§1. Basic Study on the Electromagnetic Properties of Oxide Superconductors for Nuclear Fusion Reactor

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1. Introduction

Till last year we studied the temperature dependences of the I_c-B properties and the ac losses in YBCO and GdBCO superconducting tapes with a buffer layer of GZO, whivh were fabricated by IBAD-PLD method, to understand the basic electromagnetic properties. We clarified that the critical current, I_c, the magnetizations and the ac losses were scaled with temperature. This year we investigated the temperature dependences the I_c-B properties of GdBCO superconducting tapes with a buffer layer of MgO, which were introduced with the aim of increasing a production speed. The sample taps were also fabricated by IBAD-PLD method.

2. Magnetization measurement and I_c estimation

First we measured the magnetization curves of sample GdBCO tapes with a buffer layer of MgO in perpendicular magnetic field to the wide surface. Sample straight tapes with a length of 60mm were inserted into a saddle-shaped pickup coil. Magnetic field was applied in perpendicular to the wide surface. Temperature ranged from 35 to 77K. The observed magnetization curves became expanded with decreasing temperature in accordance with J_c increment.

Next we estimated I_c-B characteristics by using the observed magnetization curves and the following expression,

$$\begin{aligned} I_c(B) &= 4h \times \{((I_c(B)/2) \times (w/2))/\ wh\} \\ &= 4h \times (m(B)/wh) \\ &= 4h \times M(B) \end{aligned}$$

where $m(B)$ is the magnetic moment due to the induced shielding current at the applied field, B, w and h is the width and the height of superconducting layer. The estimated I_c-B characteristics are shown in Fig.1.

Here we found out that the specific field at the breaking point of I_c-B curves in log scale, B_b, and the constant I_c around zero field, I_{c0}, have the same temperature dependence and that the B dependences of I_c are the same for $B > B_b$ regardless of temperature. So we normalized the I_c-B curves by I_{c0}. The obtained result is shown in Fig.2. We can see that the normalized I_c-B curves coincide with each other.

As a result, it was shown that the I_c-B characteristics, the magnetization and the ac losses in GdBCO superconducting tapes with a buffer layer of MgO, which were introduced for the aim of increasing a production speed, were scaled with temperature in the same manner as YBCO and GdBCO superconducting tapes with a buffer layer of GZO.

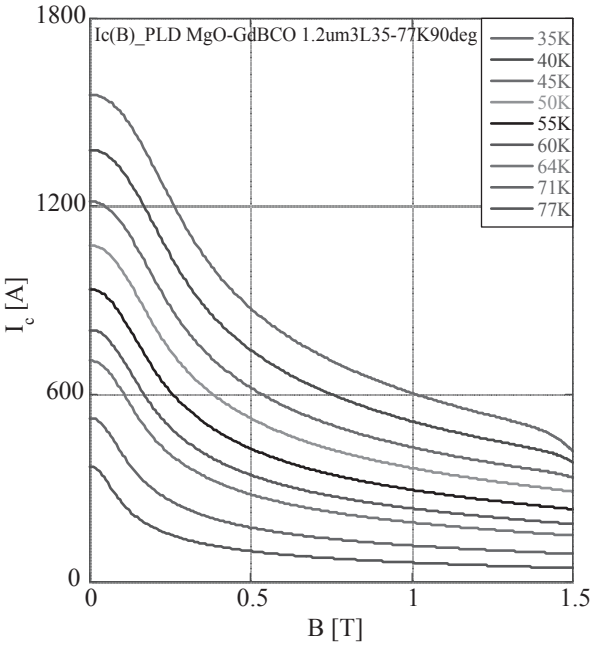

Fig.1 Estimated I_c-B curves by using the observed magnetization curves

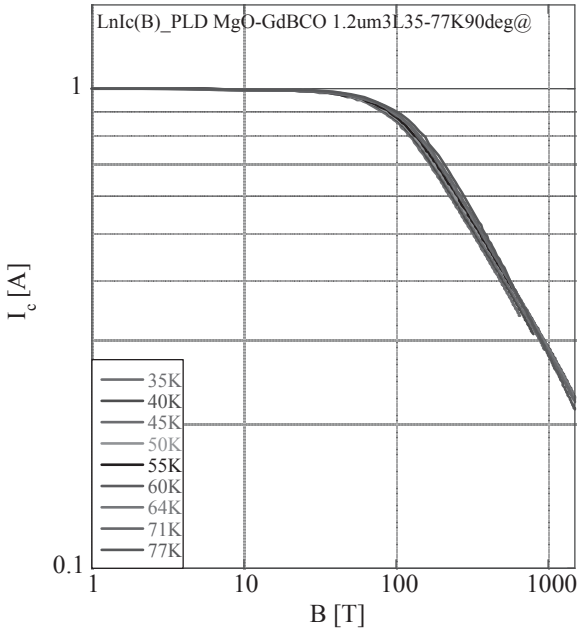

Fig.2 Normalized I_c-B curves by using zero field I_c at the respective temperatures