

§20. HTS Current Leads Prepared by Y-based Superconducting Tapes

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1. Introduction

Y-based $Y_1Ba_2Cu_3O_7$ (YBCO) high temperature superconductor (HTS) with critical temperature T_c above 90 K is attractive for current lead application⁽¹⁻³⁾. In present work, transport performance at 77 K in liquid nitrogen for the current lead has been reported. The HTS current leads using YBCO tapes with large transport current and small heat load are promising for superconducting magnet system.

2. Experimental

The YBCO tapes with 5 mm in width shown in Fig. 1 (a) are prepared by Tri Fluoro Acetates - Metal Organic Deposition (TFA-MOD) process. The YBCO superconducting layer of 1.5 μm in thickness is formed on the intermediate oxide buffered layers deposited on Hastelloy substrate schematically shown in Fig. 1 (b). An Ag layer, around 24 μm in thickness, is deposited on the YBCO layer for improving thermal and electrical stability

Fig. 2 shows the HTS current leads composed of twenty-four YBCO tapes, both Cu end caps and a pair of stainless steel SS boards. Six bundles stacked by four YBCO tapes are soldered to each slit (4 tapes/slit) in front side (3 slits/side) and similarly done in back side of Cu caps. The critical current of 24 YBCO tapes ranges from 147 A to 155 A at 77 K and self-field. The SS boards are attached as shunt in case of quenching, and serve mechanical reinforce and relieves thermal stress in the thin YBCO tapes. The current lead was cooled down to 77 K by liquid nitrogen in a tub. Transport current were measured by facilities of National Institute for Fusion Science (NIFS).

3. Results and Discussion

Fig. 3 shows transport performance at 77 K for the current lead. The transport current of 3,000 A was carried stably in liquid nitrogen with almost no voltage on each tape. The current of 3,500 A was successfully applied with maximum voltage of 80 μV on some YBCO tapes. The voltages: $V_{Cu(+)}$ and $V_{Cu(-)}$ almost linearly increased with increasing transport current, and reached around 1.35 mV and 1.17 mV at 3,000 A, respectively. The low voltage results from the low contact resistance of 0.39-0.45 $\mu\Omega$ between Cu cap and YBCO tapes, and cause a small Joule heating at the joints.

The heat leakage of the twenty-four YBCO tapes 200 mm in length is calculated to be 245 mW between 77 K and 4.2 K. Therefore, the heat load at transport current of 3,000 A corresponds to 0.082 W/kA, which is one order of magnitude smaller than that (1.2 W/kA) of conventional Cu current lead. The small heat leakage results from high current performance and low thermal conductivity in the TFA-MOD processed YBCO tapes.

- 1) Y. Yamada, et al.: IEEE Trans. Appl. Supercond. **21** (2011) 1054.
- 2) Y. Sakai, et al.: ICEC24-ICMC2012, 15P-P07-12, 74.
- 3) H. Motohashi, et al.: Abstracts of CSJ Conf., **86** (2012) 19.

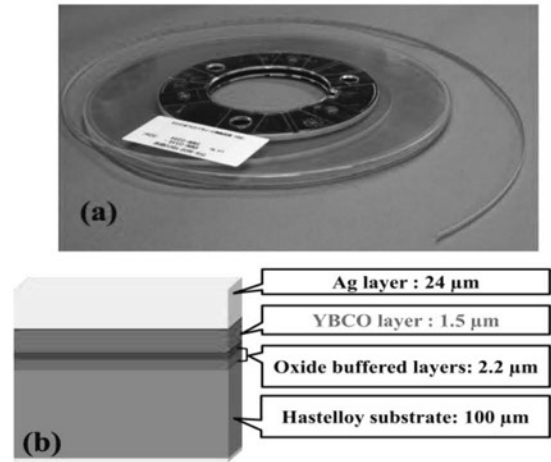


Fig. 1. TFA-MOD processed YBCO tape (a) long YBCO tape, (b) schematic cross-section of the tape.

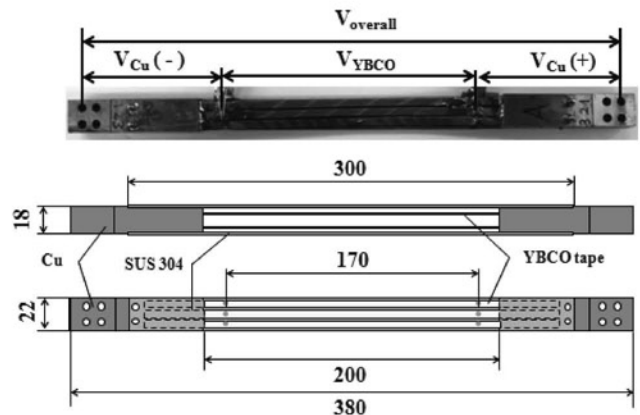


Fig. 2. HTS current lead prepared by twenty-four YBCO tapes.

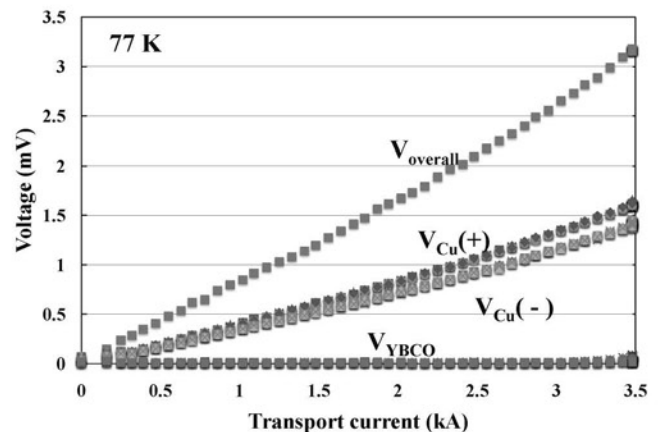


Fig. 3. Transport performance at 77 K for the HTS current lead.