§13. Cooling Owing to High Thermal Conduction Plastic and Stability of Coil

Takao, T., Hachisuka, D., Asano, S. (Sophia Univ.), Nishimura, A.

This work is increase the stability from a viewpoint of thermal conductivity in coil bobbin material. [1,2] We changed the bobbin material to a high thermal conduction and non-metallic material. The name of the material is the Dyneema fiber reinforced plastic (DFRP), where Dyneema is the trademark of Toyobo Co. Ltd.

We fabricated a small double pancake coil as shown in Fig. 1. Each pancake has 5 turns. A superconducting tape is a typical Bi2223 tape whose width and thickness are 2.3 mm and 0.24 mm respectively. As is written before, the bobbin material is DFRP. We used three kinds of winding angles (85, 60, and 45 degrees) of Dyneema fibers in the DFRP. In the article we name those bobbins as D85, D60 and D45. To compare the measured results, we made a GFRP-bobbin coil. GFRP is a glass fiber reinforced plastic and is one of typical non-metallic materials. There are two kinds of winding tensions which are one newton and almost zero newton. We named the tensions as 1 N and 0N respectively.

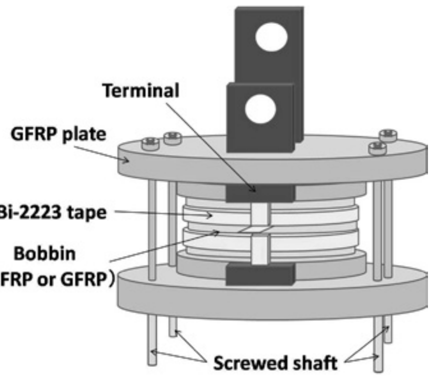

Fig. 1: Sample coil.

The coils were cooled down using a refrigerator. At a cryogenic temperature, we gave a constant DC current to the coil and measured voltage of the pancake.

Figure 2 is an example of measured data. The horizontal axis means the time from the DC current started. Even if the DC currents equal between the 0 and 1 N of the winding tension which means that the heat generation is equal between the 0 and 1 N of the winding tension, the take-off time is not same. When the winding tension becomes large, the thermal contacting between the Bi tape and the bobbin becomes better, and hence the take-off time of the 1 N-coil delayed.

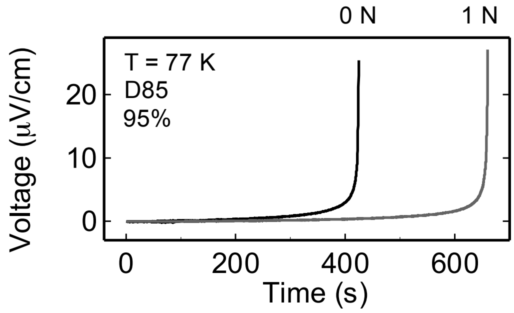

Fig. 2: Take-off of coil and winding tensions. Coil current is 95 % of Ic and bobbin material is D85.

We also experimentally studied dependence of a take-off time on the bobbin materials. The measured results are shown in Fig. 3. The coil configuration such as the size, the winding tension, the superconducting tape, and so on is same in those coils shown in the figure. The only deference is the bobbin materials; the take-off time strongly depended on the bobbin materials. In GFRP, D45, D60, and D80, D80 has the best thermal conductivity, and the next is D60. GFRP has the worst thermal conductivity in those materials. The order of the thermal conductivity is same as the order of the take-off time.

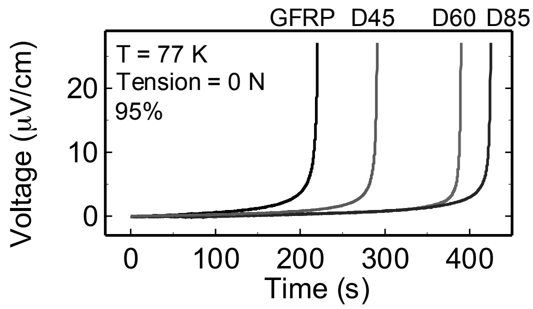

Fig. 3: Dependence of take-off time on bobbin materials.

From those results, to increase of thermal stability of the coil, we will use the high thermal conduction bobbin such as the D85 bobbin.

1) T. Takao, et al., Increase of cooling performance of conduction cooled superconducting coils using high thermal conduction plastic, presented at MT22, No. 1HP2-1, Marseilles, France, September (2012).

2) K. Ishikawa, T. Takao, et al., Estimation of cooling performance of high thermal conduction composite in conduction-cooled double-pancake HTS coil –part 3-, National convention of IEE-J, No. 5-123, Hiroshima, March (2012).