and Disturbance in the Large Helical Device

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I. Summary

Superconductors in windings are fixed by frictional forces at contact surfaces between the conductors and spacers to support the conductors subject to electromagnetic forces. To analyze stability of the conductors against mechanical disturbances due to conductor motions, which are the main causes of premature quenches in the windings, it is important to estimate contact forces and frictional coefficient between the conductors and the spacers. We statistically computed fluctuation of contact forces caused by irregularities in the dimensions of the conductors and spacers, and experimentally analyzed the coefficient of friction at the contact surface of them.

II. Irregularity in conductor's and spacer's dimensions

Fluctuations of the contact forces between the conductors and the spacers which have irregularities in their dimensions are statistically analyzed taking mechanical properties of the conductors and the spacers, the coil structures such as the diameter and the spacer length, and the size of irregularities into consideration. In the analysis, we assume that the coil is the solenoid coil having 12 layers of the KISO-32 conductor, and the standard deviation (SD) of the irregularities of the conductors' and spacers' dimensions are 38 and 39 μm respectively. Figure 1 shows the dependence of the SD of the fluctuation in the contact forces at the innermost layer of the solenoid coil on the length of the spacer along the conductor. The solid line means the analytical result and the dotted line shows the SD to become the contact force between the conductors and spacers zero. The dotted line always does not become zero.

III. Frictional coefficient between conductor and spacer

The specimens for the experiment are a Cu cylinder and a GFRP plate, which simulate a superconductor and a spacer respectively. In this experiment, the contact geometry of the specimens is line, the oscillation frequency is 2 Hz, and the contact stress is 42 MPa. The dependence of the frictional coefficient on the number of cycles in oscillation is shown in Figure 2. From the figure, it is clear that the coefficient of friction decreases with decreasing of the bath temperature.

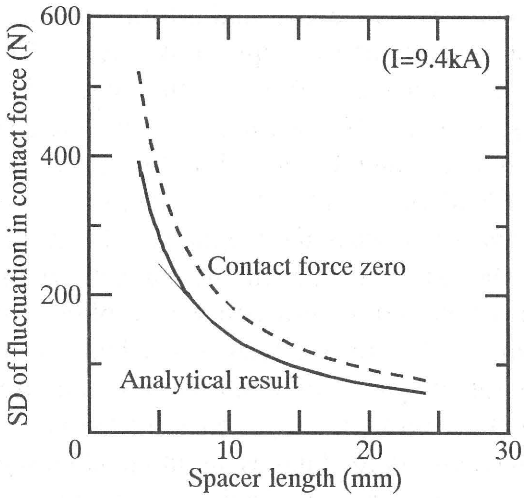

Fig. 1. Dependence of SD of fluctuation in contact forces on spacer length.

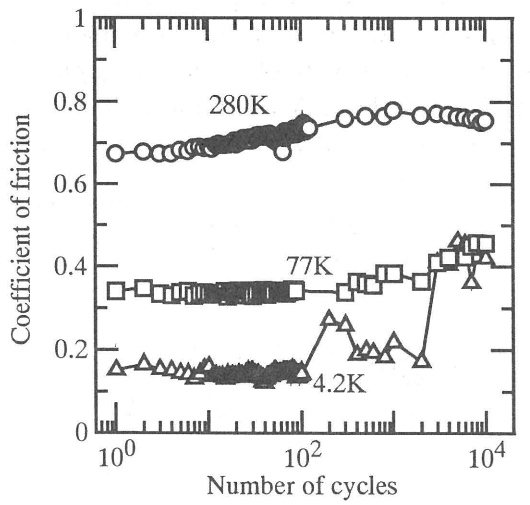

Fig. 2. Frictional coefficient against number of cycles at three temperatures.