§15. Stability of LHD Superconductor Against Mechanical Disturbance

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We are developing a theory to stochastically estimate the possibility of a quench in a superconductor caused by a mechanical disturbance due to a conductor motion. In our study main efforts are put to develop a method to estimate the disturbance energy due to a conductor motion. To estimate the disturbance energy, it is important to estimate the length of moving segment of the conductor, and we had derived a theory to statistically predict the length of movable signet of a conductor (LMSC) based on the fixing condition of the conductor[1].

This year, we studied on the relation between the LMSC and the copper-to-superconductor (Cu/Sc) ratio by applying our theory, and, based on our study, we explained experimental results by Ghosh et al. on the influence of Cu/Sc ratio on the conductor stability[2].

Ghosh et al. performed a systematic experiment, changing the Cu/Sc ratio from 1.2 to 1.8 to examine the stability of prototype of cables for SSC magnets. Their experimental result shows that the stability of the cable strongly depends on the Cu/Sc ratio and that the number of training quenches decreases by increasing the Cu.Sc ratio. However, the stability analysis based on the thermal equilibrium equation shows that the influence of Cu/Sc ratio on the minimum quench energy is not large[3] and can not explain the Ghosh's experimental results.

In the model simulating Ghosh's experimental arrangement, we assume that the cable, electrical insulation and fixture inevitably have irregularities in their dimensions, and that, even if a uniform force is applied to the fixture for fixing the cable, the contact force at the surface of the cable fluctuates. An insufficient local contact force allows mechanical disturbances due to motion of the cable. In the analysis, the irregularities in the dimensions of the cable, mylar and fixture are combined together and attributed to the fixture surface to simplify the analysis. We also assume that the irregularity of a solid surface possesses a Gaussian stochastic distribution. Fig.1 shows the predicted number of quenches vs. the Cu/Sc ratio for the quench currents to reach the plateau region for the supporting pressure of 68.9MPa[4]. In this calculation, we assume that the plateau is a region where the conductor current is more than 99% of the cable critical current. The results show that the training characteristics strongly depend on Cu/Sc ratio. And that predicted training characteristics are quite similar to the experimental results obtained by Ghosh.

The close agreement between our analytical predictions and previously obtained experimental data leads us to conclude the basic accuracy of our model.

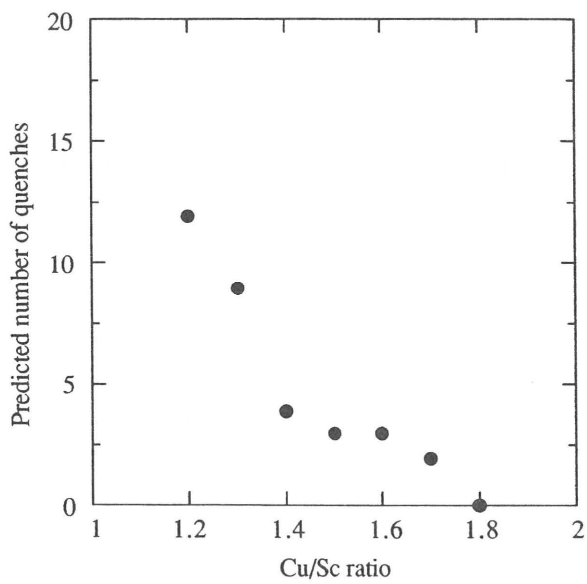

Fig.1 Predicted variation in the number of quenches with Cu/Sc ratio

References

[1] O. Tsukamoto, *Fusion Engineering Design*, Vol.20, pp.327-332, 1993.
[2] N. Amemiya and O. Tsukamoto, *Cryogenics*, Vol.31, pp.528-532, 1991.
[3] A. K. Ghosh et al. *IEEE trans. on Magn.*, Vol.25, No.2, pp.1831-1834, 1989.
[4] T. Takao and O. Tsukamoto et al., *IEEE Trans. on Magn.*, July (1994) (to be published)