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Fabrication and Superconducting Properties of Ex-Situ Processed MgB_2/Fe Monofilament Tapes without any Intermediate Annealing

E. Yucel,[1] C. Terzioglu,[1,*] A. Varilci,[1] A. Gencer,[2] and I. Belenli[1]

[1]*Department of Physics, Faculty of Arts and Sciences, Abant Izzet Baysal University, 14280 Bolu, Turkey*

[2]*Department of Physics, Faculty of Science, Ankara University, 06100 Ankara, Turkey*

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We have investigated the effect of annealing time and temperature on the formation of the MgB_2 phase, transition temperature (T_c), lattice parameters (a and c), full width at half maximum (FWHM) of the X-ray diffraction, crystallinity, resistivity (ρ), residual resistivity ratio (RRR), active cross-sectional area fraction (A_F), and critical current densities (J_c) of MgB_2/Fe monofilament tapes fabricated using an ex-situ powder-in-tube (PIT) method without any intermediate annealing. To obtain the optimum annealing temperature, MgB_2/Fe monofilament tapes were annealed at 650, 750, 850, 950, and 1050 °C for 60 minutes. From these investigations, the optimum annealing temperature was found to be 950 °C. Then, to obtain the optimum annealing time, the samples were annealed at 950 °C for 15, 30, 60, 120, 180, and 240 minutes. The samples were characterized using X-ray diffraction (XRD), scanning electron microscope (SEM), energy dispersive X-ray spectrometer (EDS), optical microscope, critical transition temperature (T_c), and critical current density (J_c) measurements. The transport and microstructure investigations show that T_c, J_c, and the microstructure properties are remarkably enhanced with increasing annealing temperature up to 950 °C. The highest value of the critical current density was obtained after annealing at 950 °C for 60 minutes. The J_c and T_c^{offset} values of the sample annealed at 950 °C for 60 minutes were found to be 260.43 A/cm^2 at 20 K and 38.1 K, respectively.

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I. INTRODUCTION

MgB_2 compound, which was found to be a superconductor at 39 K, has many advantages, such as: high T_c value, simple structure, light weight, absence of weak-links, low anisotropy, large coherence length, and high critical current density value. The MgB_2 superconductor has the highest transition temperature among the inter-metallic compounds. These properties make it a good candidate for theoretical studies and practical applications [1–3]. The MgB_2 superconductor has been fabricated successfully in wire, tape, bulk, thin film, and single crystal forms using various methods by many research groups [4–10]. The magnesium diboride wires and tapes are generally fabricated by the PIT method [11–18]. There are two processes for fabricating MgB_2 wires and tapes using the PIT method, which are known as the ex-situ and in-situ methods. In the ex-situ method, fabrication of MgB_2 wires and tapes are made by using MgB_2 reacted powder [11, 14], while in the

