§23. Quench Characteristics and Structural Materials in Superconducting Coil

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Aim of the study is to increase stability of a superconducting coil from a standpoint of a structural material of the coil. The structural material has remarkable properties which are both high electric resistivity and high thermal conductivity. The name of the material is Dyneema fiber reinforced plastic (DFRP). In the study, we made small superconducting coils whose bobbins were DFRP, and measured coil voltages in the over current to the coil. In some experiments, glass fiber reinforce plastic (GFRP) was also used as a bobbin material for compare the measured data.

Figure 1 shows a schematic illustration of the sample coil. The diameter and height of the bobbin are 55 and 50 mm respectively. The Bi-2223 tape (width = 4.2 mm) are wound in approximately 4 turns. Winding tension is 10 N at room temperature. When the bobbin is DFRP, we also choose 4 and 7 N of the tension to study dependence of winding tension on thermal stability of the coil. We placed the coil on a cold head of a refrigerator, and cooled down the coil to 77 K without a liquid coolant.

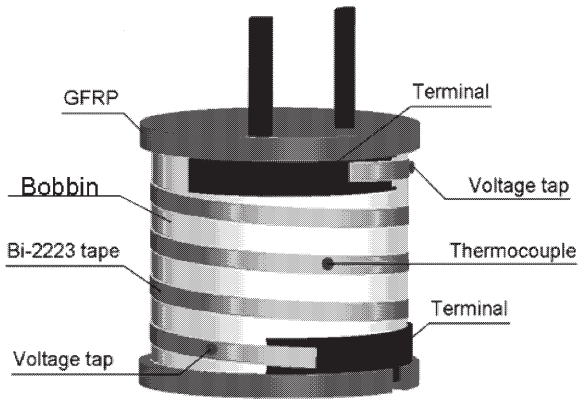

Fig. 1: Schematic illustration of sample coil. The bobbin is made of DFRP or GFRP.

After the cool down, a DC current, which was equal to a critical current of the HTS tape, was applied to the coil. Hence, the flux flow occurred, and the voltage of the coil, which was between two voltage taps on the HTS winding, gradually rose up. When a thermal flow is good from the HTS tape to the bobbin, the rise up of the coil voltage becomes slow. Hence, we estimated the thermal stability of those coils by the rise up of the voltage.

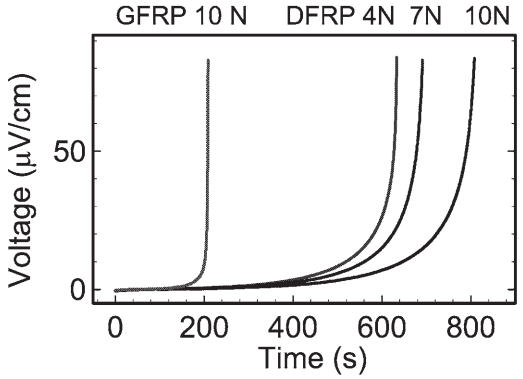

Fig. 2: Measured data of voltages from four coils.

The measured data are summarized in the figure 2. In the figure, the vertical axis is an electrical field between the voltage taps of the winding. The four curves are the GFRP-bobbin coil, and three kinds of winding tension in the DFRP coils. From the figure, when the DFRP was used as the bobbin material, the rise up of the coil voltage shifted to right, that is, the cooling down of the DFRP is better than that of GFRP. And the cooling performance became better with increasing winding tension, because the thermal contact became better from the HTS tape to the bobbin surface.

DFRP has another remarkable property; DFRP expands with cool down. If we use the property effectively, the thermal contact between the HTS tape and the dobbin surface can be better than the contact in this experiment. We will approach the issue in the next step.

Publication lists:

(1) T. Takao, et al., Cooling performance of conduction cooled superconducting magnet using high thermal conduction plastic, presented at 2008 Applied Superconductivity Conference, No. 2LPQ04, Chicago in USA, August (2008).

(2) T. Yuhara, T. Takao, et al., Cooling performance evaluation in contact condition of Bi-2223 tape and high-thermal-conduction composite (part VI), IEEJ 2009 Annual Meeting, Sapporo, March (2009).