Comparative Study on Pore Formation and Current Properties of MgB_2 Bulk Prepared by *In-situ* and *Ex-situ* Reaction Process

J. H. Yi[a,b] , B. H. Jun[a], J. Joo[b], C.-J. Kim[a]

[a] *Neutron Science Division, Korea Atomic Energy Research Institute, P.O. Box 105, Yuseong Daejon, 305-353, Republic of Korea*

[b] *School of Advanced Materials Science and Engineering, Sungkyunkwan University, Suwon, Gyeonggi, 440-746 , Republic of Korea*

The MgB_2 bulk superconductor can be prepared by two different processes: in-situ and ex-situ. The former is a reaction process of (Mg + 2B) to form MgB_2, while the later is a sintering process for MgB_2 powders. One important problem in making MgB_2 bulk and wire is the evolution of pores during the formation reaction of MgB_2. The pores are considered to be formed by melting of Mg and capillary motion into narrow spaces. The presence of pores of a non-superconducting volume decreases the critical current density (J_c) of MgB_2. To enhance the J_c of MgB_2, therefore, the pores should be eliminated, or the volume should be minimized. To understand the mechanism of pore formation and its influence on the superconducting properties of MgB_2, MgB_2 bulk superconductors were fabricated by the in-situ and ex-situ process, and the combination. (Mg + 2B)/(MgB_2 +Mg + 2B) ratios (x) was changed from x=0, 0.1, 0.2, 0.3, 0.4, 0.5, 1. The powder mixtures of various compositions were pressed into pellets and heat-treated at 900 ^oC for 1 h and 600 ^oC for 1 h in an argon atmosphere and cooled to room temperature. The microstructure, phase formation were analyzed by powder x-ray diffraction and scanning electron microscopy. Superconducting transition temperature and critical current density were measured by magnetic property measurement system. The J_c values at 4 K and 20 K were calculated using a Bean model from the magnetization loops.

It was found that an apparent density after heat-treatment at 600 ^oC and 900^oC decreased linearly as an x value increase, which indicates that the (Mg + 2B) reaction to form MgB_2 is attributed to the formation of pores. In addition to the density decrease, an increase in pellet size was also observed as a strong evidence of the out-growth of MgB_2 grains. However the J_c increased as an x value increased. The reason why the J_c increased in spite of the density decrease is considered to be due to the improved connectivity of grain boundaries by in-site reaction. Detail features of microstructure evolution regarding pores and J_c variation are reported.

Keywords : *in-situ*, *ex-situ* process, MgB_2, density, pore formation, critical current density

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