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Current-carrying capacity of HTS single layer cable in parallel magnetic field

V. S. Vyatkin[1*], K. Tanimura[1], M. Kiuchi[1], E. S. Otabe[1], T. Matsushita[1], M. Ohya[2]
[1]**Kyushu Institute of Technology,** [2]**Sumitomo Electric Industries, LTD**
E-mail: vyatkin@aquarius10.cse.kyutech.ac.jp

Introduction: Structures of DC superconducting cable with higher current-carrying capacity than in conventional cables were proposed in [1-2]. The characteristic point is to use parallel magnetic field to enhance the critical current density. In this work the current-carrying capacity of a single layer composed of Bi-2223 tapes was measured in the parallel magnetic field to prove the feasibility of the proposed cable. This simulated the innermost layer of the proposed cable.

Experiment: A single layer cable was manufactured with 13 Bi2223 tapes (Fig. 1). The diameter was about 19 mm. The width of each tape was 4.4 mm. Each tape was parallel to the axis and the length of current contact with the lead was about 15 mm. The distance between the voltage contacts was 31 mm.

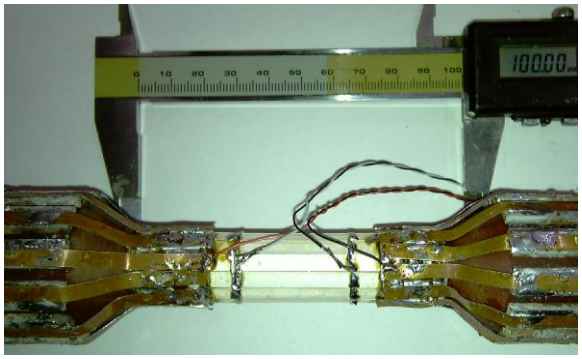

Fig. 1. Untwisted single layer cable with 13 Bi2223 tapes.

During the experiment, the transport current was increased with step 7.5 A in a half second, and the voltage was measured. The transport current was applied until the voltage reached 0.31 mV (electric field 0.01 V/m). The critical current was obtained with electric field criterions from the current-voltage curve.

Results and Discussion: The current-carrying capacity is almost flat with increasing magnetic field up to about 0.1T and then, decreases gradually, as shown on Fig.2. This behavior is completely different from that in a transverse magnetic field. This suggests the superiority of the proposed cable structure for the current-carrying capacity. In Fig. 2 the current-carrying capacity is compared with the critical current of a single tape multiplied by 13. It is found that the current-carrying capacity of the single layer cable is higher. This indicates that the cable structure eliminates the normal magnetic field component at the edges of the superconducting tapes.

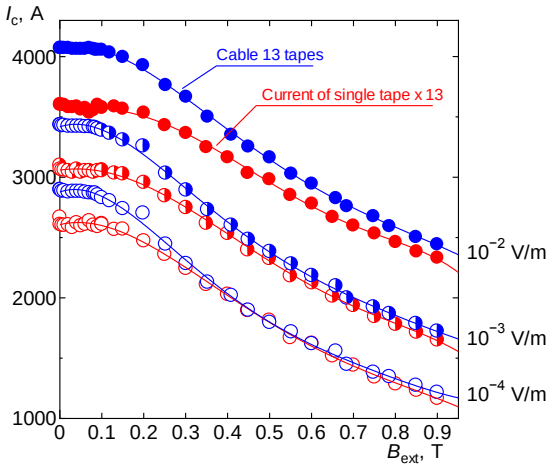

Fig. 2. Current-carrying capacity of the cable determined with various criterions. The data are compared with the critical current of a single tape multiplied by 13.

Conclusion: It was obtained that the cable has the critical current about 10% higher than the same amount of single superconducting tapes due to the estimation of the normal field. From the flat characteristics of the critical current in the parallel magnetic field, the current-carrying capacity of the cable can be appreciably enhanced by optimizing the structure.

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References:

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