Fracture low-temperature properties of MgB_2 bulk fabricated by hot isostatic pressing

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Introduction

Understanding of mechanical properties such as fracture strength and fracture toughness of superconducting bulk is indispensable because superconducting bulk is subjected to electromagnetic force and thermal stress in the superconducting devices. However, mechanical properties of MgB_2 bulk have not been understood extensively. In our previous study, packing ratio of an MgB_2 bulk fabricated by hot isostatic pressing (HIP) was higher than those of conventional MgB_2 bulk fabricated by capsule method [1]. The fracture strength of the former MgB_2 bulk was excellent at room temperature (RT) [1]. Evaluations of the mechanical properties at cryogenic temperature are informative for the practical application of superconducting bulk. In the present study, fracture strength and fracture toughness of an MgB_2 bulk fabricated by HIP were evaluated at 77 K through bending tests for specimens cut from the bulk. The fracture strength at very low temperature was estimated from the bending test results at 77 K and RT.


Fracture strength and fracture toughness in an MgB_2 bulk with the packing ratio of 92 % fabricated by hot isostatic pressing were evaluated at 77 K through bending tests for specimens cut from the bulk. The average fracture strength of the MgB_2 bulk at 77 K (257 MPa) was higher than that at room temperature (220 MPa). The fracture strength at 77 K of the MgB_2 bulk was also higher than that of a high-density RE-Ba-Cu-O bulk. Considering the experimental results, the fracture strength at 77 K of ideal MgB_2 bulk, whose packing ratio is 100 %, is estimated to be around 419 MPa. The fracture strength at 4.2 K of the HIP MgB_2 bulk (Packing ratio: 92 %) is estimated to be around 269 MPa.

Conclusion

The maximum fracture strength value is observed for the region near the surface. The minimum fracture strength value is observed for the inner region. There is no significant difference in the fracture toughness value between the regions near the surface and inner.