DOI: 10.1017/S1431927605502599
Microsc Microanal 11(Suppl 2), 2005

Nanostructural Characterization of YBCO Layer on Textured Ceramics Buffer Layer Fabricated by Pulsed-Laser Deposition

T. Kato[1], H. Sasaki[1], T. Watanabe[2], A. Ibi[2], Y. Iijima[3], K. Kakimoto[3], Y. Sutoh[3], T. Muroga[2], S. Miyata[2], Y. Yamada[2], T. Saitoh[3], T. Izumi[4], Y. Sasaki[1], T. Hirayama[1] and Y. Shiohara[2, 4]

1) Materials R&D Lab, Japan Fine Ceramics Center, 2-4-1 Mutsuno, Atsuta-ku, Nagoya, 456-8587, Japan
2) SRL-Nagoya Coated Conductor Center, ISTEC, 2-4-1 Mutsuno, Atsuta-ku, Nagoya, 456-8587, Japan
3) Material Technology Lab, Fujikura Ltd., 1-5-1 Kiba, Koto-ku, Tokyo, 135-8512, Japan
4) SRL-Division of Superconducting Tapes and Wires, ISTEC, 1-10-13 Shinonome, Koto-ku, Tokyo, 135-0062, Japan

A great deal of research has been directed toward the development of long $YB_2C_3O_{7-x}$ (YBCO) coated superconductor cable. In order to fabricate practical YBCO layers having a high critical current density (J_c) and a high critical current (I_c) values on metal tape, several methods have been applied. In particular, YBCO layers formed by pulsed-laser deposition (PLD) on a metal tape with textured ceramics buffer layer obtain J_c values of more than 1MA/cm^2 and continuous coated conductors more than 100 m long have been successfully produced [1]. However, as the YBCO layer prepared by the PLD become thicker, more than 1 μm, the J_c values of the YBCO layer decrease and the I_c values do not increase as much. In this study, we characterize the nanostructures of PLD-YBCO layers on the metal tape using transmission electron microscopy (TEM).

A Hastelloy with textured $CeO_2/Gd_2Zr_2O_7$ multilayer was used as substrate. The in-plane alignment ($\Delta\phi$) of the $CeO_2/Gd_2Zr_2O_7$ multilayer is less than $5°$. Two thickness of YBCO layer was deposited using PLD. One is 4μm-thick YBCO on stationary substrate at 760 °C. The other was using reel-to-reel tape transferring system. The YBCO layer was totally deposited 7 times and the substrate transferring rate was 10 m/h from first to sixth deposition, then the last deposition was at 2 m/h. As the YBCO layer becomes thicker, referential deposition temperatures increase from 810 to 830 °C. Total thickness of the YBCO film was 3 μm and an I_c value of the film was 293 A. [2, 3]. Focused Ion Beam was used to prepare cross-sectional TEM specimens, and then nanostructural characterization of the YBCO layer were preformed by TEM.

Fig. 1 shows a dark-field image of 4μm-thick YBCO using the (006) reflection of YBCO. The broken lines indicate the boundaries between a- and c-axes oriented grains. Since many screw dislocations, perpendicularly the YBCO/CeO_2 interface, are observed in the c-axis oriented grains, these grains are considered to grow spirally. An a-axis oriented grain left hand side in

Fig. 1 nucleates on CeO_2, and the a-axis grain grows large with increasing the thickness of YBCO layer. In addition, many gaps or pores are formed at the boundaries of YBCO grains.

Fig. 2 shows a dark-field image of 3μm-thick YBCO layer using the (006) reflection of YBCO. The broken lines also indicate the boundaries between a- and c-axes oriented grains. In YBCO layer composed of c-axis oriented grains, a layer structure corresponding to the multi-deposition process is clearly observed, and arrows indicate the boundaries between each deposited layer. The thickness of each deposited layer from the first to the sixth deposition can be seen to be uniform. In addition, enormous stacking fault are observed in the each deposition layer. Since screw dislocations in c-axis oriented grains penetrate each layer, formation of each layer is strongly correlated by the orientation and the local structure of the underlying layer. However, a-axis oriented grain seems to nucleate after 4th deposition, and the grains grow large with increasing the thickness of YBCO. The a-axis oriented grain growth and formation of the gaps or pores between YBCO grains are considered to decrease the I_c values of YBCO. Therefore, it is important to find out optimum process conditions to suppress such structures. Deposition temperature is one of most important process conditions to produce practical YBCO layers with high I_c values.

References

[1] Y. Iijima et al., *Supercnd. Sci. Technol.*, 17 (2004) 264.
[2] T. Watanabe et al., *IEEE Trans. Appl. Supercond.*, submitted for publication.
[3] T. Kato et al., *Physica C*, (2005) accepted.
[4] This work was supported by the New Energy and Industrial Technology Development Organization (NEDO).

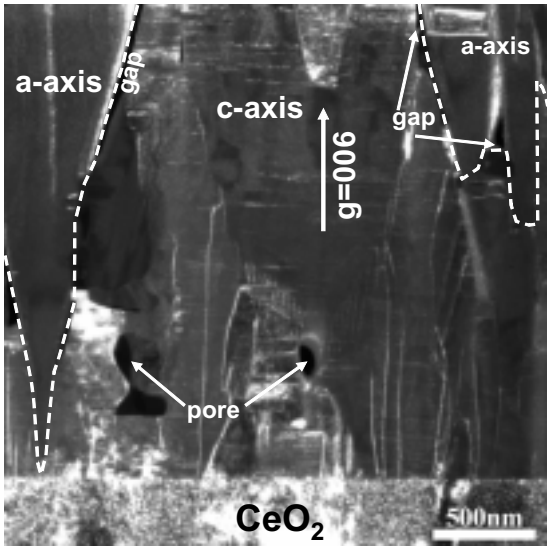

Fig. 1 Dark-field image of 4μm-thick YBCO layer using the (006) reflection.

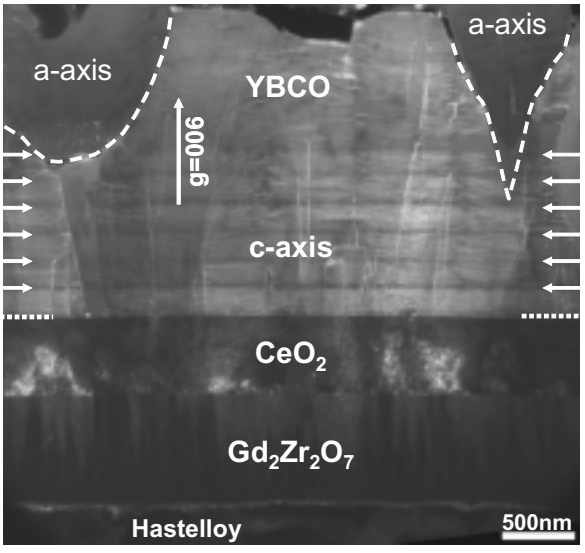

Fig. 2 Dark-field image of 3μm-thick YBCO layer using the (006) reflection.

https://doi.org/10.1017/S1431927605502599 Published online by Cambridge University Press