AC Loss Properties of Stacked Multifilamentary REBCO Superconducting Tapes

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Introduction

For ac applications of superconductors, ac loss is most of the heat load. Therefore, it is very important to evaluate the ac losses in superconducting windings for the design of cooling system. However, to measure the ac loss needs a huge amount of time and cost, and simple and easy estimation method of ac loss is required. Therefore, the temperature scaling law has been proposed as a method to easily estimate the ac loss. The temperature scaling law is a law that the dependence of the AC loss on the magnetic field amplitude converges to one curve regardless of temperature by using $I_{c0}$. In this study, the ac loss properties of stacked multifilamentary REBa$_2$Cu$_3$O$_y$ superconducting tapes which were fabricated by the pulsed laser deposition process and laser-scribing technique was investigated. AC losses of sample tapes was measured with a saddle-shaped pick-up coil.

Experimental Setup

Parameter of Sample tapes

Sample tapes used in this study were EuBCO superconducting tapes fabricated by the IBAD-PLD technique, and the filament is divided into four by laser scribing. In order to investigate the magnetizations and the ac losses in the case of stacked sample tapes, we stacked tapes into 3 and 6 layers besides a single tape.

Results and Discussion

Magnetization and $I_{c}$ estimation

The dependence of $I_{c}$ on magnetic field, $B$, of REBCO superconducting tapes was estimated from the observed magnetization loops by assuming the uniformity in $I_{c}$ over the tapes. The $M(B,T)$ and $I_{c}(B,T)$ defined as

$$M(B) = \frac{I_{c}(B)}{16h} \quad I_{c} = 16hM(B)$$

Saddle-shaped pickup coil method

The magnetization and AC loss was measured by an electrical method using a saddle-shaped pickup coil. The stacked sample tapes were inserted into the saddle-shaped pickup coil that was inserted into the inner vessel of cryostat.

There are 5T NbTi Magnet which is cooled with liquid helium, and this magnet generates magnetic field. In this manner, the magnetization is measured and the AC loss is calculated using the following equation.

$$W = -\int MdB$$

REBCO tape is cooled by GM refrigerator in the range of 30k to 77k.

Conclusion

The critical current characteristics and AC loss characteristics of REBCO superconducting tapes divided into four filaments by laser scribing were evaluated using a saddle type pickup coil. As a result, it was confirmed that the temperature scaling law can also be applied to stacked multifilamentary tapes when the number of stacked tape is 3 and 6. Also, it was confirmed that the division number of the filament is irrelevant to whether or not the temperature scaling law holds. Therefore, it is confirmed that AC loss at an arbitrary temperature is estimated if the temperature dependence of $I_{c0}$ and the AC loss at a certain temperature are known. This will make it easier to predict AC loss.