§3. Basic Study on the Ac Loss Reduction of Oxide Superconductors for Nuclear Fusion Reactor

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1. Introduction

In order to understand the basic electromagnetic properties of $RE_1Ba_2Cu_3O_{7-x}$ (RE: Rare Earth, Y, Gd et al., REBCO) superconducting tapes, we have investigated the temperature dependences of the I_c-B and ac loss properties of YBCO and GdBCO superconducting tapes with a buffer layer of GZO or MgO, which were fabricated by the IBAD-PLD method. As a result, we clarified that the critical current, I_c, the magnetizations and the ac losses were scaled with temperature. This year we investigated whether the scaling law is applicable to the ac loss of GdBCO superconducting tapes which were striated into a 5-filament structure by laser-scribing with the aim of reducing an ac loss or not.

2. Magnetization and ac loss measurement

The present sample tapes were also fabricated by the IBAD-PLD method. The width was 10 mm. One sample tape was not scribed and the other one was scribed into a 5-filament structure. Sample straight tapes with a length of 60mm were inserted into a saddle-shaped pickup coil. We measured the magnetization and ac losses of sample GdBCO tapes. 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. Accordingly the ac loss increased with decreasing temperature. In addition the magnetization and ac losses were reduced with decreasing filament width. Fig. 1 shows the observed magnetic field amplitude dependences of the ac losses of scribed tapes at 35 K, 45 K, 64 K and 77 K. We confirmed that the ac losses were reduced in proportion to the width of the filaments for the larger magnetic field amplitude than the penetration field, which corresponds to the breaking points of the ac loss curves.

Next we estimated the I_c-B characteristics by using the observed magnetization curves and normalized I_c-B curves by the zero field I_c at the respective temperature, $I_{c0}(T)$. Further we normalized the observed ac loss curves as shown in Fig. 1 by using $I_{c0}(T)$. The normalized ac loss curves are shown in Fig. 2. We can see that the observed ac loss curves of GdBCO superconducting tapes agreed with one master curve and the ac losses were scaled with temperature whether the tapes were scribed into a 5-filament structure for ac loss reduction or not.
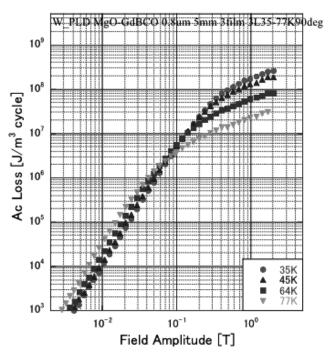
Fig. 1 Observed magnetic field amplitude dependences of the ac losses of the 5-filament GdBCO superconducting tape.
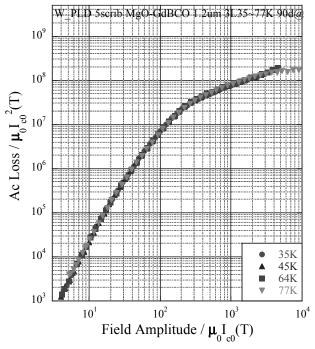

Fig. 2 Normalized magnetic field amplitude dependences of the ac losses of the 5-filament GdBCO superconducting tape.