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The influence of seed layer on the structure and superconducting property of $BaHfO_3$ doped $Y_{0.5}Gd_{0.5}Ba_2Cu_3O_{7-\delta}$ film prepared by pulsed laser

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◆ Introduction

➢Second generation $REBa_2Cu_3O_{7-x}$ (REBCO, RE=rare Earth) high temperature superconductors, also called as coated conductors (CCs), have properties of high critical current capacity make them attractive for use in most applications, such as for cable, motors, generators, and transformers.

➢Improvement in the in-filed transport properties of REBCO coated conductors is needed to meet the performance requirements for various practical applications, which can be accomplished by introducing artificial pinning centers (APCs), such as second phase dopant.

➢Unfortunately, with increasing dopant level the critical current density J_c at 77 K in zero applied magnetic field decreases.

➢In this paper, we propose a self-seeding technique in order to improve the performance of doped REBCO films.

➢5 mol% $BaHfO_3$ (BHO) doped $Y_{0.5}Gd_{0.5}Ba_2Cu_3O_{7-\delta}$(YGBCO) layer with self-seed layer was grown on CeO_2 buffered ion beam assisted deposition MgO (IBAD-MgO) tape by pulsed laser deposition (PLD).

➢The effect of the seed layer deposition temperature on the quality of 5 mol% BHO doped YGBCO top layer was investigated by X-ray diffraction (XRD) measurements and scanning electron microscopy (SEM) observations.

◆ Experimental

➢CeO_2 buffer layer was directly deposited on IBAD-MgO template by reel-to-reel PLD.

➢On the CeO_2 buffer layers, 2 nm thick 5 mol% BHO doped YGBCO seed layers were deposited at different temperature ranging from710 °C to 820 °C by PLD.

➢ Then 200 nm thick 5 mol% BHO doped YGBCO superconducting films were deposited by PLD on the self-seed layers at 820 °C .

➢Ag layer was fabricated by reel-to-reel DC magnetron sputtering.

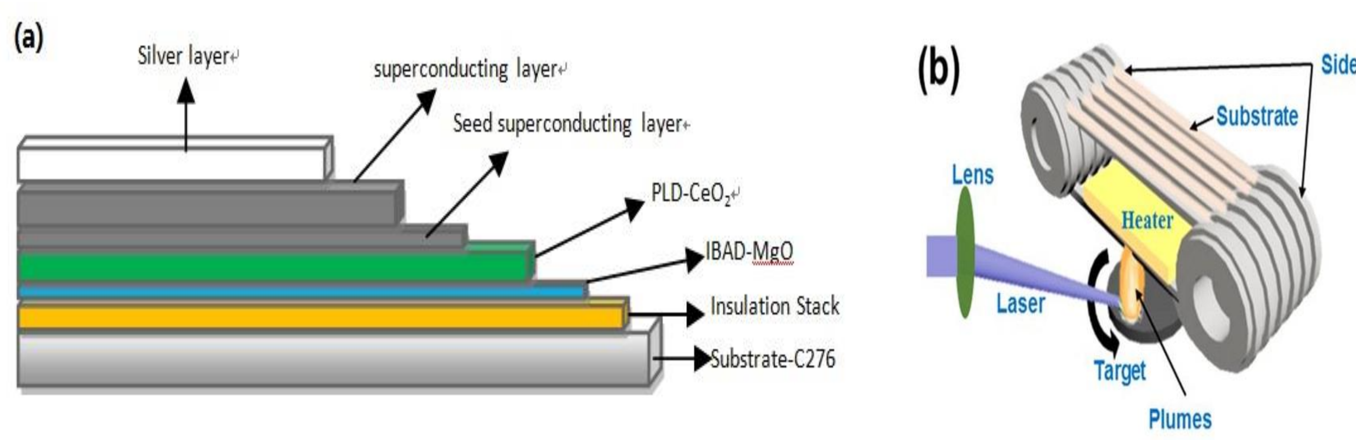

Fig. 1. Schematic diagrams of the cross section of coated conductor architecture based on IBAD-MgO templates (a) and a reel-to-reel PLD system (b).

Table 1. The deposition temperature of seed layer in all the samples

Sample	S1	S2	S3	S4	S5	S6	S7
Seed layer	2 nm thick 5 mol% BHO doped YGBCO film						
Seed layer deposition temperature (°C)	710	730	750	770	790	810	820

◆ Results -structure

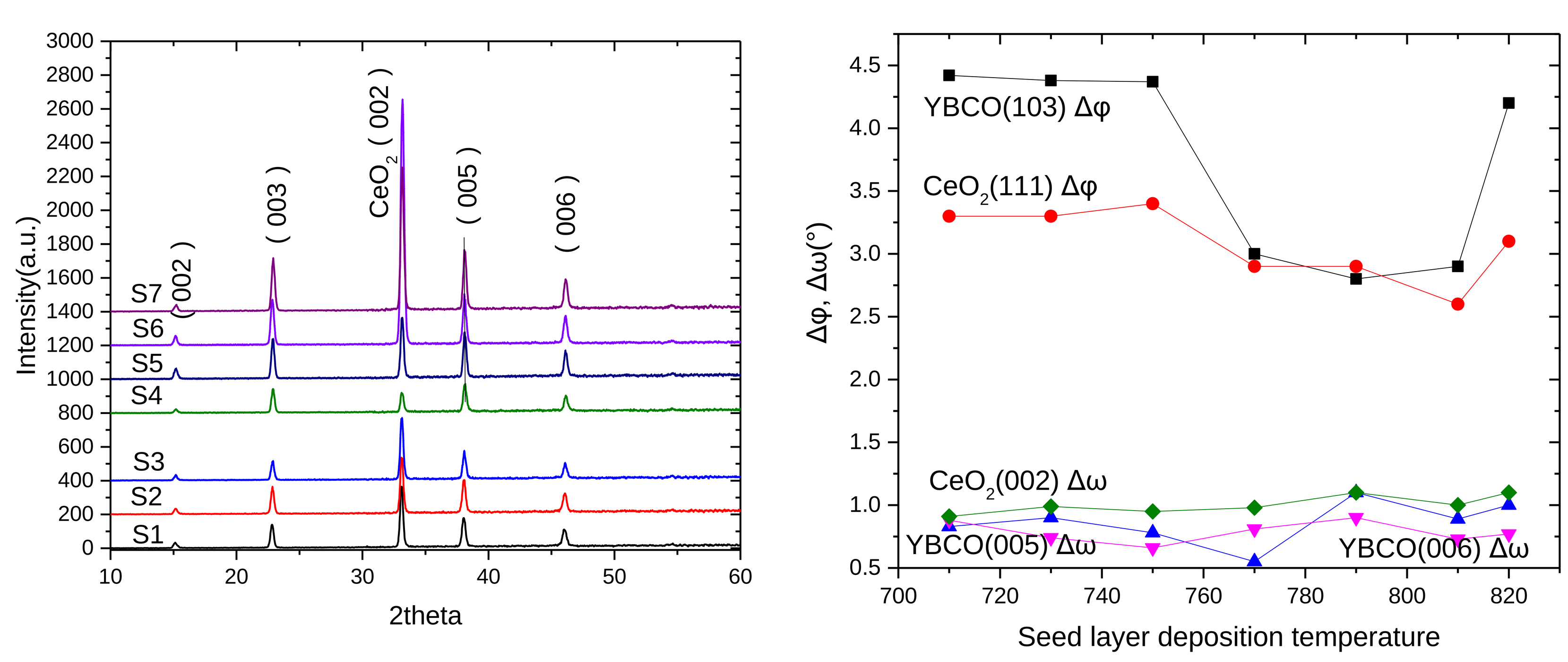

Fig. 2. (a) XRD θ-2θ patterns of all the samples, (b) FWHM values of YBCO (103) φ scan , CeO_2(111) φ scan , YBCO (005) ω scan, YBCO (006) ω scan and CeO_2 (002) ω scan.

➢For all the samples, only (00l) YGBCO peaks reflecting c-axis oriented YGBCO grains are observed.

➢With increasing the deposition temperature of seed layer, full-width half-maximum (FWHM) of X-ray ϕ scan of YBCO (103) peak and ω scans of YBCO (005) first decreased and then increased.

➢No large deviation in FWHM values of ω scans, except for the minimum Δω value of self-seed layer deposited at 770 °C .

➢From YBCO (103) Δϕ values, It was evident that 5 mol% BHO doped YGBCO superconducting films with self-seed layers fabricated at substrate temperature ranging from 770 to 810 °C had good crystallinity.

◆Results-surface morphology of self-seed layer

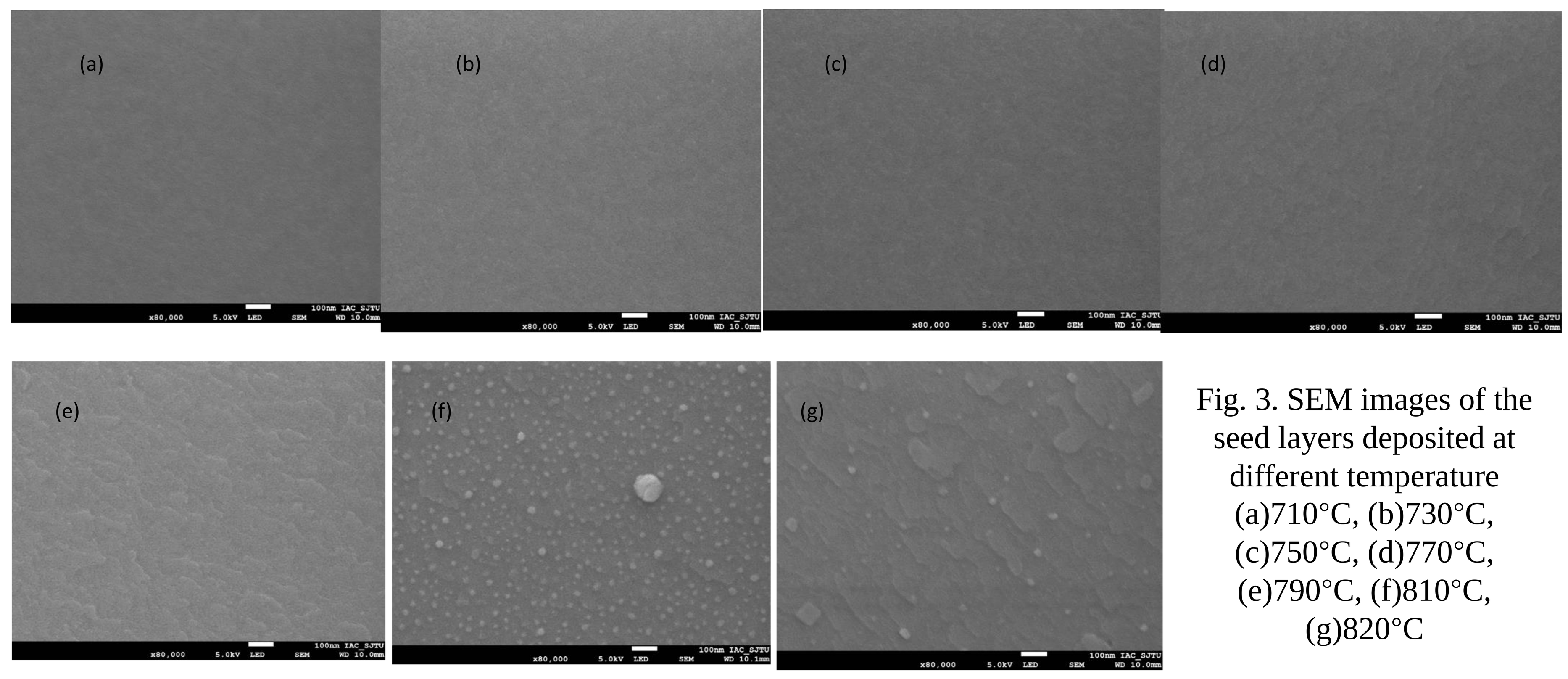

Fig. 3. SEM images of the seed layers deposited at different temperature (a)710°C, (b)730°C, (c)750°C, (d)770°C, (e)790°C, (f)810°C, (g)820°C

➢ A surface roughness increase trend in seed layer was observed with increasing the deposition temperature.

➢When deposition temperature was increased to 770 °C, crystal grain was observed. With further increasing deposition temperature, grain became larger and surface became rougher.

◆Results- surface morphology of 5 mol% BHO doped YGBCO top layer

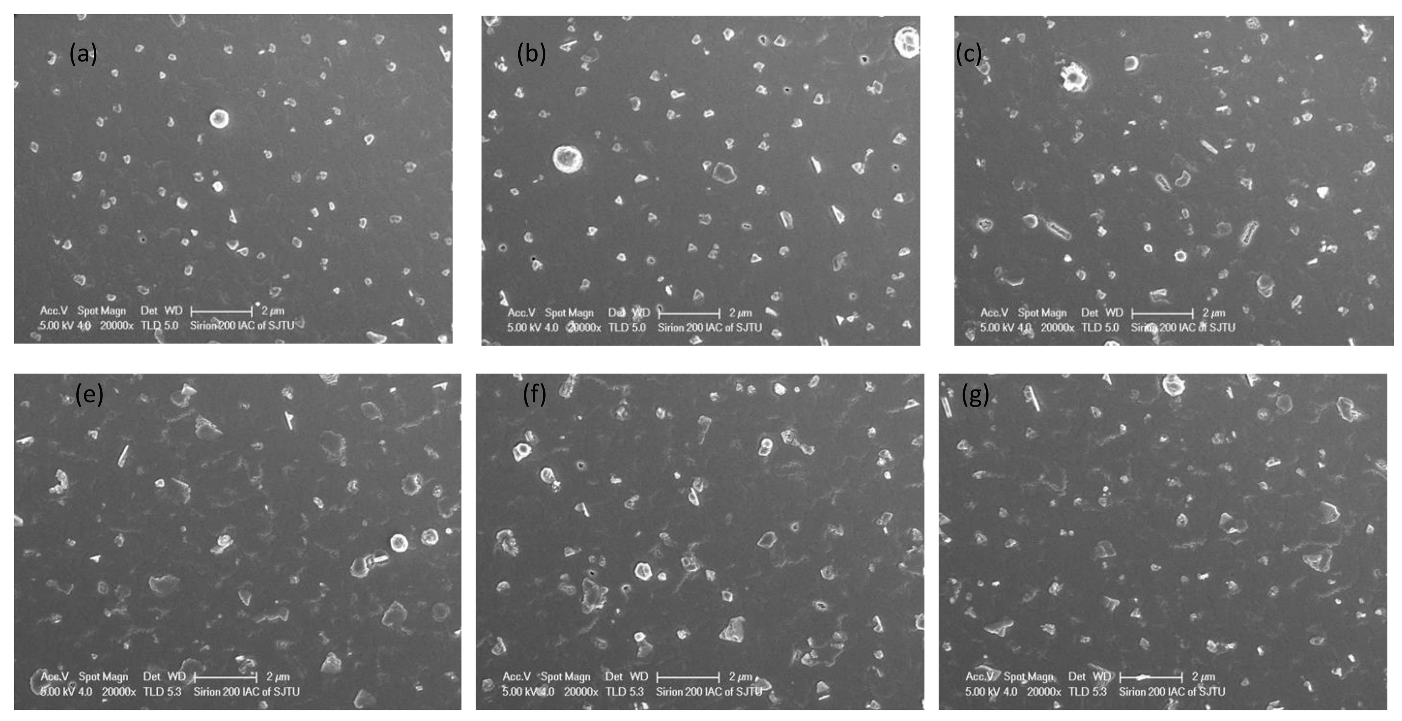

Fig. 4. SEM images 5 mol% BHO doped YGBCO films deposited on self-seed layer fabricated at different temperature (a)710°C, (b)730°C, (c)750°C, (d)770°C, (e)790°C, (f)810°C, (g)820°C

➢With increasing the deposition temperature of seed layer, particles number first decreased and then increased. While the surface of 5mol% BHO doped YGBCO top film had no apparent difference.

➢When the seed layer deposition temperature increased to 770 ℃, scaly crystal appeared.

◆Results- superconducting property

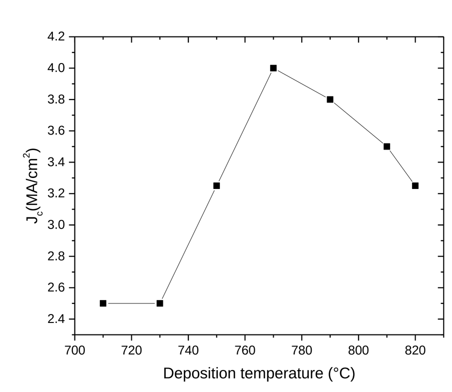

Fig. 5. The dependence of J_c at 77 K and self-field on the seed layer deposition temperature.

➢With increasing the growth temperature of self-seed layer from 710 to 820 ℃, J_c at 77 K and self-filed of the 5 mol% BHO doped YGBCO top layer first increased from 2.5 to 4 MA/cm^2 and then decreased to 3.25 MA/cm^2.

◆Conclusions

➢The effect of growth temperature for seed layer on the quality of 5 mol% BHO doped YGBCO top layer was systematically investigated by XRD and SEM observations.

➢Pure c-axis oriented 5 mol% BHO doped YGBCO superconducting films were fabricated by self-seeding PLD.

➢With increasing the growth temperature of self-seed layer from 710 to 820 ℃, J_c at 77 K and self-filed of the 5 mol% BHO doped YGBCO top layer first increased and then decreased.

➢The J_c (77 K, self-field) of the 5 mol% BHO doped YGBCO film with self-seed layer deposited at 770 ℃ was the largest, 4.0 MA/ cm^2.

◆Acknowledgment &Contact

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