Thermal conductivity and dilatation of a Bi-2223/Ag (DI-BSCCO) superconducting wire laminated with Ni-alloy tapes

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Introduction

DI-BSCCO™ Tapes

- Commercial silver sheathed Bi2233 tapes (manufactured by Sumitomo Electric Industries) are used.
  - Void-free
  - High mechanical strength
  - Very small non-superconducting region

Thermal stability

To design a superconducting application, we must consider heat leakage, Q_max, through a tape.

Heat leakage, Q_max, is generally given as

\[ Q_{\text{max}} = S \left( \frac{dL}{dT} \right)_{\text{meas}} \]

Objective

To increase the mechanical strength, the DI-BSCCO tape reinforced by various kinds of alloy tapes has been fabricated. The thermal conductivity and dilatation of an alloy depends on the species of element and the composition.

In this study, we measure the thermal conductivity and dilatation of the DI-BSCCO with a sandwiched structure.

Experimental

DI-BSCCO tape fabrication

- Powder in tube (PIT) method with the Controlling-Overpressure (CT-OP™) sintering technique.
  - Type H: Ag sheath, standard tape
  - Type HT: Type H is sandwiched by the reinforcing alloy tape using solder

- Thermal conductivity: steady-state heat flow method
- Chromel-constantan thermocouple
- S~200 K (to eliminate radiation loss)

\[ K = \frac{Q_{\text{app}}}{A \Delta T} \cdot \frac{L}{S} \]

- Thermal dilatation: strain gage method
  - Strain gage: CFA1-350-11 (Tokyo Sokki Kenkyujo Co., Ltd.)
  - Adhesive: EA-2A (epoxy resin)

Results & Discussion

Specification of the measured tapes

Thermal conductivity

- The shape of κ(T) of the HT-NX tape is qualitatively similar to those for the type H, HT-CA, and HT-SS tapes.
- The absolute value of κ(T) depends on the species and thickness of the alloy tape.
- In HT-NX tape, Q app mainly flows through the Ag sheath in the type H tape.
- The contribution of the alloy tape to the heat transport can be neglected.

Thermal dilatation

- The dLL(T) of the HT-NX tape is somewhat smaller than those of other tapes, which might originate from the small dLL values of a Ni-based alloy.

Summary

We have measured the thermal conductivity of the Bi-2223/Ag (DI-BSCCO) superconducting wire laminated with Ni-alloy tapes.

- The shape of κ(T) of the Bi2223/Ag-Ni-alloy tape was qualitatively similar to those for the conventional bare and reinforced Bi2223/Ag tapes.
- The dLL(T) of the Bi2223/Ag-Ni-alloy tape is somewhat smaller than those of other tapes, which might originate from the small dLL values of a Ni-based alloy.