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GROWTH OPTIMIZATION OF YBa_2NbO_6 BUFFER LAYERS (POSTPRINT)

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14. ABSTRACT
The growth optimization of YBa_2NbO_6 (YBNO) buffer layers on LaAlO3 (100), MgO (100) single crystals, and IBAD MgO buffered Inconel substrates has been investigated. X-ray diffraction confirms the epitaxial growth of highly *h00* oriented YBNO thin films on single crystal substrates and IBAD MgO buffered Inconel substrates. The best average surface roughness of the YBNO films deposited on buffered substrates is 2 nm. The critical temperature (T_c) of $YBa_2Cu_3O_{7-x}$ (Y-123) thin films deposited on these YBNO buffer layers ranges from 80 to 87 K. The deposition of YBNO may be further optimized and the IBAD MgO layers were only of sufficient quality to test for compatibility and epitaxial growth of the new buffer. Hence, the results presented here are preliminary in nature and can be improved upon.

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Growth Optimization of YBa_2NbO_6 Buffer Layers

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ABSTRACT

The growth optimization of YBa_2NbO_6 (YBNO) buffer layers on $LaAlO_3$ (100), MgO (100) single crystals, and IBAD MgO buffered Inconel substrates has been investigated. X-ray diffraction confirms the epitaxial growth of highly *h00* oriented YBNO thin films on single crystal substrates and IBAD MgO buffered Inconel substrates. The best average surface roughness of the YBNO films deposited on buffered substrates is 2 nm. The critical temperature (T_c) of $YBa_2Cu_3O_{7-x}$ (Y-123) thin films deposited on these YBNO buffer layers ranges from 80 to 87 K. The deposition of YBNO may be further optimized and the IBAD MgO layers were only of sufficient quality to test for compatibility and epitaxial growth of the new buffer. Hence, the results presented here are preliminary in nature and can be improved upon.

INTRODUCTION

The quality of superconducting films epitaxially grown highly depends on the substrate choice. It is well known that $SrTiO_3$ (100), $LaAlO_3$ (100), YSZ (100) and MgO (100) are suitable single crystal substrates for producing high quality superconducting thin films, especially $YBa_2Cu_3O_{7-x}$ (Y123). However, it has been reported that for 123 films deposited on MgO single crystal, an interlayer of barium salt is formed at the interface if the processing temperature is above 700 ^oC [1]. Also, another problem reported with the films grown on MgO is the presence of 45^o in-plane rotated grains which degrades the crystalline quality of the deposited $RBa_2Cu_3O_x$ (where R = Y, rare earths) [2,3]. A possible solution is to use a suitable buffer layer on the MgO substrate for the growth of the subsequent Y123 film. The same concept can be extended to coated conductor applications. YBa_2NbO_6 (YBNO) has a cubic perovskite structure (a ~ 8.4 Å) and has moderate dielectric properties [4]. In this paper we report the growth of YBa_2NbO_6 compound as a new dielectric buffer layer on MgO (100) and $LaAlO_3$ (100) single crystal, and IBAD MgO buffered Inconel substrates for the subsequent deposition of Y123 thin films.

EXPERIMENTAL

YBa_2NbO_6 target has been prepared with 4N purity Y_2O_3, $BaCO_3$ and Nb_2O_5 powders by the standard solid-state synthesis method. LPX 304i Kr F excimer Laser with 248nm wavelength

was used to deposit YBNO films and subsequent Y-123 thin film deposition on various substrates. Substrate block temperatures are varied between room temperature to 850 ^{o}C. Other parameters such as O_2 (250 mTorr) pressure, Substrate Target distance (7cm), laser pulse energy 3J/cm^2 and pulse frequency (6Hz) are kept constant during the YBNO deposition. The texture of IBAD MgO buffered Inconel substrates obtained from LANL is 4-6^{o}. Films were characterized by x-ray diffraction (XRD), atomic force microscopy (AFM), and ac susceptibility measurements.

RESULTS AND DISCUSSION

XRD results confirm that YBNO films deposited on single crystal substrartes are epitaxial and transparent (Figure 1). YBNO films deposited on IBAD MgO buffered Inconel are highly *h00* oriented. Epitaxial YBNO films were grown between 800-850^{o} C on single crystal substrates and IBAD MgO buffered Inconel metal substrates. Films deposited at room temperature are amorphous. The surface morphology of the YBNO films reveals out growths even though the average surface roughness is only 2-4 nm (Figure 2). The average surface roughness *Ra* of YBNO films determined from AFM studies is listed in Table 1. Highly c-axis oriented Y-123 film was deposited on CeO_2/YBNO/IBADMgO/Inconel. Critical temperatures (T_c) determined from AC susceptibility measurements vary about 80-89 K on different substrates (Table 2). The broadening of the $\chi^{"}$ or $\chi^{'}$ curves suggest that there is a weakly coupled grain structure (Figure 3). The deposition of YBNO may be further optimized as the IBAD MgO samples were only of sufficient quality to test for compatibility and epitaxial growth of the new buffer. Hence, the results presented here are preliminary in nature and can be improved upon in future work.

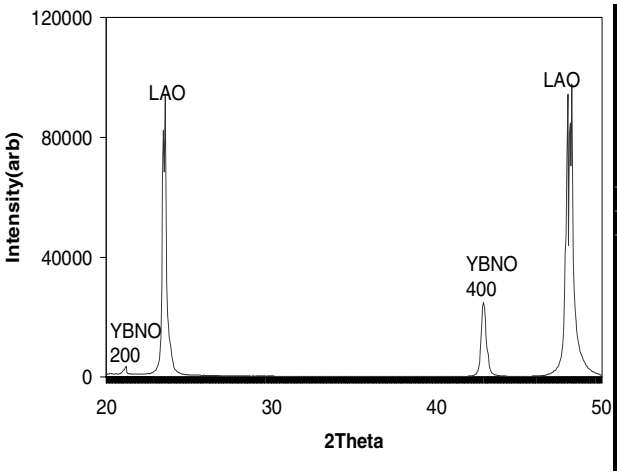

Figure 1

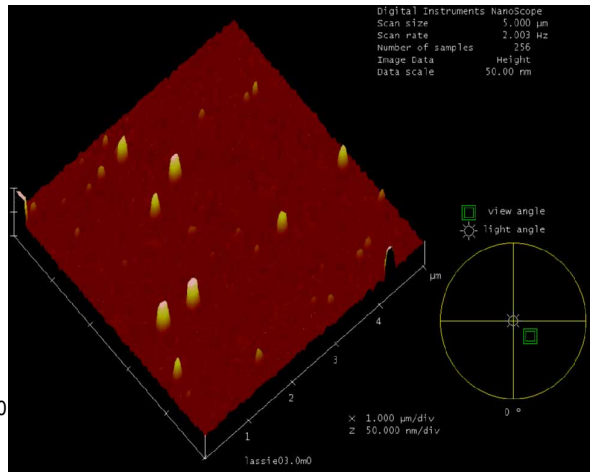

Figure 2

Figure 1. XRD pattern of *epitaxial* YBNO film on $LaAlO_3$ (LAO)
Figure 2. AFM micrograph of YBNO film deposited on IBAD MgO substrate

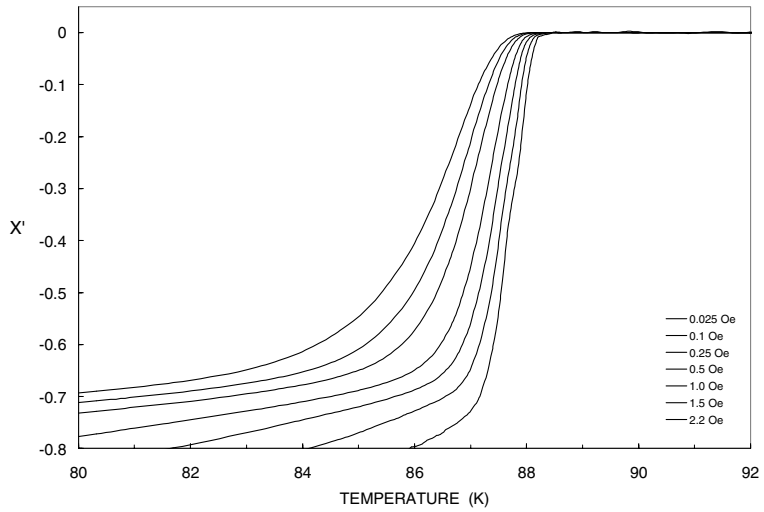

Figure 3. AC susceptibility data of Y-123 film deposited on CeO_2/YBNO/IBAD MgO/Inconel

Table 2. YBNO Surface roughness data from AFM analysis

Substrate	YBNO RMS roughness (nm)	T_c of Y123 film (from ac susceptibility)
$LaAlO_3$ (100)	3-7	82
MgO (100)	2-6	84
IBAD MgO	2-4	86
Inconel	5- 40	80

CONCLUSIONS

Epitaxial YBNO films were grown on single crystal as well as IBAD MgO buffered metal substrates. Initial results of Y123 thin films deposited on these buffer layers are promising for coated conductor applications. Further optimization of the buffer layer is in progress.

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