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Effect of growth condition on lattice strain of $SmBa_2Cu_3O_y$ films induced by $BaHfO_3$ nanorods

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$BaMO_3$ (BMO, M=Zr, Sn, Hf etc) self-organizes into a nanorod shape within $REBa_2Cu_3O_y$ (REBCO, RE=Y, Sm, Nd etc) films grown by vapor phase deposition method such as pulsed laser deposition (PLD). In order to improve flux pinning in a high magnetic field, it is necessary to introduce high number density of BMO. However, excess amount of the BMO causes T_c reduction due to lattice strain of REBCO induced by BMO nanorods. If the diameter of nanorods becomes smaller, we can expect that lattice strain become smaller. From our previous studies, diameter of BMO nanorods can be controlled by substrate temperature, deposition rate and volume fraction of BMO [1-3]. In this study, in order to control nanorods diameter and evaluate lattice strain, $SmBa_2Cu_3O_y$ (SmBCO) films including 16 vol% of $BaHfO_3$ (BHO) were prepared by low temperature growth (LTG) technique [3].

The BHO-doped SmBCO films were deposited on $LaAlO_3$(100) (LAO) single-crystal substrates using a conventional PLD method with a Nd: YAG laser. To control nanorod diameter, we used the LTG technique. In the LTG technique, a thin SmBCO layer (seed layer) was deposited at a relatively high substrate temperature (T_s) of 880ºC, and then a SmBCO layer (upper layer) was homo-epitaxially grown on the seed layer at 790ºC – 880ºC.

Fig. (a) shows critical current density (J_c) depending on magnetic field. From this figure, slope of the J_c-B curves is changed at a magnetic field and the magnetic field was defined as B_{end}. Except for 790ºC sample, B_{end} increased with decreasing T_s. This indicates that number density of BHO nanorods increased and the diameter of the BHO nanorods decreased due to constant volume fraction of BHO. Figs. (b) and (c) indicate lattice strain of REBCO and BMO as a function of T_s. Except for the 790ºC sample, with decreasing T_s, tensile strain applied to SmBCO reduced, on the other hand, compressive strain applied to BHO increased. It indicates that narrow nanorods grown at low T_s are easy to compress.

Figs. (a) J_c of SmBCO films as a function of magnetic field. T_s dependence of lattice strain (b) in SmBCO and (c) in BHO.

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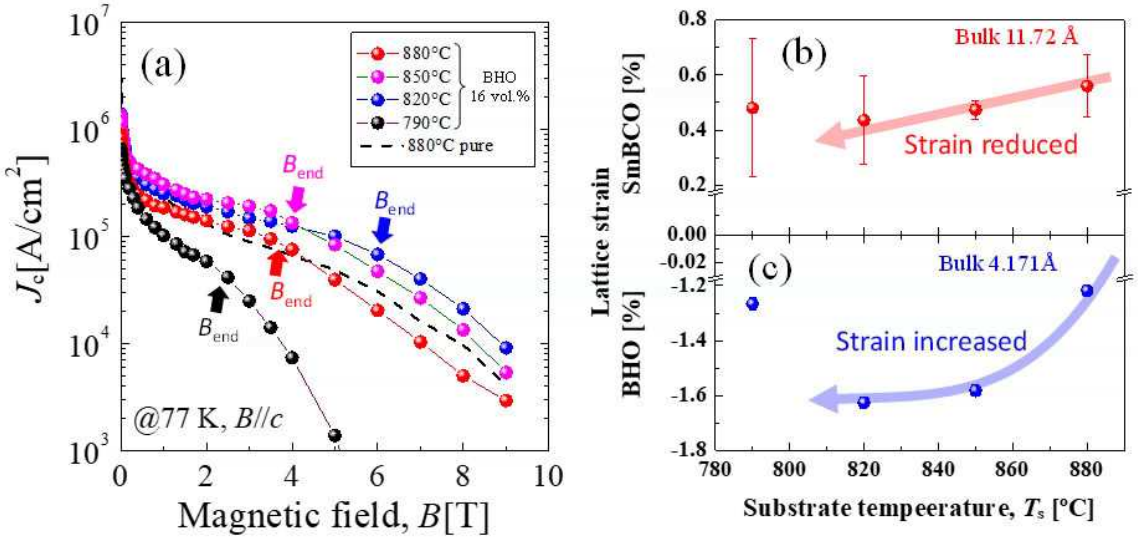

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