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Fabrication of $YBa_2Cu_3O_y$ coated conductor by Vapor-Liquid-Solid growth technique using Reel-to-Reel system

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In fabricating $REBa_2Cu_3O_y$ (REBCO) superconducting coated conductors (CCs), in order to reduce the production cost, it is necessary to increase deposition rate. However, when using PLD method, the crystallinities of the REBCO layer are deteriorated by increasing the deposition rate. From our early studies, by using VLS (Vapor Liquid Solid) growth technique, we found that VLS growth technique was possible to achieve both favorable crystallinities and high deposition rate[1]. However, previous reports on VLS growth technique are using a static system without the substrate transportation during the YBCO film deposition, so it is difficult to prepare long REBCO CCs. In this study, we extended the VLS growth technique for fabricating YBCO CCs by using Reel-to-Reel (RtoR) system with substrate transportation.

REBCO CC using the VLS growth technique consists of three layers of solid layer, liquid layer and vapor layer. When a YBCO CC is fabricated by VLS growth technique using the RtoR system, the liquid layer is solidified since the substrate is away from the heater after the liquid layer deposition. Therefore, we examined whether the solidified liquid layer would be melted by re-approaching to the heater. Fig. 1 shows X-ray diffraction patterns of the VLS-YBCO thin films re-approaching the heater at different transfer-speeds of 1.8 and 3.6 m/h. In the case of 1.8 m/h, no $BaCuO_2$(600) peak appeared due to re-melting the liquid layer. On the other hand, when transfer-speed was 3.6 m/h, there was $BaCuO_2$(600) peak. This fact indicates that the solidified liquid layer is not able to re-melt because the substrate temperature was not able to follow the heater temperature due to the high transfer-speed.

Fig. 2 shows liquid layer thickness dependence of J_c at each solid layer thickness. The total film thickness about 1.8 µm. With reducing the thickness of the solid layer and the liquid layer, we achieved 2.04 MA/cm^2 at overall deposition rate 17 nm/s. This result indicates that the thin solid layer provided good seed crystal without *a*-axis grains and the reducing liquid layer thickness suppresses melt-back of the seed layer to the liquid layer.

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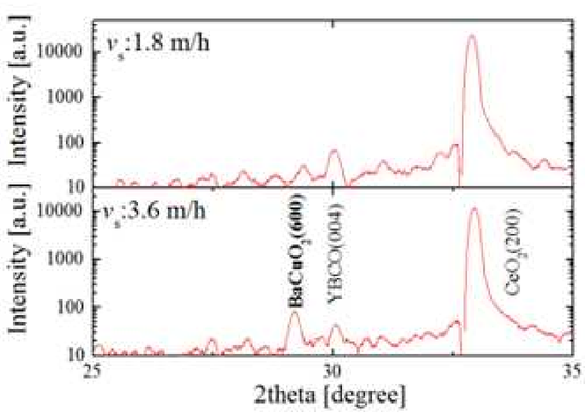

Fig. 1 X-ray diffraction patterns of VLS-YBCO CCs re-approaching to the heater at transfer speeds of 1.8 and 3.6 m/h.

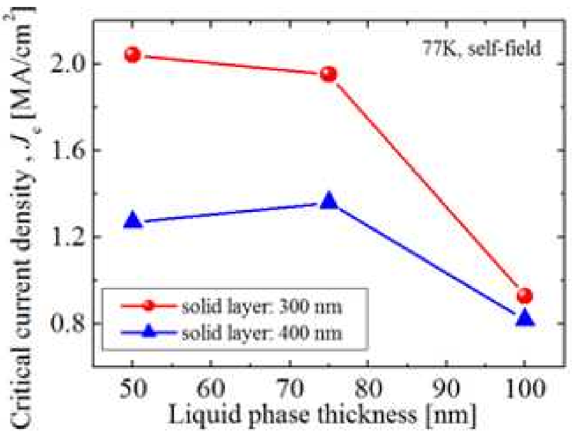

Fig. 2 Liquid layer thickness dependence of J_c at each solid layer thickness.

[1] T. Ito *et al.*: Abstracts of CSSJ conference, Vol.96, p.31 (2018)

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