§24. Excitation Characteristics of the HTS Floating Coil of the Mini-RT Device

Yanagi, N., Mito, T.
Ogawa, Y., Morikawa, J. (Univ. of Tokyo)
Iwakuma, M. (Kyushu Univ.)

A magnetically levitated superconducting coil system, Mini-RT, has been constructed at the High Temperature Plasma Center of the University of Tokyo for the purpose of examining the magnetic confinement scheme of high-beta plasmas with a new relaxation process [1]. For the floating coil (diameter: 300 mm, weight: 17 kg), an Ag-sheathed Bi-2223 tape (critical current: 108 A at 77 K, self-field) of ~400 m length was used, and this device has become the world first application of high temperature superconductors (HTS) for plasma fusion experiments.

In the Mini-RT device, the nominal excitation condition (cable current: 118 A) of the HTS floating coil was achieved after overcoming many difficulties. The most serious ones were as follows: (1) At the beginning, the refrigeration power was not enough due to the unexpectedly high heat in-leak mainly from the transfer tubes. Thus, the second cold-box was added so that the specified temperature of 20 K could be achieved. (2) In the first excitation, we observed that the coil-lead cables did not fully become superconducting due to the large heat in-leak from the detachable current feeders. Then we added copper blocks as thermal anchoring. (3) Even with the above improvement, these sections still experienced quench when the coil current reached up to about 80 A. We finally cooled the room temperature side of the current feeders by liquid nitrogen. Then, we could successfully raise the current up to the nominal value.

After achieving the nominal current, a persistent current mode was realized by switching the persistent current switch (PCS) on. Figure 1 shows an example of excitation for magnetic levitation experiment. We found that the coil current decreased rather rapidly and the decay time constant of the persistent current was significantly shorter than the expected value. Even though, the coil current decayed rapidly, we could successfully realized magnetic levitation for up to about one hour.

From the observed waveform of the persistent current, the effective coil resistance was evaluated and plotted as a function of the coil current in Fig. 2. One important fact is that the effective coil resistance is proportional to the square of the coil current. The mechanism for causing this degradation is now under consideration from the viewpoint of electromagnetic effects.

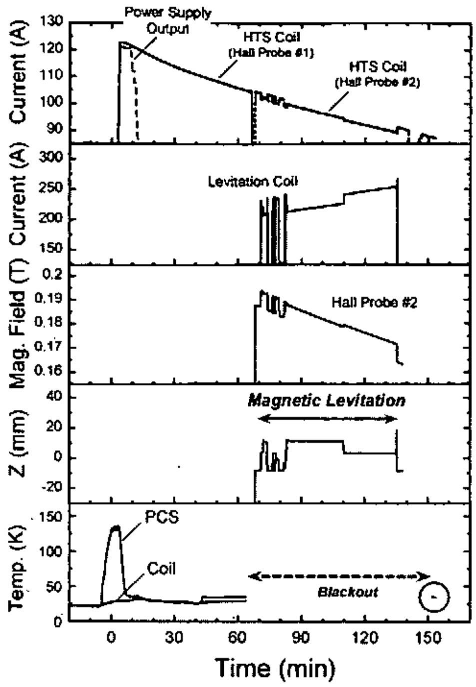

Fig. 1. Waveforms of the coil currents, magnetic field, levitation position and temperature of the coil and PCS during a magnetic levitation experiment.

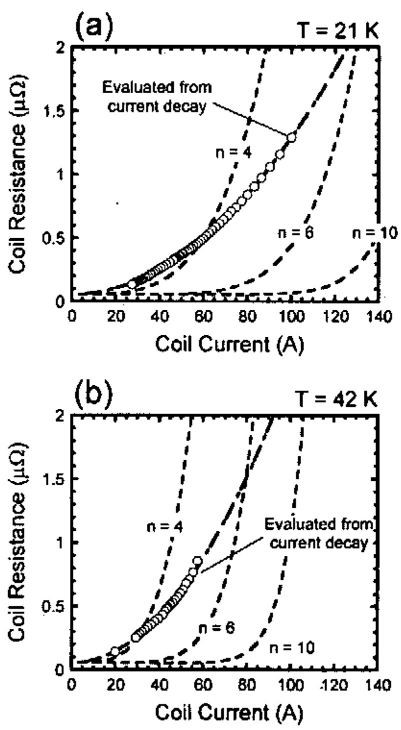

Fig. 2 Dependence of the effective coil resistance as a function of the coil current for two temperature cases.

References

1) Y. Ogawa, et al., AIP Conf. Proc. (1999) pp. 417-422.
2) Yanagi, N. et al.: IEEE Trans. Appl. Supercond. 12 (2002) pp.948-951.