§15. Study on Mechanical Properties of Large Single-grain Superconducting Bulks Fabricated by RE Compositional Gradient Technique

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Recently, super-large single-grain RE-Ba-Cu-O (RE: Y or rare-earth elements) superconducting bulk 150 mm in diameter has been successfully produced. In order to overcome the problem of undesirable nucleation at the position away from the seed crystal, a new process based on the difference in the melting temperature between RE elements was employed in the basic melt-growth processing. Understanding of mechanical properties of superconducting bulks is important for practical application. In the present study, we investigate the mechanical properties of the super-large single-grain superconducting bulk.

Bending tests for specimens cut from a super-large single-grain RE-Ba-Cu-O bulk 150 mm in diameter were carried out (Fig. 1). Gd and Dy were chosen as RE. Dy content in the precursor increases with increase of the distance from the seed crystal. Some specimens, denoted as Specimens A1-A5, were cut from the bulk such that the specimens did not contain the RE compositional boundaries between two regions with different Dy content. On the other hand, the other specimens, denoted as Specimens B1-B4, contained the boundaries. After the bending tests, RE (Gd and Dy) mapping figures on the polished side surface of the fractured specimens were obtained by using micro X-ray fluorescence (μ-XRF) spectrometer.

Relationships between the fracture strength and the porosity of the Specimens A and B are shown in Fig. 2. An extraordinary data point marked by an asterisk at the porosity of around 0 % was excluded for the approximation of the data points. No significant difference was observed for the approximation curves between the Specimens A and B.

RE (Gd and Dy) mapping figures on the side surface of the fractured B1 specimens are shown in Fig. 3. Sites where the fracture occurred are marked with arrows. It is observed that the RE compositional boundaries did not always cause the fracture of the specimens. Since the specimen cut from the 1st layer contained few pores and no significant difference in the fracture strength was observed between the specimens A and B of the 1st layer, it is deduced that the inherent fracture strengths of the RE compositional boundaries are similar to those of non-RE compositional boundary sites.

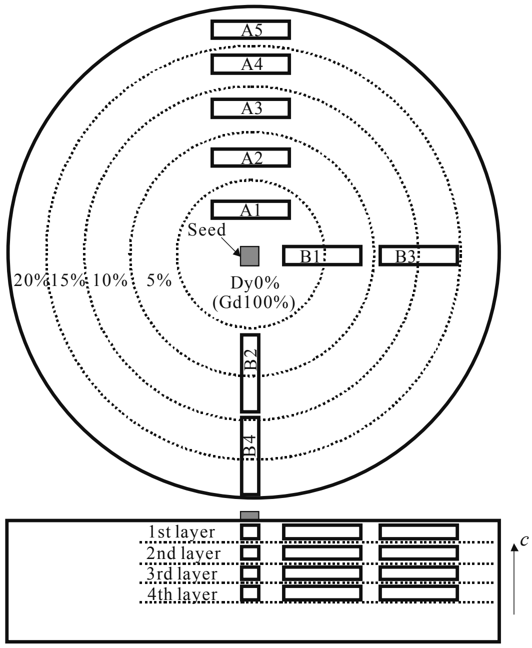

Fig. 1. Schematic illustration of cutting out of bending test specimens.

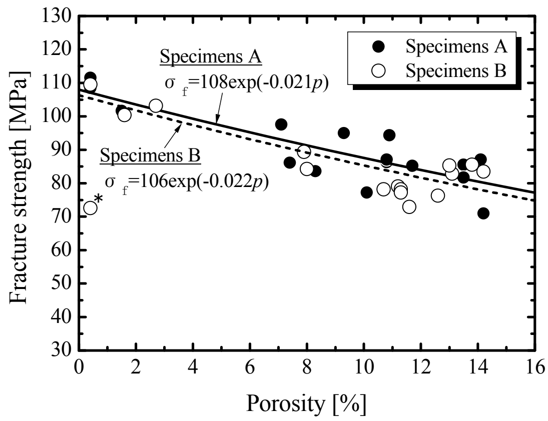

Fig. 2. Relationship between fracture strength and porosity.

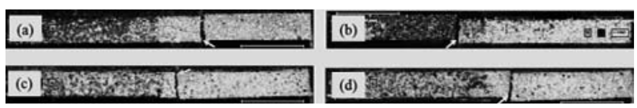

Fig. 3. RE (Gd and Dy) mapping figures on the side surface of the fractured B1 specimens. Specimens cut from (a) 1st, (b) 2nd, (c) 3rd and (d) 4th layers, respectively. Sites where the fracture occurred are marked with arrows. Dark area represents Gd rich and light area represents Dy rich, respectively.