

## §27. Development of a Small Bobbin-less Superconducting Solenoid Magnet of 3T Class for Adiabatic Demagnetization Refrigerator

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Adiabatic Demagnetization Refrigerator (ADR) is one of available refrigerators for extremely high sensitive detector under sub-Kelvin such as X-ray sensor using Transition Edge Sensor (TES) <sup>1), 2)</sup>. Superconducting magnet is one of most important element in ADR. The superconducting solenoid magnet for ADR is required 3 features: large magnetic field, small current, rather large bore size of inner magnetic field area. Thus the present superconducting magnet of bobbin-less was developed for the better efficiency of ADR system.

The thin multifilament superconducting wire of 0.127 mm in diameter was used for this magnet. Because of difficulty of the tension control for this thin wire, the special winding machine was used to make the magnet. The machine can control small tension less than 3 N. The strength of magnet is kept with the epoxy resin (Nito fix) under cryogenic temperature condition. The epoxy resin was chosen due to easy handling, rather high thermal conductivity as shown in Fig.1. The resin has rather high viscosity, but no void observed in the cross section of the test magnet shown in Fig.2. The process of winding and fixing by the resin were done at the same time.

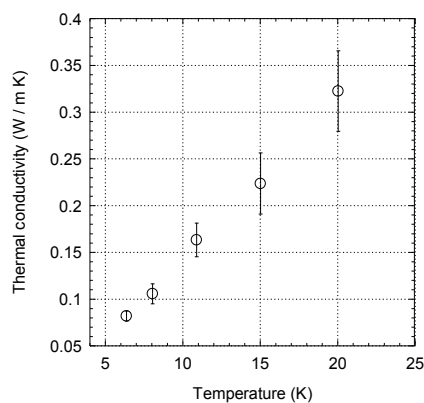


Fig. 1 Thermal conductivity of the epoxy resin (Nitofix)



Fig. 2 A picture of cross-section of the bobbin-less magnet

The specification of the present magnet is shown in Table.1. This kind of bobbin-less magnet is the first trial for rather small magnet though the technique of bobbin-less magnet is familiar for rather large magnets<sup>3)</sup>.

The measurement of center magnetic field is shown in Fig.3. The experiments are conducted in liquid Helium about 4.2 K. Center magnetic field 3T was recorded with no experience of training quench when electric current 6A was applied.

It can be concluded that the development is succeeded and the process of small bobbin-less magnet for ADR is established.

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Table. 1 Specification of the magnet

Inner Diameter	31.0 mm
Outer Diameter	47.4 mm
Height	65 mm
Turn	26531 turn
Total length of superconducting wire	3026.4m
Inductance	7.2 H

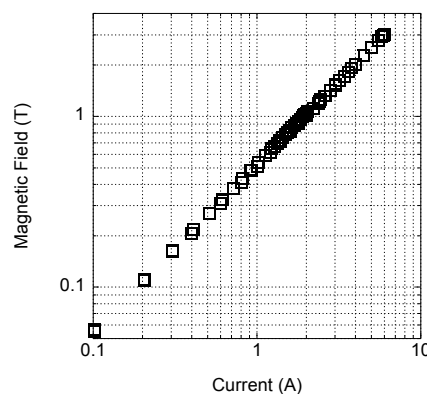


Fig. 3 Center magnetic field measurement of the magnet in LHe bath

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- 3) Makida, Y., *et al.*, IEEE Trans. Appl. Supercond. **17**(2007)1205