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Effects of growth temperature and laser repetition rate on the shape of nanorods in $BaSnO_3$-doped $SmBa_2Cu_3O_y$ films prepared by pulsed laser deposition method

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$BaSnO_3$ (BSO) is one of the APC materials, which are known to grow up as nanorods in REBCO. Although a large number of studies have been performed on BSO-doped REBCO films, it has not been fully clarified about relationships between shape of nanorods and growth conditions such as substrate temperature (T_s) and laser repetition rate (f_L) in pulsed laser deposition (PLD) method. According to our previous simulation results, T_s and f_L have some effects on shape of nanorods. The purpose of this paper is to clarify effects of T_s and f_L on the shape of BSO nanorods and the superconducting properties, experimentally.

Using 2 vol% BSO-mixed SmBCO target, BSO-doped SmBCO films were prepared on CeO_2 buffered IBAD-MgO by PLD method, T_s is 800, 820, 840°C and f_L is 2, 5, 10, 20 Hz, respectivity. J_c versus magnetic field applied angle (J_c-θ) was measured at 77 K for the field of 1 T and 65 K for the field of 3 T. We defined the term J_c^{min} as the lowest value of the J_c-θ curves. In order to consider the shape of nanorods, we evaluated the J_c^{min} and $J_c(B//c) / J_c(B//ab)$ *depending on* T_s *and* f_L.

Fig. 1 shows the contour plot on (a) J_c^{min}, and (b) $J_c(B//c) / J_c(B//ab)$ depending on T_s and f_L at 65 K in 3 T. In Fig. 1(a), J_c^{min} has a maximum value when T_s was 800°C and f_L was 20 Hz, and as T_s became larger and f_L became lower, the value tended to decrease. This result indicates that isotropic flux pinning is achieved in the film deposited at low T_s and high f_L. On the other hand, in Fig. 1(b), $J_c(B//c) / J_c(B//ab)$ showed a maximum value when T_s was 840°C and f_L was 2 Hz, and as T_s became lower, the value tended to decrease. This result indicates that c-axis correlated pinning centers are included in the film deposited at high T_s and low f_L. From these facts, we argued that straight BSO nanorods along the c-axis of SmBCO grow in the films deposited at high T_s and low f_L, in contrast, short and inclined BSO nanorods grow in the films deposited at low T_s and high f_L. This tendency is almost the same with the previous simulation result. These results clearly show that the shape of nanorods can be controlled by T_s and f_L. We will compare this result with the films doped with other BMO materials.

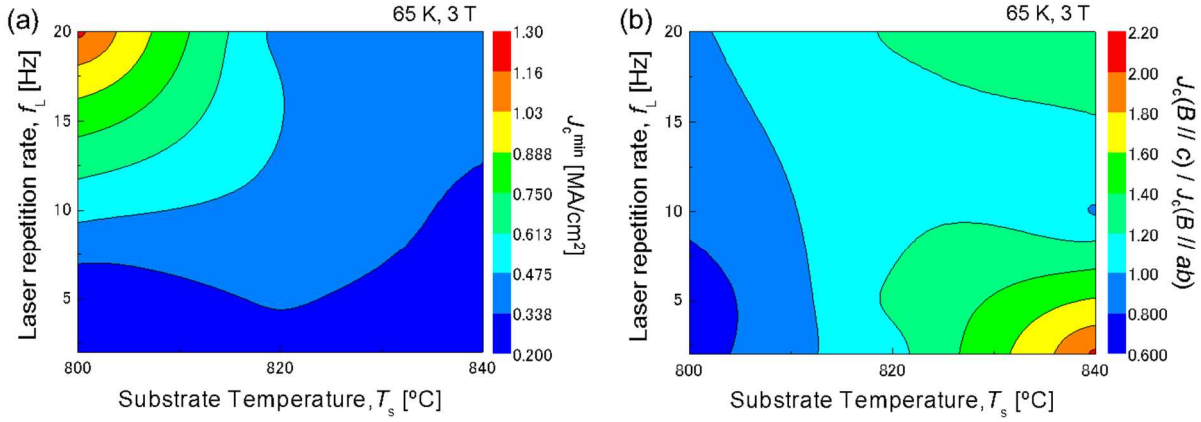

Fig.1 Contour plot of (a) J_c^{min}, and (b) $J_c(B//c) / J_c(B//ab)$ depending on substrate temperature T_s and laser repetition rate f_L at 65 K in 3 T.

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