§38. Evaluation of Sensors and Materials for Low Temperature Use

Ninomiya,A.(Seikei Univ.)
Yamaguchi,S.

The LHD is a large superconducting coil system which is composed of some kinds of superconducting coils. To operate and control the system safely, it is necessary to monitor continuously the condition of the coil system applying a lot of sensors into it. In this case, the sensor's characteristics may have suffer considerable changes under high electromagnetic field. The first aim of this research is to investigate the characteristics of many sensors installed into the low temperature and high electromagnetic field region. And, the second is to measure the physical properties of materials applied to the LHD system and construct a data-base of these materials.

This time, we have investigated following matters:

(1) Magneto-resistance effect of high magnetic field on stabilizing materials such as Cu, Al.

(2) Possibility of improvement of thermal conductivity of epoxy materials.

(3) Selection of AE sensors for low temperature use.

The obtained results are shown as follows.

[1] Magneto-resistance effect on stabilizing materials

Copper and aluminum increase the resistivity due to the Hall effect under high magnetic field. Usually, this phenomenon is considered to be induced by the normal component of the magnetic field to the superconducting conductor. However, our investigations on this phenomenon shows that the Hall effects may be affected also by the parallel component of magnetic field to the conductor.

Superconducting conductor used for the helical coil experiences both normal and parallel components of electromagnetic field. So, the selection of stabilizing materials should be done taking into consideration this magnetic field effect.

[2] Possibility of improvement of thermal conductivity of epoxy materials

In general, epoxy materials such as stycast include powder of alumina. The thermal conductivity of this epoxy material is dependent on the alumina's thermal conductivity, which is 20–25W/mK. If the powder of aluminum nitrate is included in the epoxy instead of alumina, its thermal conductivity is expected to increase more than five times as large as that of conventional epoxy material. This is due to the high thermal conductivity of aluminum nitrate of 120–200W/mK. While, the mechanical strength of the epoxy material with aluminum nitrate is same order of that with alumina. From now on, we will investigate this material experimentally.

[3] Selection of AE sensor for low temperature use

Fundamentally required performance of AE sensor for low temperature use is to detect a local disturbance in a superconducting coil reliably. For this purpose, the evaluation of the characteristics of the AE sensor and the design of the amplifier are important. From the experimental result of module coil, it becomes clear that the frequency range suitable for the evaluation of the coil performance is 100–200kHz, and the frequency component of the AE wave with higher energy is concentrating in lower frequency range (20kHz–100kHz). Therefore, the required frequency range of the amplifier for AE sensor is 20kHz–200kHz. And, the gain of the amplifier should be adjusted in wide range because the amplitude of the AE signal distributes very widely. Furthermore, the isolated type amplifier was adopted to avoid the interference with other many measurement devices.