## §24. Experimental Studies on Stability and Current Distribution of Rutherford Cables

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Superconducting cables for particle accelerator magnets are multi-stranded to increase current carrying capacity. However, the current carrying capacity of such cables is less than the sum of the current capacities of the individual strands in the cable. It is not possible in practice to obtain the current capacity and stability expected from calculations due to lack of uniformity of current distribution in the cable. Even if the currents are evenly distributed in the steady state, there can be current re-distribution or commutation in transient state, and this makes the cable unstable. This commutation can introduce a fast quench to the whole cable.[1),2),3)]

To obtain the effect of current distribution, we have measured the MQE (minimum quench energy) and normal zone propagation behaviors of two types of Rutherford cables with and without CuMn barrier around the bundle of filaments, in the presence of various transport currents, magnetic fields and heating pulse widths. The only one difference between the two cables is that the cable with barrier has bigger interstrand contact resistance. The cables were heated by spot heaters with various energy, and the MQE's were obtained. Normal zone propagation and current sharing phenomena were detected by pairs of voltage taps soldered to alternate strands on both sides of the cables.[2),3)]

Fig. 1 shows the MQE vs. heating pulse width. In this figure, pre-heat data mean the data taken after heating with energy slightly less than MQE, and reset means no pre-heat. Fig. 2 shows voltages measured at the taps on cable with higher contact resistance.[2),3)]

In this experiments, we could see that there is current re-distribution even in the cable with low contact resistance and that the pre-heating makes the MQE higher. Also we found that the cable with higher contact resistance is more stable though there is a large current re-distribution in the heater strand as shown in Fig. 2. The cable with higher contact resistance was always more stable if the transport current is low or the heating pulse is short.[3)]

These results suggest that the normal zone propagation is controlled by heat transfer between strands when the transport current is low. It is well known the normal zone propagation for high transport current is electromagnetic phenomenon.

To verify this suggestion, we need more experiments including measurement of MQE and normal zone propagation in the region of high current and shorter heating pulse.

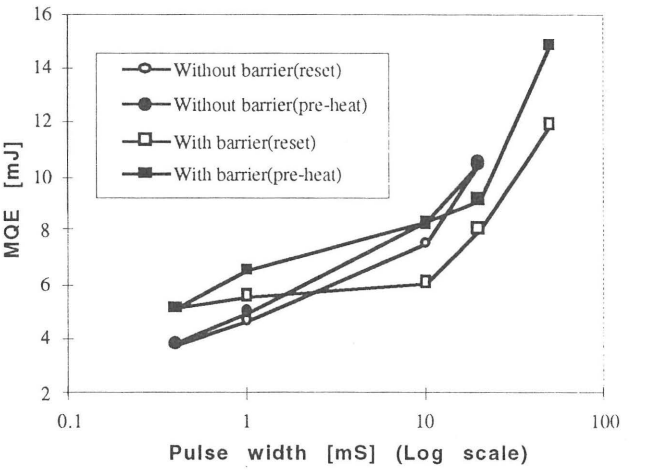


Fig. 1 MQE's of two kinds of cables vs. heating pulse width

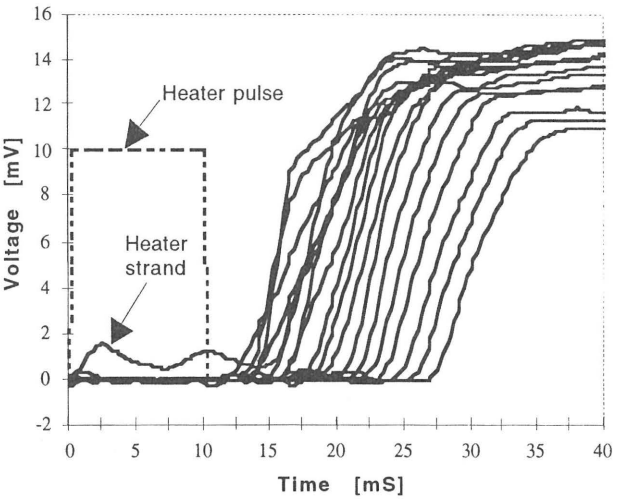


Fig. 2. Voltage measured by taps on strands

References

1) A. Kimura, et al., Stabilities of the Rutherford Cables with Cu and CuMn Barrier, IEEE Trans. on Applied Superconductivity, 5(1995)2.
2) S. W. Kim, et al., Studies on stabilities of superconducting Rutherford Cables, ICMC (1995).
3) S. W. Kim, et. al, Experimental studies on stabilities of Rutherford Cables for superconducting accelerator magnets, MT-14(1995).