§13. Microstructural of MgB₂ Wires Fabricated by Low-temperature In-situ Processes with Mg₂Cu Addition


An in-situ powder-in-tube (PIT) process using Mg, B and Mg₂Cu as starting powders is a promising process to fabricate MgB₂ wires at low temperatures below 773 K[1]. We investigated microstructure in the MgB₂ wires using transmission electron microscopy (TEM) and scanning transmission electron microscopy (STEM).

Foil specimens for TEM/STEM observation were prepared by focused ion beam (FIB) microsampling and milling techniques. TEM/STEM observation and energy dispersive x-ray spectroscopy (EDX) analysis were carried out at accelerating voltage of 200 kV.

MgB₂ crystals below 300 nm in sizes have plate-like shapes with (001) facets (Fig. 1), suggesting a reaction of solid B and liquid Mg-Cu. The average size of MgB₂ crystals increases with the amount of Mg₂Cu while the amount of residual B decreases. Two kinds of Mg-Cu compounds, Mg₂Cu and Cu₂Mg, are formed during the heat treatment process. Spaces between the plate-like MgB₂ crystals are filled with the Mg-Cu compounds showing orientation relationships with (001) planes of the plate-like MgB₂ crystals (Fig. 2). These Mg-Cu compounds formed between MgB₂ grain boundaries may be effective for enhancing magnetic-flux pinning but not effective for MgB₂ grain growth suppression because these compounds are formed after the crystallization of MgB₂ crystals. From critical current measurements, the optimum amount of Mg₂Cu addition is 3 mol%. This value may be determined from the microstructural advantages and disadvantages of the Mg₂Cu addition in the in-situ PIT process.

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