₂ wires by external Mg diffusion process.

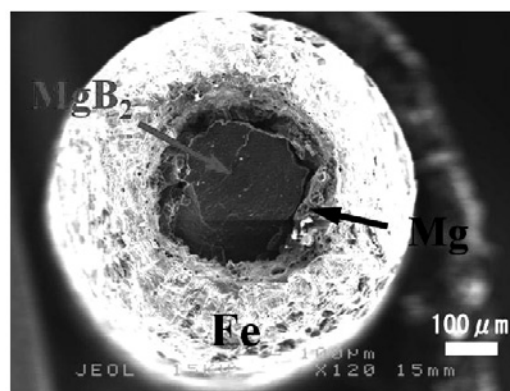


Fig. 2. SEM image of the fractured cross-section of MgB₂ wire.

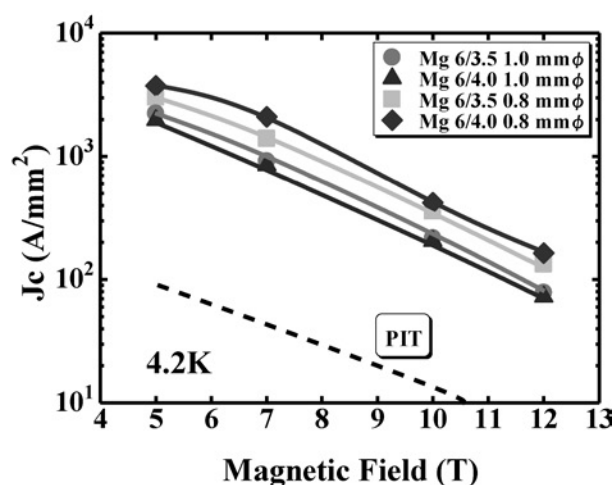


Fig. 3. Magnetic field dependence of J_c at 4.2 K for the MgB₂ wires.