

# §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 superconducting tapes fabricated by IBAD-PLD and TFA-MOD 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 artificial pinning centers of  $ZrO_2$  particles, which were fabricated by IBAD-PLD method in a similar way.

## 2. Magnetization measurement and $I_c$ estimation

First we measured the magnetization curves of sample GdBCO tapes 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 31 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 in which artificial pinning centers were introduced for the sake of the enhancement of  $J_c$  were scaled with temperature in the same manner as YBCO superconducting tapes.

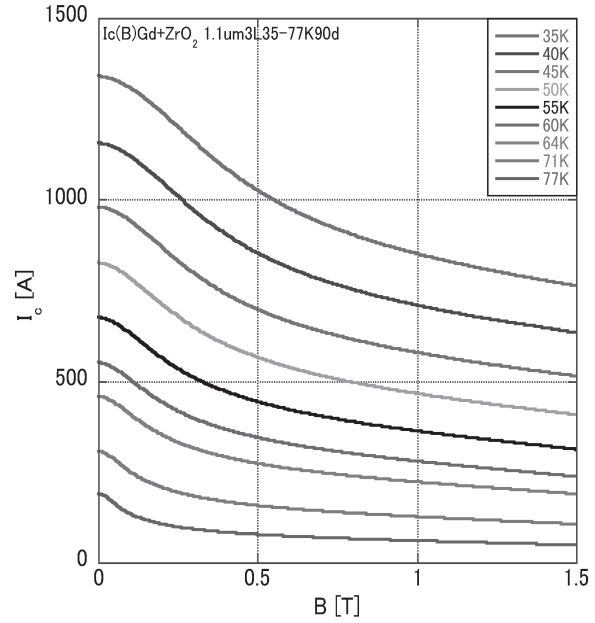


Fig.1 Estimated  $I_c$ - $B$  curves by using the observed magnetization curves

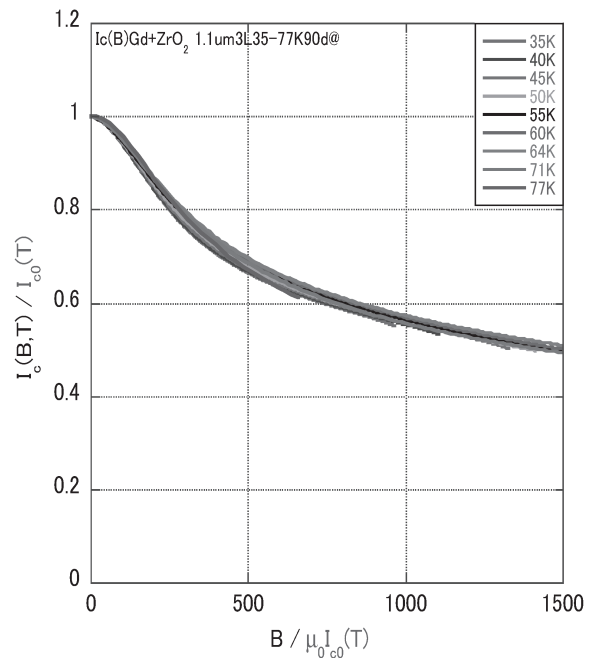


Fig.2 Normalized  $I_c$ - $B$  curves by using zero field  $I_c$  at the respective temperatures