§21. Stabilization of Cable in Conduit Superconductor (CCSC) with Non-Uniform Current Distribution Among Strands

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We are studying a stabilization method for a CCSC by locally short-circuiting the strands of the first level cable of the CCSC. In this method, the current in the quenched strand is transferred to other stands through the short-circuiting parts and the stability in term of the minimum quench energy (MQE) is expected to drastically increase when the transport current of the CCSC is lower than a certain threshold level.

In the previous study, the principle of the method was demonstrated by preliminary experiment. In this fiscal year, the MQE of a triplex (a cable made of three superconducting strands) with periodic and local short-circuiting parts was measured and compared with that of a triplex made of bare strands without short-circuiting parts. This method was analyzed also by computer simulation.

i) Experiment [1)]

Two test samples, A and B, were made. The sample A was wound of a triplex where each of three strands was insulated and the strands were locally short-circuited at every 20 cm along the triplex. The sample B was wound of triplex of tightly twisted bare strands. A heater was attached on one strand of the triplex. The strands of the triplex of the samples A and B were superconducting wires of 0.3 mm dia and super-to-copper ratio 1.08. In the experiment, applying a pulse current to the heater, MQE was measured by changing the transport current of the triplex I_p. The results for the samples A and B are shown in Fig. 1. For the comparison, the MQE of a single strand is also shown in the figure. As is seen in Fig. 1, the sample has a threshold current I_{th} below which its MQE increases stepwise. I_{th} of the sample A is 450 A (about 60 % of the quench current of the triplex) and much higher than 75 A, I_{th} of the sample B. This result shows that the stability of the sample A was much improved, because the current of the quenched strand was transferred to other strands through the short-circuiting parts.

ii) Analysis

By computer simulation, we analyzed the stability of the triplex stabilized by our method. The analytical result is shown in Fig. 2. The analysis shows that the MQE jumps up below a certain threshold transport current and that the threshold depends on the thermal conductivity k_{cn} among the strands.

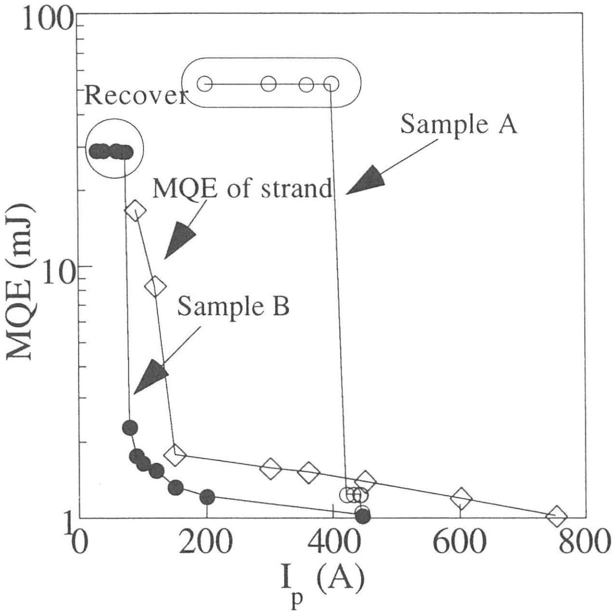

Fig. 1. MQE vs. transport current I_p for strand and samples A and B (I_p for the strand was expressed as three times of the single strand current)

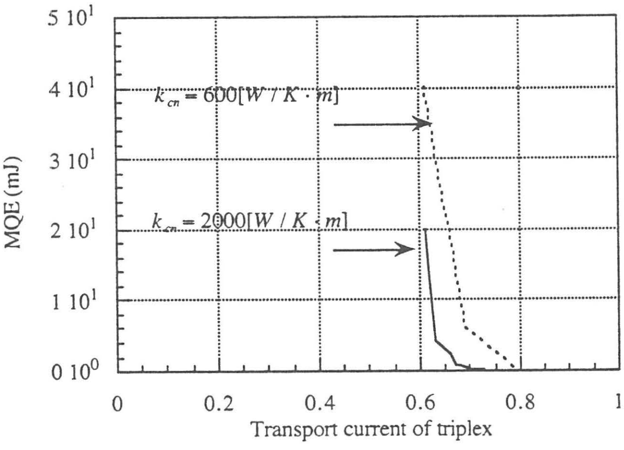

Fig. 2. Analytical result

iii) Concluding remarks

It was experimentally and theoretically demonstrated that the stability of a triplex was drastically improved by our method. In the next step, we study about AC loss characteristics of cable conductor stabilized by our method and try to find optimum configuration of CCSC with high stability and low AC loss.

Reference

1) T.Sasaki, O. Tsukamoto et al, Technical report JIEE, ASC-97-17, pp.49-53 ('97)