§12. Transverse-Field Losses in Aluminum-Stabilized Superconducting Conductors

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Aluminum-stabilized superconducting NbTi conductors are used for the winding of large-scale dc magnets, such as for the helical coil system of the Large Helical Device [1]. In such a conductor, a large amount of stabilizer generates large inter-strand coupling losses in a changing external magnetic field [2]. In order to elucidate their loss mechanism, the frequency characteristic of ac losses in aluminum-stabilized superconducting conductors are investigated by using our measuring system originally developed [3].

AC loss measurement is carried out for the short and straight sample conductor as shown in Fig. 1. The sample of about 50 cm in length is subjected to an ac ripple field with a frequency range from 0.05 to 337 Hz and an ampitude of $\mu_0 H_m$=0.8, 1.6mT superimposed on the bias field. Figures 2 is the measured frequency characteristic curve of the loss for the sample conductor (KISO-32), where the directions of the applied magnetic field for the two cases are shown by the mark // and ⊥ as shown in Fig. 1. In this figure, the vertical axis i.e., the 'normalized loss', is the loss per cycle normalized by $\mu_0 H_m^2$. The experimental results show that the loss feature much depends both on direction of the transverse magnetic field and location of the stabilizer relative to the strand bundle.

We show the calculated results of the frequency characteristic of losses in the conductor (KISO-32) in Fig. 3, where W// and W⊥ are the total loss density per unit volume of the whole conductors for each case of field direction of // and ⊥, respectively. The observed results are quantitatively explained by the theoretical analysis.

In addition, we studied the Hall effect on coupling losses in the above aluminum-stabilized superconductor [4]. This conductor is used under the coexistence of the transverse and the parallel magnetic fields. The conductor must generally be designed so as to avoid the increment in the resistivity of the aluminum due to the Hall effect at quench, but the low loss point of view should also simultaneously be taken into account in such a conductor design

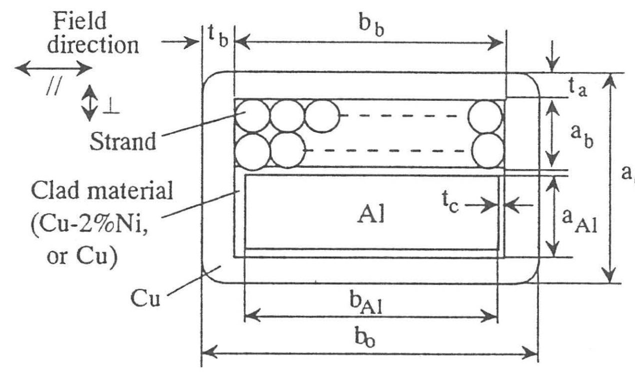

Fig. 1. Schematic cross-sections of the sample conductor.

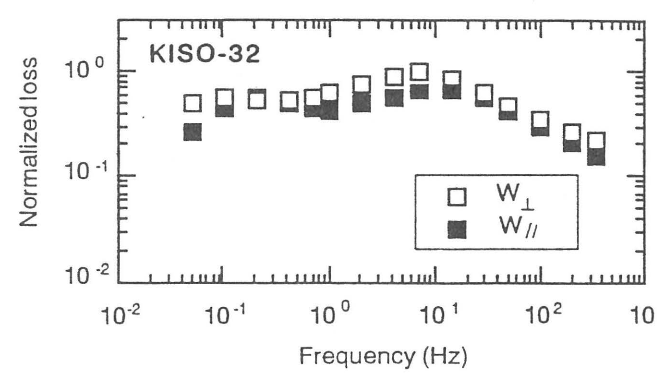

Fig. 2. Measured loss-frequency characteristics.

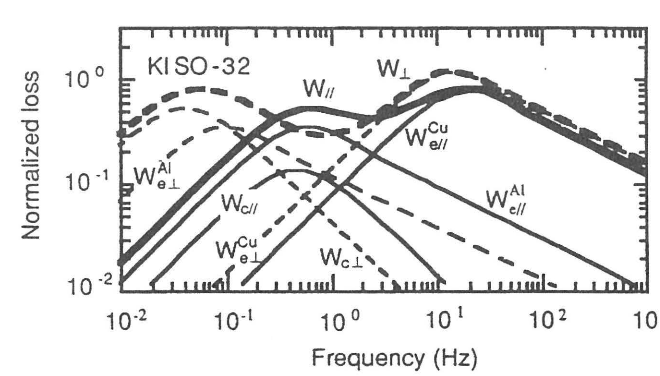

Fig. 3. Calculated frequency characteristic curves of the ac loss.

References
1) Motojima, O. et al. : IEEE Trans. Magn., **MAG-27** (1991) 2214.
2) Sumiyoshi, F. et al. : IEEE Trans. Magn., **MAG-28** (1992) 210.
3) Sumiyoshi, F. et al. : IEEE Trans. Magn., **MAG-30** (1994) to be published.
4) Kawashima, T. et al. : IEEE Trans. Magn., **MAG-30** (1994) to be published.