§7. Improvement of Superconducting Pulse Coils Using Tapes with High Aspect Ratio of Cross-section

Kawagoe, A., Kawabata, S. (Kagoshima Univ.), Yanagi, N., Mito, T.

In order to improve performance of fusion devices, it is necessary to develop superconducting coils with high stability and low losses. Recent development of technology that creates wire from high-temperature superconductors (HTS) progresses. Developments of superconducting devices that use HTS wire are also on going. In order to evaluate ac losses in HTS conductors with large current capacity, both of proposal and demonstration of a new measuring method were carried out [(1)].

In general, HTS wires are formed into tape shape. So, there are anisotropy on ac losses in their wires under external transverse magnetic fields. Therefore, controlling direction of the external transverse magnetic fields applied to the HTS wires is taken as following measure: Firstly, the measuring sample shape is short and straight, and its length is about 100 mm. Secondly, the sample is put in uniform magnetic field. Finally, the sample is rolled around its axis to control the angle of direction magnetic fields applied to the sample. However, length of superconducting conductors for fusion devices is required more than a few meters to evaluate their properties, because the conductors are composed of a several tens or hundreds wires to be achieved large current capacity.

In this study, a new method to measure the electromagnetic properties of the conductors mentioned above had been proposed and the validity of the method had been clarified. In this method, samples were formed into coil shape. In order to control the angle of the direction of the magnetic fields that were applied to the sample coil, the sample coils were put near edge of the magnet that generate the external magnetic fields. In this area, external magnetic fields spread to radial direction of the magnet. ”Magnetizaiton method” that is well known as a method of measuring ac losses is the sample with coil shape, cannot be applied under spreading magnetic fields. In this study, the measuring method, that can measure ac losses in the sample coils under spreading magnetic fields by measuring Poynting’s vectors around sample coils, are introduced.

Fig. 1 shows the measuring system. In this year, magnetic fields were applied to the sample without transport currents. In this case, electric fields around sample coils are only inductive components of electric fields, and their direction is circumferential direction. Therefore, electric fields can be measured by one-turn pick-up coils. Magnetic fields with direction of sample axis on inner and outer surfaces of the sample coil are measured. On top and bottom surfaces of the sample coil, magnetic files with radial direction are measured.

The sample coil is wound with Bi-2223 multifilamentary tape. Turns of the coil are 19 turns x 2 layers. Ac losses in the sample coil under spreading magnetic fields were measured. Angles of the magnetic fields applied to the tape face are 4 – 6 degree. The sample coil was cooled by liquid nitrogen. Frequency of the magnetic fields is 100 Hz. Fig. 2 shows the results of the measurements. Horizontal axis is amplitude of magnetic fields applied to the center of wound area of the sample coil. Experimental data are shown by plots. A solid line shows theoretical values calculated by Bean-London model. Experimental and theoretical values agree well. It is confirmed that our method can obtain exactly the ac loss values of the sample coil under spreading magnetic fields.

1) T. Shiraki, et al., Abstracts of CSSJ Conference, Vol. 90 (2014), p. 174.

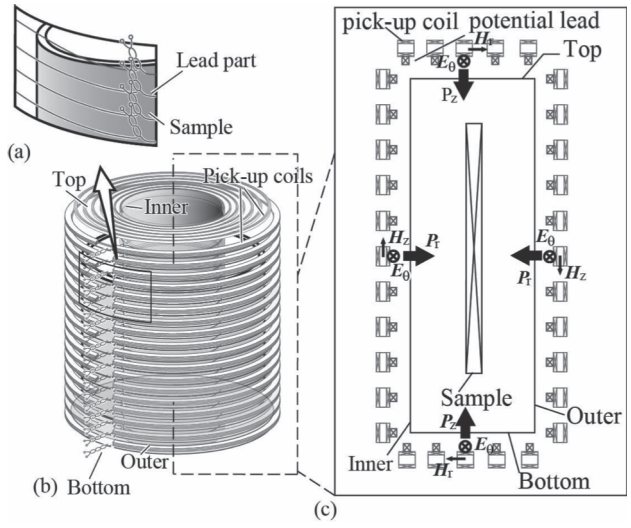

Fig. 1 Configuration of new measuring system

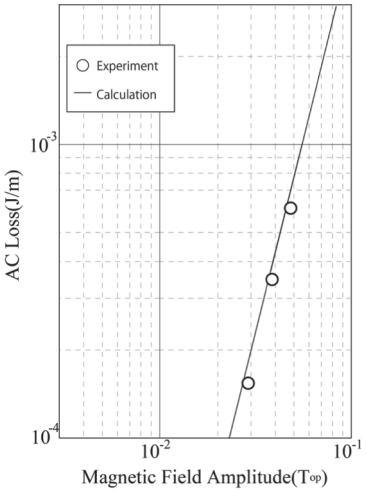

Fig. 2 Measuring results