§1. Basic Study on the AC Loss Reduction of Oxide Superconductors for Nuclear Fusion Reactor

Iwakuma, M. (Kyushu Univ.),
Mito, T.

1. Introduction

In order to develop $RE_1Ba_2Cu_3O_{7-x}$ (RE: Rare Earth, Y, Gd et al., REBCO) superconductors with a large current capacity and a low ac loss property for nuclear fusion reactors, we have investigated the ac loss properties of GdBCO superconducting tapes and have proposed a tremendous method to reduce the ac loss, especially for a perpendicular magnetic field against the tape face. It is the combination of the striation by a laser-scribing into a multi-filamentary structure and a special winding process. This year we made a test coil using a 5-filament GdBCO tape and investigated the current sharing properties among the filaments under ac operation. Comfirming even current distribution among the 5 filaments, we verified the low ac loss property of the GdBCO superconducting tapes striated into a 5-filament structure.

2. Current-sharing measurement

The GdBCO tape with a length of 50 m were fabricated by the IBAD-PLD method. The tape was 5 mm in width and was striated into a 5-filament structure. The photograph of a striated tape is shown in Fig. 1. Using it, we made a 1-layer solenoidal coil as shown in Fig. 2. The special winding points were located in reverse. The test coil was bath-cooled by liquid nitrogen into 77.3 K.

Applying ac current at 10 to 200 Hz, we investigated the current sharing among the filaments with Rogowski coils.

The observed branch current ratios are shown in Fig. 3. We can see that every branch current was almost even. Shielding current which produces a coupling current loss among the filaments is a loop current. So uniform current distribution among the filaments suggests no shielding current. It means that the present striated tape into a 5-filament structure has a low ac loss property even in a coil configuration.

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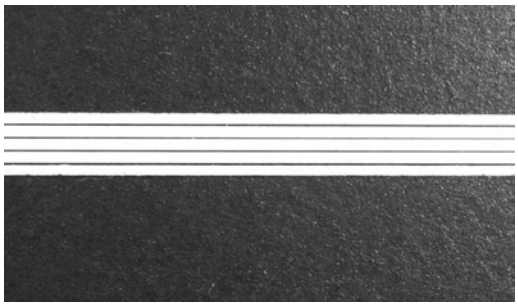

Fig. 1 Photograph of a striated GdBCO superconducting tape into a 5-filament structure with a width of 5 mm.

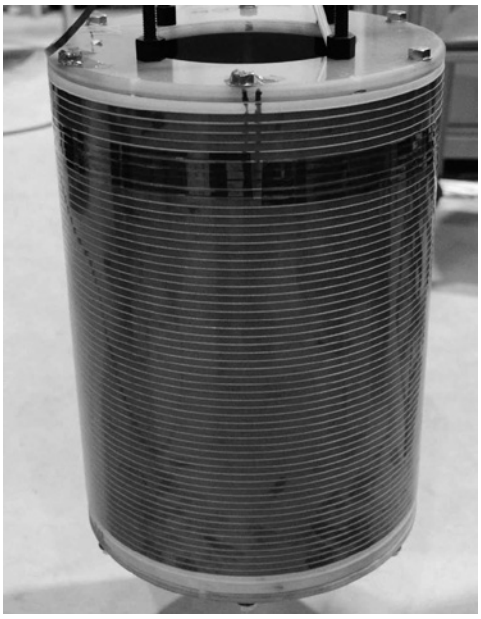

Fig. 2 Test coil wound into a 1-layer solenoidal one with a 5-filament GdBCO superconducting tape.

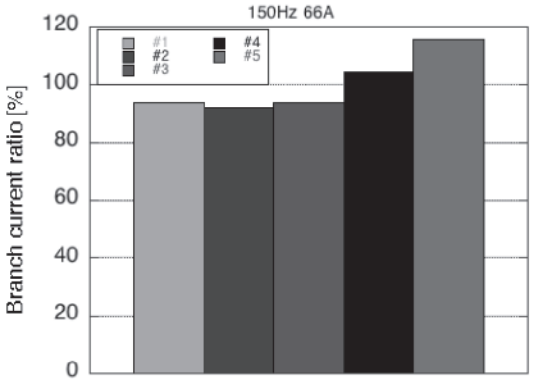

Fig. 3 Observed branch current ratios among the filaments in the test coil wound with a 5-filament GdBCO superconducting tape. The coil was bath-cooled by liquid nitrogen into 77.3 K. The total transport current was 66 A peak and the frequency was 150 Hz.