

§6. Thermal and Mechanical Properties of Composite Materials for Superconducting Coils

Takao, T., Nakamura, K., Watanabe, A. (Sophia University)

Low weight of a large-scale superconducting coil such as the coils for nuclear fusion reactor is one of important issues. One solution is that high strength and high-thermal-conduction non-metallic composites are used in the coils. In the study, we proposed those materials and experimentally studied to apply the composites to a structural material in the coil.

We used a Dyneema fiber reinforced plastic (DFRP), a glass fiber reinforced plastic (GFRP), and aluminum nitride (AlN) as the sample materials. An experimental setup is that a short Bi-2223 tape is clamped from both sides of the tape faces by the material. That experimental arrangement is cooled down using a GM refrigerator. In the experiments, liquid nitrogen as a coolant has not been used. At a cryogenic temperature, a constant DC current was applied to the Bi tape, and the voltage and temperature rise of the tape were measured.

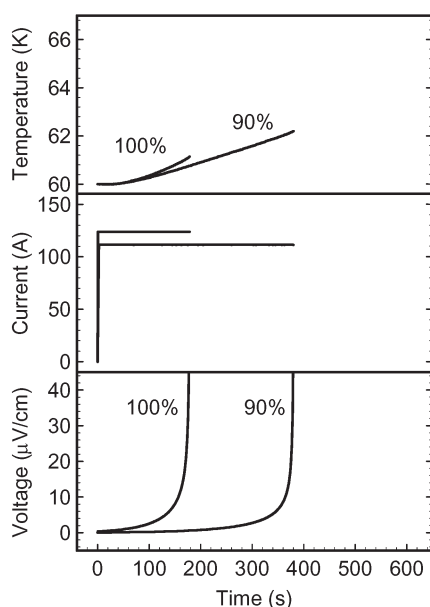


Fig. 1. Example of observed waveform.

A typically observed waveform of the voltage and the temperature rise are shown in Fig. 1. The

sample material is DFRP, and currents are 90 and 100 % of I_c . We compared the voltage rise and generated heating between the three materials at the time of 280 seconds after starting of the experiment. The result is summarized in Fig. 2.

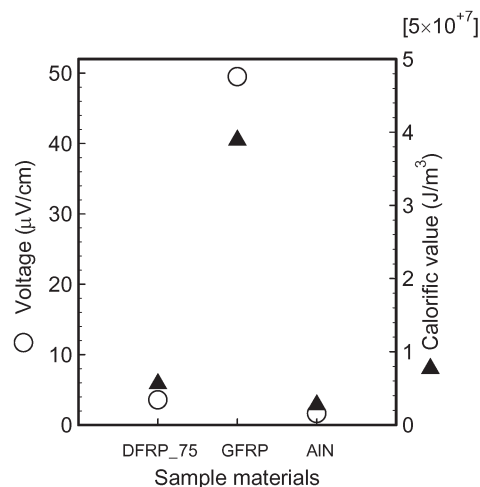


Fig. 2. Voltages and heating in three materials.

From the figure, both of the voltage and the heating were of the material of GFRP were largest in the three materials. Those in DFRP and AlN were relatively small. The cooling performance of the AlN is as same as that of DFRP, or a little better as shown in the figure.

List of publications and presentations:

- (1) K. Nakamura, H. Suko, T. Takao and A. Nishimura, "Relation between contact resistance and twist pitches in superconducting doublets," *IEEE Trans. on Applied Superconductivity* (in press).
- (2) T. Takao, M. Yamaguchi, H. Yamamoto, H. Watanabe, A. Yamanaka, "Stability of conduction cooled Bi2223 tapes using high thermal conduction plastics," presented at ASC2004, USA, October 2004.
- (3) K. Nakamura, M. Yamanouchi, K. Hashimoto and T. Takao, "Effects of contact resistance between strands with Cr/non-Cr coating in cable-in-conduit conductors," *IEEE Transactions on Applied Superconductivity*, vol. 14, no. 2, pp. 1306-1309, June 2004.
- (4) A. Watanabe, A., M. Yamaguchi, H. Yamamoto, Y. Iso, T. Takao, A. Yamanaka, Estimation of cooling performance of structural materials for conduction cooled superconducting magnets, *Cryogenics and superconductivity*, 1C-a02, Hachinohe, Autumn, 2004.