Mon-Af-Po1.20-06[79]

MT 26
International Conference
on Magnet Technology
Vancouver, Canada | 2019

Study on the effect of metallic protection ring in no-insulation HTS coils

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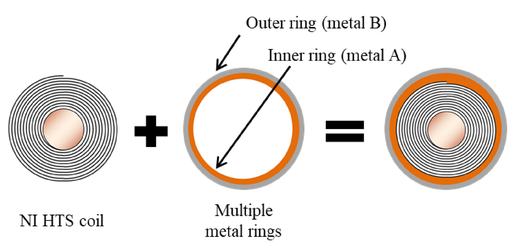
I. Introduction

To apply the NI techniques :

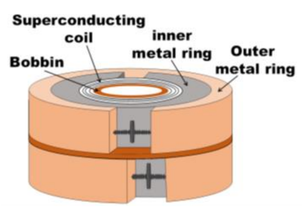
We need to understand….
- transient stability and thermal properties
- electrical and mechanical properties
- behaviors of current bypassing into the transverse direction

Purpose of the metallic protection ring

The metallic protection rings installed on the outermost turn of NI coil are proposed to improve the thermal, mechanical and electrical stabilities of NI coils.



II. Effects of the metallic protection rings

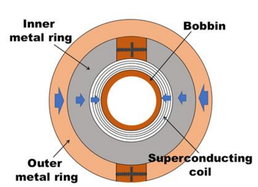


a. mechanically and electrically connected to NI coil

b. composed of 2 or more rings which have different electrical and mechanical properties

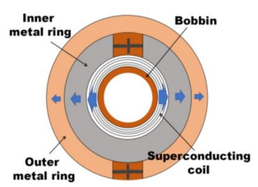
Mechanical stability

During the cooling process to bath temperature



support the mechanical shrinkage

During the process returning to room temperature

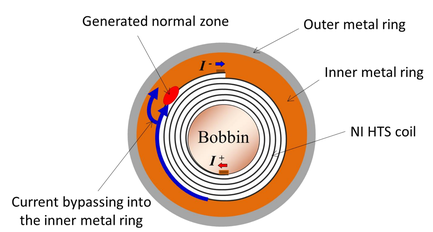


suppresses the thermal expansion

Thermal shrinkage : Outer metal ring > Inner metal ring > NI HTS coil

Thermal expansion : Outer metal ring < Inner metal ring < NI HTS coil

Electrical and thermal stabilities



Electrical conductivity :
Inner metal ring >> normal stated 2G wire

Thermal conduction in longitudinal direction :
will be improved

Thermal stability of NI coil :
will be improved

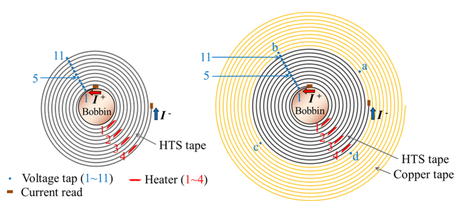
III. Electrical and mechanical properties by metallic protection rings (Cu tape)

A. Experimental details

The metallic protection ring to improve the electrical and mechanical stabilities of NI HTS coil was suggested, however in this study, the electrical effectiveness of the metallic protection ring will be discussed using wrapped by 8-turns Cu tape around the outermost layer of test coil.

Specifications of 2G wire and Cu tape

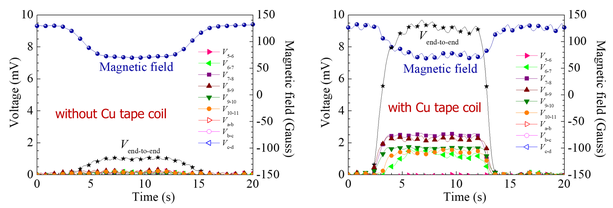
	GdBCO wire	Cu tape
Width (mm)	4.1	4.0
Thickness (μm)	234	100
Stabilizer thickness (μm)	45 × 2 (Brass)	-
Critical current (A)	180 @ L. N_2	-



Schematic drawing of 10 turns NI test coils with/without a Cu protection ring

B. Transient property by Cu tape (instead of the metallic protection rings)

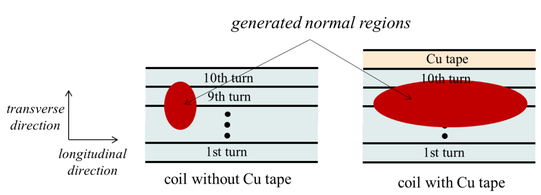
Voltage profiles and self-magnetic field : Heater3, 6 W input and 80 A



- **There was no current bypassing into the Cu tape.**
- **magnitude of the generated voltages in the longitudinal direction**

without Cu tape coil << with Cu tape coil

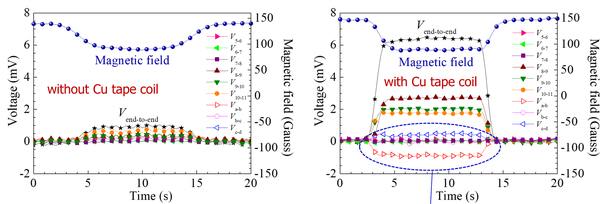
- **reduced the both self-magnetic field are 50 G (5 turns)**

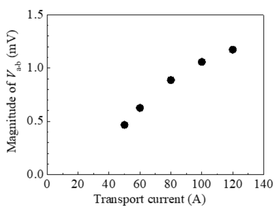


Schematic drawing of the predicted normal-state transition in both test coils with/without Cu tape

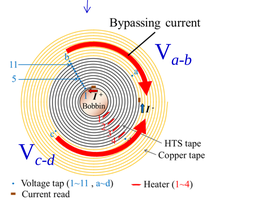
C. Current bypassing characteristics by Cu tape

Voltage profiles and self-magnetic field : Heater4, 10 W input and 90 A





Magnitude of the measured V_{a-b} (Heater4, 10 W input)

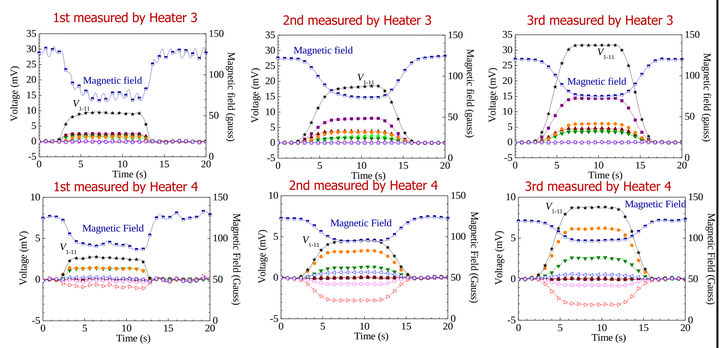


Schematic drawing of the current bypassing in the Cu tape

D. Characteristics by thermal cycle (with Cu tape coil)

Test coil was cooled by L. N_2 → 1st measurement
→ test coil was returned to room temperature → 2 weeks later
→ cooled by L. N_2 → 2nd measurement → returned to room temperature
→ 2 weeks later → cooled by L. N_2 → 3rd measurement

Voltage profiles and self-magnetic field : Heater 3 & 4, 6 W input and 80 A



IV. Conclusions

- The metallic protection rings to improve the electrical and mechanical stabilities of NI HTS coil are suggested.
- The NI test coil with Cu tape instead of a metallic protection ring was prepared and experimentally investigated.
- It is expected that the generated hot spots in the outermost region of NI HTS coils can be suppressed.
- Now we are starting to measure with metallic ring....