

Enhanced critical current density in MgB₂ prepared by reaction of MgB₄ and Mg

Abstract

Instead of reacting B and Mg powders, MgB₄ was used as precursor to react with Mg to obtain the polycrystalline samples of nominal composition Mg_xB₂ (x = 1.2, 1.5, and 1.7). Upon increasing the sintering temperature to 750 °C, the reaction between MgB₄ and Mg was thermodynamically intensified leading to the formation of larger MgB₂ weight fraction as estimated from X-ray diffraction (XRD) data using the Rietveld method. Despite no further improvement to the weight fraction of this phase by increasing the excess nominal Mg, it was shown that the critical current density (J_c) was enhanced by almost one order of magnitude. At 5 K, 2 T, J_c for the sample Mg_{1.5}B₂ is estimated to be 4.5×10^5 A cm⁻². The enhancement of J_c is attributed to the collective effect of improved grain connectivity and flux pinning by unreacted Mg. Incorporation of nano-SiC for reaction resulted in a more gradual drop of J_c with applied magnetic field. Hence, J_c can be tailored to meet the range of fields intended for various applications via optimization of excess nominal Mg and dopant additions.

Keyword: Critical current density; MgB₂; MgB₄; SiC; Superconductivity.