

§1. Superconducting Current Leads Prepared by the YBCO Tapes

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1. Introduction

High temperature superconductor (HTS) of $Y_1Ba_2Cu_3O_7$ (YBCO) with critical temperature T_c above 77 K is attractive for current lead application^(1, 2). In this work, transport performance at 77 K for the current lead assembled from ten current lead units has been reported. The HTS current leads prepared by the YBCO tapes with large transport current and small heat load are promising for superconducting magnet systems.

2. Experimental

The YBCO tapes with 5 mm in width are prepared by Tri Fluoro Acetates - Metal Organic Deposition (TFA-MOD) process. A 2 kA-class current lead unit is composed of ten pairs of YBCO tapes (20 tapes), a GFRP and stainless steel (SS) boards and Cu caps at both ends. The GFRP board serves mechanical reinforce and relieves thermal stress in the thin YBCO tapes. Two SS boards are attached as shunt in case of quenching. Fig. 1 shows a HTS current lead assembled from the ten current lead units (A to J). The assembled current lead was cooled down to 77 K by liquid nitrogen in a tub. Transport current of the HTS current lead were measured by the facilities of National Institute for Fusion Science NIFS.

3. Results and Discussion

Fig. 2 shows transport performance at 77 K for the current lead unit H. The voltages: V_{Cu+} , V_{Cu-} and V_{unit} almost linearly increased with increasing transport current, and reached around 1.5 mV at 18 kA, respectively. The V_{Cu+} and V_{Cu-} voltages at both ends are similar in joint resistance. The voltage: V_{YBCO} on the YBCO tapes slightly generated at transport current of 15 kA and increased to maximum 400 μV in some tapes at 18 kA.

Fig. 3 shows transport performance at 77 K for the current lead assembled from the ten units. Although the maximum voltage of 50 μV was generated in some YBCO tapes, the transport current of 15 kA was stably carried for ten minutes. The overall voltage: $V_{overall}$ of 3.4 mV almost equals to the sum of V_{unit} , voltage of Cu joints: V_{Cu+} and V_{Cu-} , though the V_{unit} ranged from 0.3 mV to 0.9 mV. Furthermore, transport current of 18 kA was successfully carried for ten minutes with mean voltage of 200 μV in YBCO tapes.

The heat leakage between 77 K and 4.2 K for the assembled current lead with 150 mm in length is calculated to be 2730 mW which corresponds to 182 mW/kA. The low heat leakage is around 1/6 in comparison with that (1.2 W/kA) of conventional Cu current lead. Most heat leakage results from high thermal conductivity of deposited Ag layer on YBCO tapes.

- 1) Y. Yamada, et al. : IEEE Trans. Appl. Supercond. **21** (2011) 1054.
- 2) Y. Yamada, et al. : IEEE Trans. Appl. Supercond. **20** (2010) 1714.

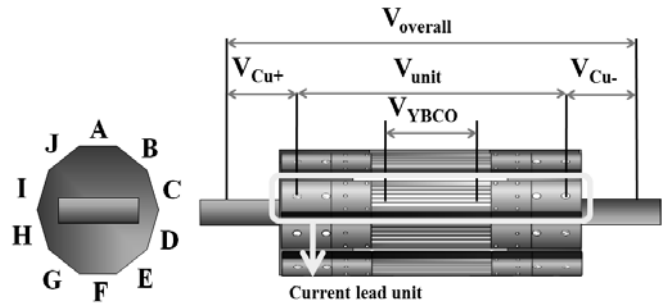


Fig. 1. HTS current lead assembled from ten current lead units with YBCO tapes.

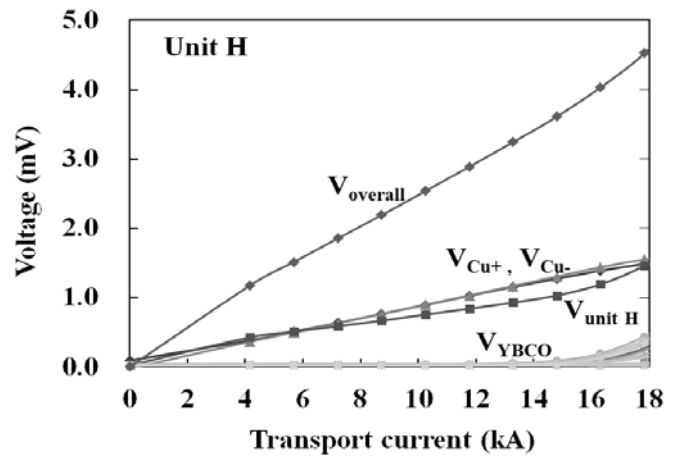


Fig. 2. Transport current performance at 77 K for the current lead unit H.

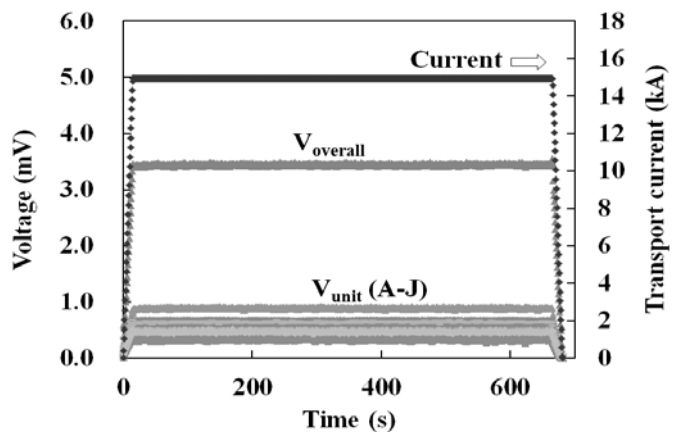


Fig. 3. Transport performance of 15 kA at 77 K for the assembled current lead.