4MP6-04

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

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Introduction

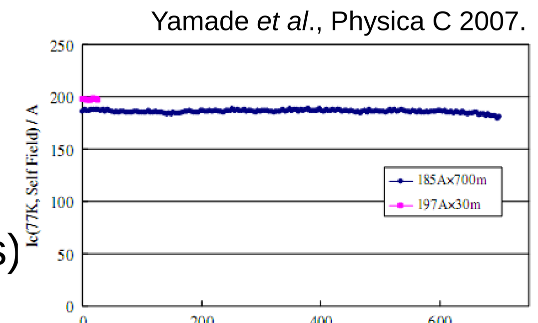
DI-BSCCO™ Tapes

★Commercial silver sheathed Bi2223 tapes (manufactured by Sumitomo Electric Industries)

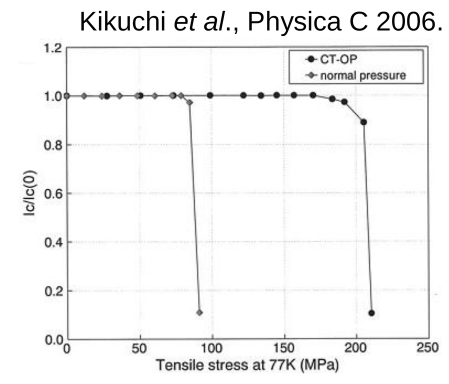
・void-free　Density: ~100%!!
・very small non-superconducting region

・High I_c: ~200 A at 77 K in the self-field
・High mechanical strength

Yamade *et al.*, Physica C 2007.



Kikuchi *et al.*, Physica C 2006.



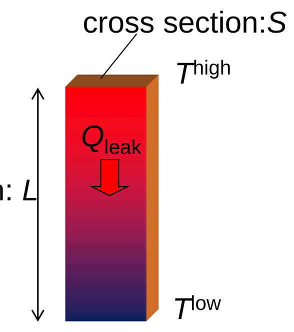
Thermal stability

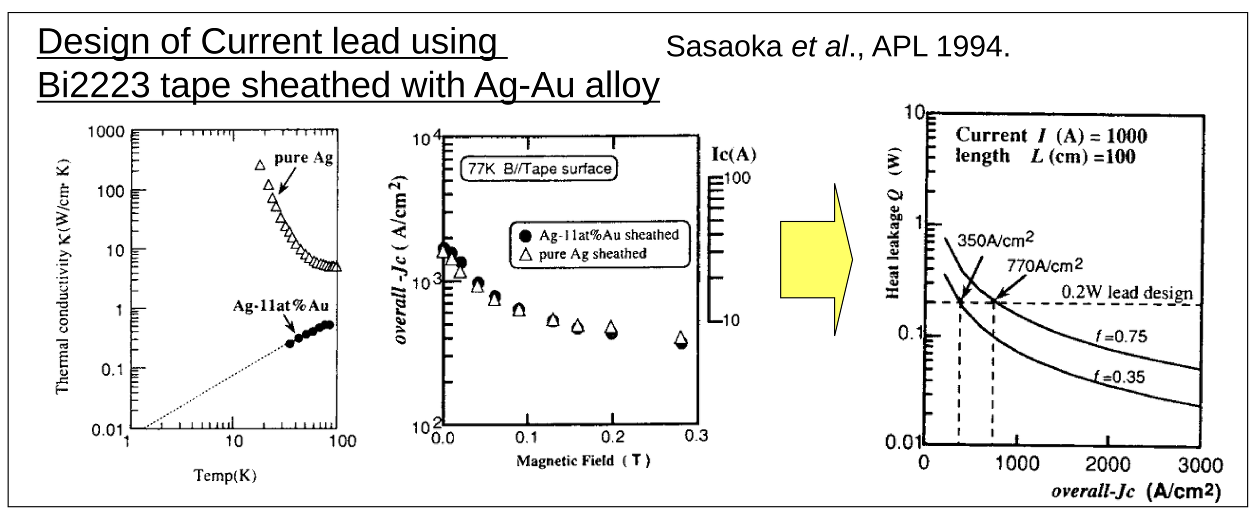
To design a superconducting application, we must consider heat leakage, Q_{leak}, through a tape.

Heat leakage, Q_{leak}, is generally given as

$$Q^{leak} = \frac{S}{L}\int_{T^{low}}^{T^{high}} \kappa(T)\,dT$$

Thermal conductivity　**Essential !!**





Objective

To increase the mechanical strength, the DI-BSCCO tape reinforced by various kinds of alloy tapes has been fabricated.
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

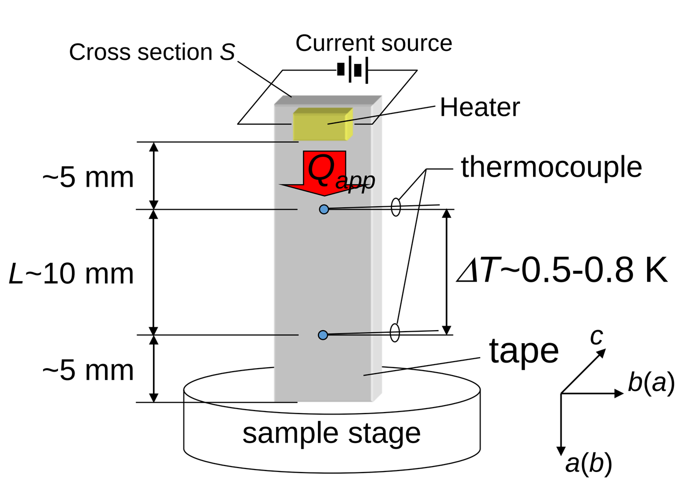
◆DI-BSCCO tape fabrication

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

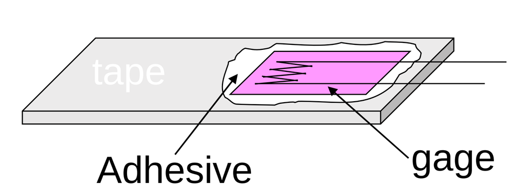
◆ Thermal conductivity
-steady-state heat flow method
-chromel-constantan thermocouple
-5～200 K (to eliminate radiation loss)

$$\kappa = \frac{Q_{app}}{\Delta T}\cdot\frac{L}{S}$$



◆Thermal dilatation: strain gage method

・Strain gage: CFLA-1-350-11 (Tokyo Sokki Kenkyujo Co., Ltd.)
・Adhesive: EA-2A (epoxy resin)

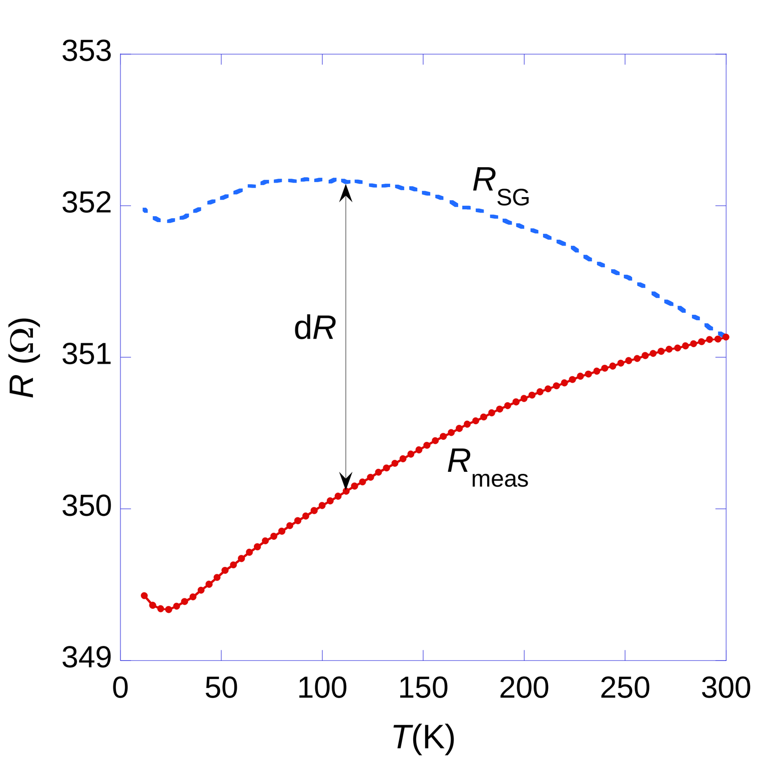


$$R_{meas} = R_{SG} + dR$$

Experimental data　Resistance of SG w/o strain　Resistance due to strain

$$\frac{dL}{L} = \frac{1}{F}\cdot\frac{dR}{R_{meas}}$$

gage factor (=2.09)



Results & Discussion

■ Specification of the measured tapes ■

Sumitomo BSCCO Wire (DI-BSCCO) Type HT

High Current Density & Tough

Specifications	Type HT - SS	Type HT - CA	Type HT-NX NEW
Average Width	4.5 ± 0.1 mm	4.5 ± 0.1 mm	4.5 ± 0.2 mm
Average Thickness	0.29 ± 0.02 mm	0.34 ± 0.02 mm	0.31 ± 0.03 mm
Reinforced Material	Stainless Steel (20 μm)	Copper Alloy (50 μm)	Nickel Alloy (30 μm)
Length	Up to 500 m		
Ic (77 K, Self Field)	(170 A,) 180 A, 190 A, 200 A		
Critical Wire Tension* (RT)	230 N**	280 N**	410 N**
Critical Tensile Strength* (77 K)	270 MPa**	250 MPa**	400 MPa**
Critical Tensile Strain* (77 K)	0.4%**	0.3%**	0.5%**
Critical Double Bend Diameter* (RT)	60 mm**	60 mm**	40 mm**

* 95% Ic Retention
** not guaranteed value

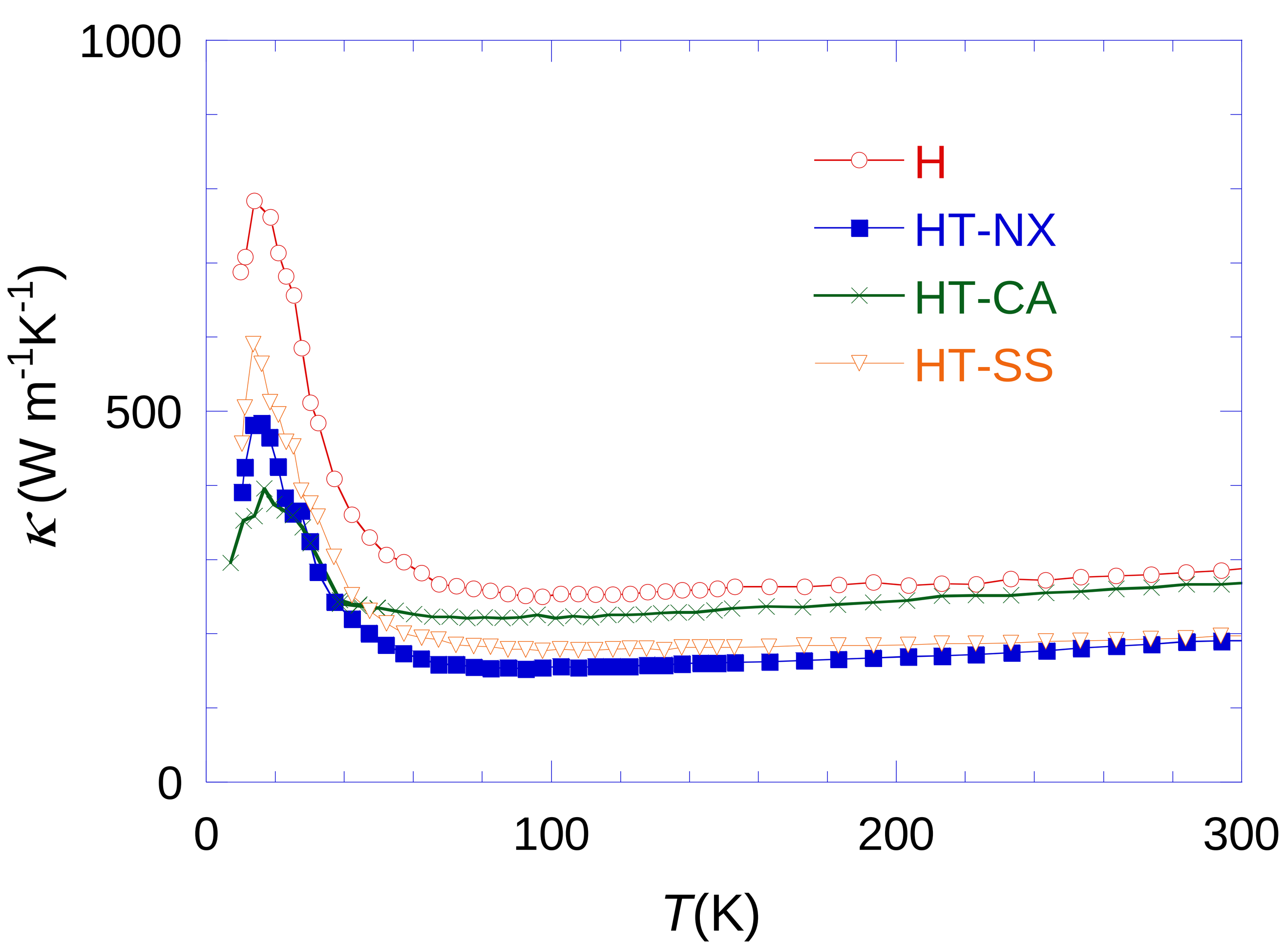
Sumitomo BSCCO Wire (DI-BSCCO) Type H

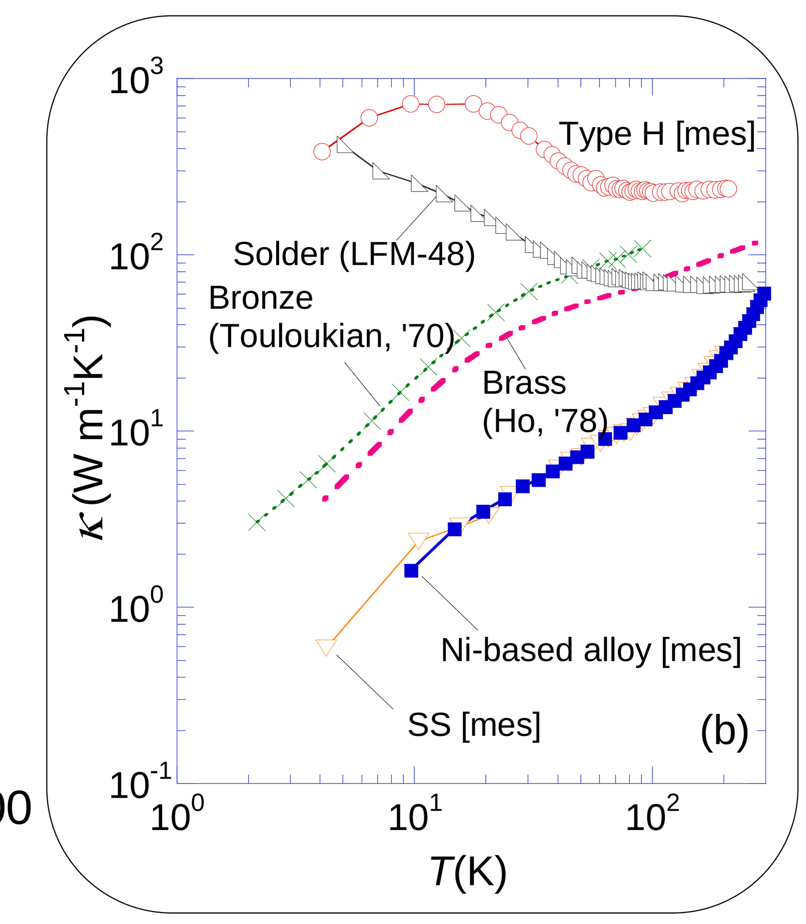
High Current Density

Specifications	
Average Width	4.3 ± 0.2 mm
Average Thickness	0.23 ± 0.01 mm
Length	Up to 1500 m
Ic (77 K, Self Field)	(170 A,) 180 A, 190 A, 200 A
Critical Wire Tension* (RT)	80 N**
Critical Tensile Strength* (77 K)	130 MPa**
Critical Tensile Strain* (77 K)	0.2%**
Critical Double Bend Diameter* (RT)	80 mm**

* 95% Ic Retention
** not guaranteed value

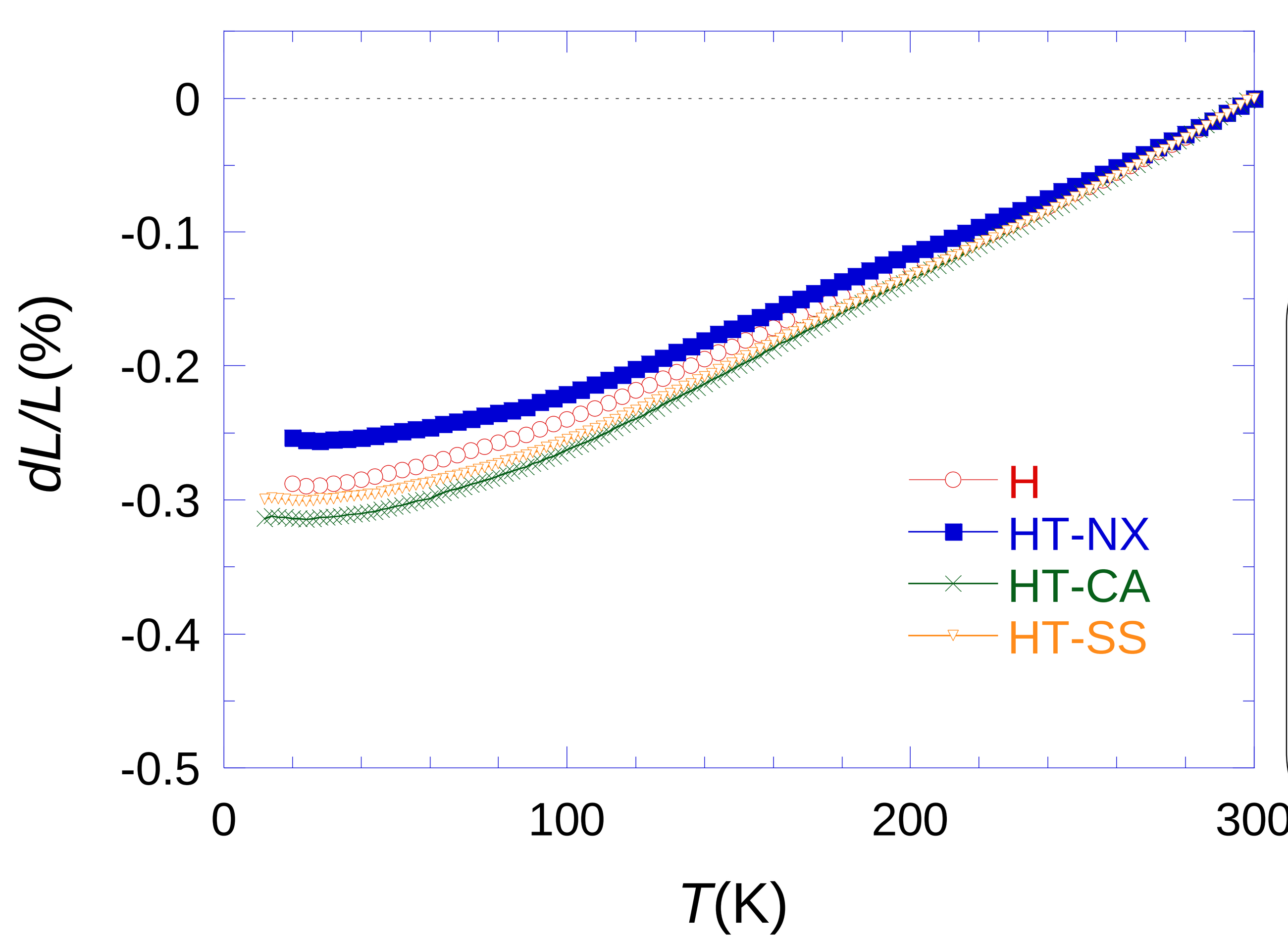
■ Thermal conductivity ■

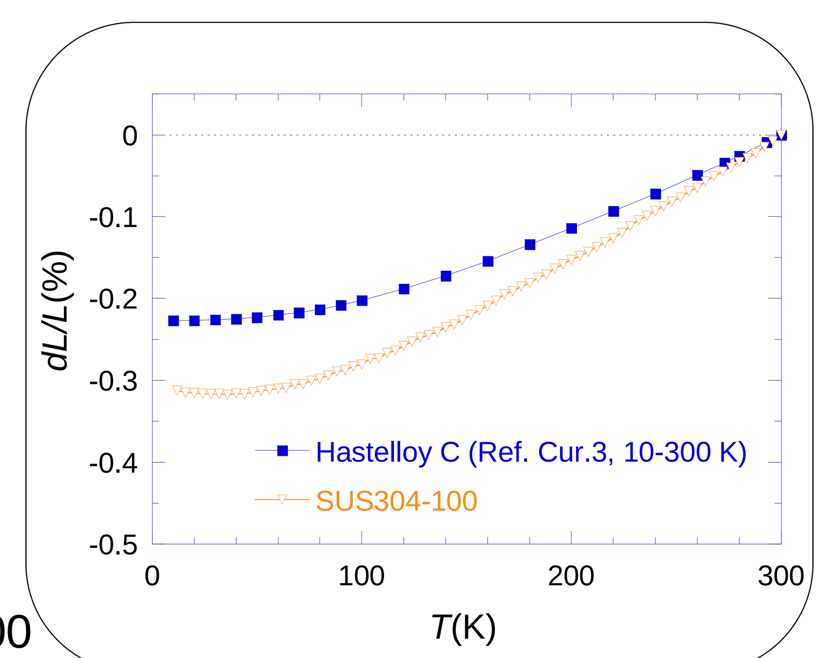




● The shape of $\kappa(T)$ of the HT-NX tape is qualitatively similar to those for the type H, HT-CA, and HT-SS tapes.
● The absolute value of $\kappa(T)$ depends on the species and thickness of the alloy tape.
● In HT-NX tape, Q_{app} mainly flows thorough the Ag sheath in the type H tape.
➡The contribution 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 $\kappa(T)$ 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