§7. Superconducting Current Leads Prepared by the YBCO Tapes

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1. Introduction

High temperature superconductor HTS such as YBCO ($Y_1Ba_2Cu_3O_7$) having critical temperature T*c* above 77 K are attractive for current lead application. In a present study, transport performance at 77 K for the current lead assembled from the current lead units has been reported. The YBCO HTS current leads with large transport current and small heat load are promising for superconducting magnet systems.

2. Experimental

Fig. 1 shows a current lead unit composed of the YBCO tapes, GFRP board and Cu caps. The YBCO tapes are prepared by trifluoroacetates - metal organic deposition TFA-MOD process. Five YBCO tapes with 5 mm in width are arrayed on the GFRP board and soldered to Cu caps. The GFRP board serves mechanical reinforce, and relieves thermal stress in the thin YBCO tapes.

HTS current lead assembled from the ten units in parallel is shown in Fig. 2. The units were mechanically bolted with In foils to both Cu joint terminals. The assembled current lead was cooled down to 77 K by liquid nitrogen in a tub. Transport current of the 10 units and assembled HTS current lead were measured by the facilities of SWCC Showa Cable Systems Co., Ltd and NIFS National Institute for Materials Science, respectively.

3. Results and Discussion

Fig. 3 shows transport critical current Ic at 77 K for the ten lead units (A-J). The Ic of them ranged from 408 A to 534 A. The mean Ic was 460 A.

Fig. 4 shows transport performance at 77 K for the HTS current lead assembled from the ten units. The transport current of 4000 A was stably carried with no voltage generation on the tapes for ten minutes. The voltages of the ten lead units V_{unit} between both Cu caps almost linearly increased with increasing transport current. They were around 0.3 mV and remained constant during transport current of 4000 A. Furthermore, the transport current of 5000 A was successfully applied with voltage of 270 μV on some YBCO tapes.

The heat leakage of HTS current lead with 150 mm in length between 77 K and 4.2 K is estimated to be 465 mW. Therefore, the heat load at transport current of 4000 A corresponds to 0.116 W/kA, which is one order of magnitude smaller than that (1.2 W/kA) of conventional Cu current lead. The small heat load results from high current performance and low thermal conductivity in the present HTS current lead.

1) K. Shiohara et al., Physica C, 469(2009), 1870-1872.
2) Y. Yamada et al., IEEE Trans. Appl. Supercond.,(2010) in press.

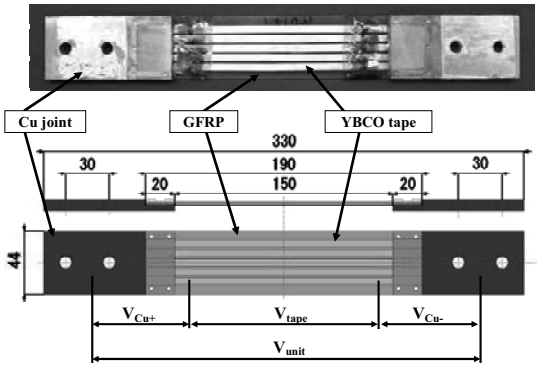

Fig. 1. HTS current lead unit prepared by five YBCO tapes.

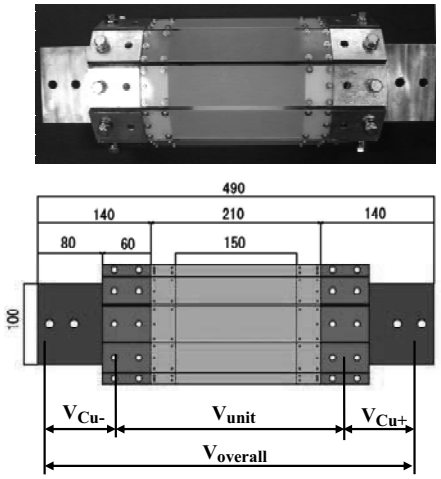

Fig. 2. HTS current lead assembled from the ten units.

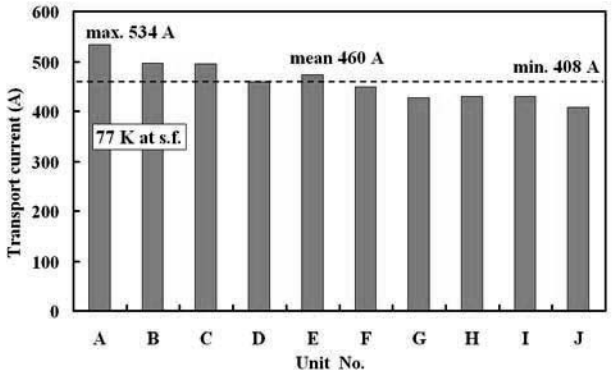

Fig. 3. Critical current of the ten lead units (A-J) at 77 K.

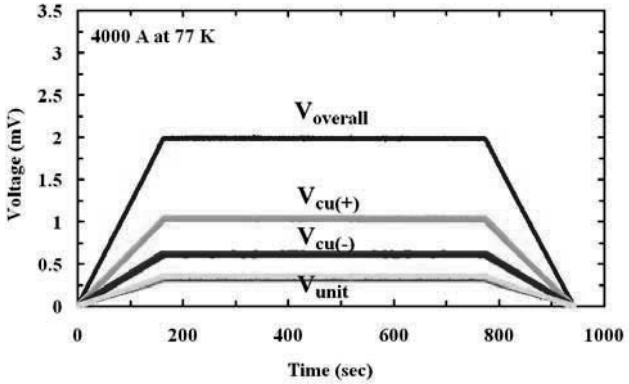

Fig. 4. Transport current of 4000 A at 77 K for the HTS current lead assembled from the ten units.