

## Continuous coating of $Y_2O_3$ buffer layers on Ni and NiW tapes by electron beam evaporation for YBCO coated conductors

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In research on  $YBa_2Cu_3O_7$  coated conductors, the development of buffer layers for epitaxial growth of  $YBa_2Cu_3O_7$  is very important. In our work, epitaxial buffer layers of  $Y_2O_3$  have been deposited on biaxially textured Ni and NiW substrates using a continuous electron beam evaporation technique. The surface morphology and texture of  $Y_2O_3$  buffer layers were characterized using SEM and XRD. The results show a sharp (2 0 0) orientation distribution and a smooth surface. Textured, crack-free, continuous  $Y_2O_3$  buffer layers were obtained on moving tape using electron beam evaporation.

**Key words:** coated conductor, buffer layer, e-beam evaporation,  $Y_2O_3$ .

### Introduction

In recent years, worldwide research efforts have been made to develop  $YBa_2Cu_3O_7$  superconducting tapes. Two promising approaches for the profitable production of long  $YBa_2Cu_3O_7$  tapes that are suitable for carrying high currents in magnetic fields are RABiTS (Rolling Assisted Biaxially Textured Substrates) [1] and IBAD (Ion Beam Assisted Deposition) methods [2]. In the RABiTS process, the necessary strong biaxial texture of the  $YBa_2Cu_3O_7$  film is achieved by epitaxial growth of buffer layers and the superconducting film on a highly textured substrate.

It has been shown that Ni or a Ni-based alloy is well suited as a substrate material because it forms a very strong cube texture after rolling and recrystallization [3]. Epitaxial ceramic buffer layers are deposited on the substrate to prevent Ni diffusion into the  $YBa_2Cu_3O_7$  layer and to transfer a strong biaxial texture from the substrate to the  $YBa_2Cu_3O_7$  layer [4]. Various appropriate materials for these buffer layers have been reported. Among them, the best-known buffer layer is the triple oxide film,  $CeO_2/YSZ/Y_2O_3$ . Since the bottom buffer layer,  $Y_2O_3$ , grows epitaxially on the metallic substrate, it is important to transfer a strong biaxial texture from the substrate to the oxide films. Many techniques including pulsed laser deposition, sputtering and electron beam evaporation have been tried for buffer layer deposition [5-7]. Among these techniques evaporation is one of the promising in view of the production costs and efficiency. In general, the most intriguing features of evaporation are high deposi-

tion rates on large areas, long term operability, reliability, and low cost of maintenance.

A moving deposition system has been designed and set up. In this paper, long Lengths of  $Y_2O_3$  have been deposited as a buffer layer on moving Ni and NiW tapes for  $YBa_2Cu_3O_7$  using (the) electron beam evaporation. The structure of the buffer layer was observed by X-ray diffraction (XRD) and surface of the buffer layer was observed by scanning electron microscopy (SEM).

### Experimental

1 cm wide 60  $\mu$ m thick textured cubic Ni and NiW metal tapes were mounted in chamber, and were moved continuously along the center line of the chamber. The travel speed of the tape could be varied.

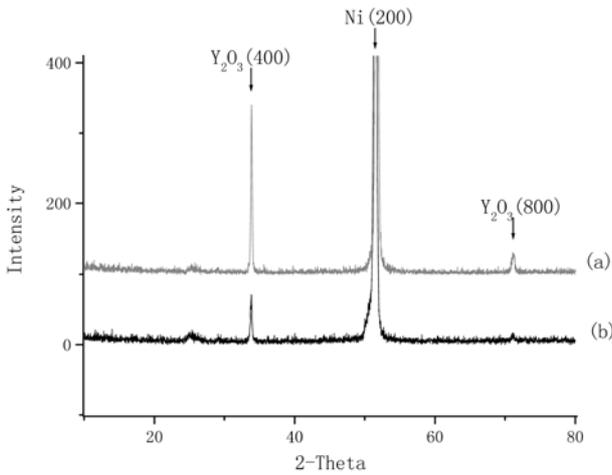
$Y_2O_3$  films of about 50-300 nm in thickness were directly deposited on The textured cubic Ni and NiW substrates by an electron beam evaporation technique. (The) Y metal with a purity of 99.9% was used as the evaporation source. The typical deposition temperatures were between 550 and 800°C. The atmosphere of the chamber during deposition was air and  $O_2$  and the gas pressure was kept between  $1.5 \times 10^{-3}$  to  $9.0 \times 10^{-3}$  Pa. The deposition speed of the  $Y_2O_3$  film was monitored using quartz crystal oscillation.

The film crystallization was evaluated by X-ray diffraction,  $\theta$ -2 $\theta$  scan, and  $\phi$ -scan (pole-figure measurement). The surfaces of the films were observed by means of SEM.

### Results and Discussion

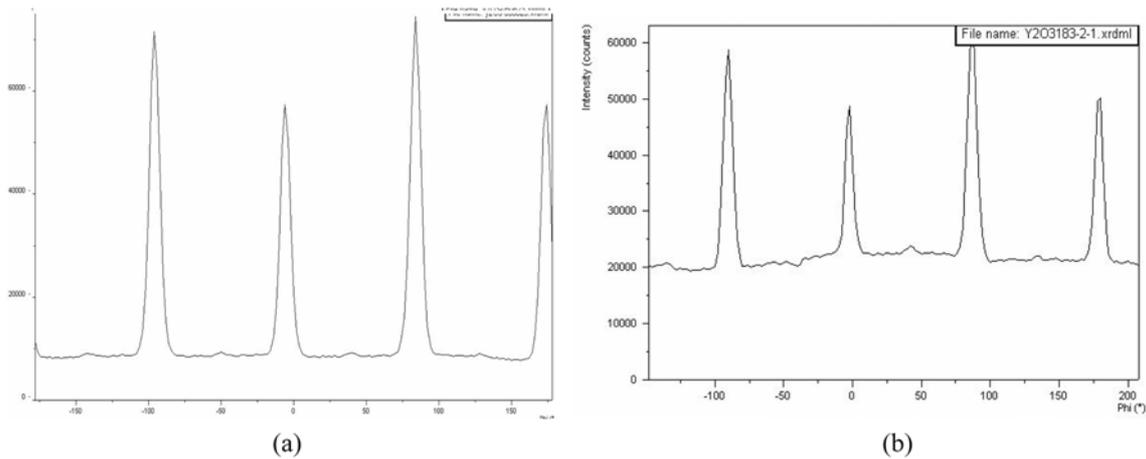
Figure 1 shows XRD  $\theta$ -2 $\theta$  scan results of  $Y_2O_3$  films grown on (a) Ni, (b) NiW. The strong  $Y_2O_3$  (400) lines

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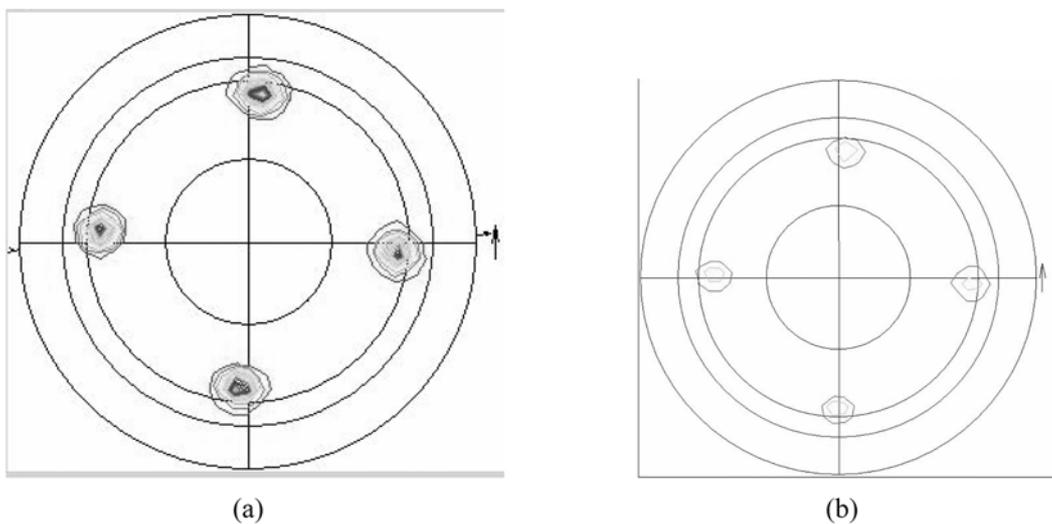


**Fig. 1.**  $\theta$ - $2\theta$  scan of  $Y_2O_3$  films deposited on (a) Ni substrate (b) NiW substrate.

show the presence of a good out-of-plane texture. Figure 2 shows the  $\phi$ -scan results for the same films.



**Fig. 2.**  $\phi$ -scan of  $Y_2O_3$  films deposited on (a) Ni substrate (b) NiW substrate.



**Fig. 3.** pole figures of  $Y_2O_3$  films deposited on (a) Ni substrate (b) NiW substrate.

The full width half maximum (FWHM) of both are 7-8°. Figure 3 gives pole figures of the same films. The XRD results demonstrate that  $Y_2O_3$  can be deposited epitaxially on Ni and NiW tapes.

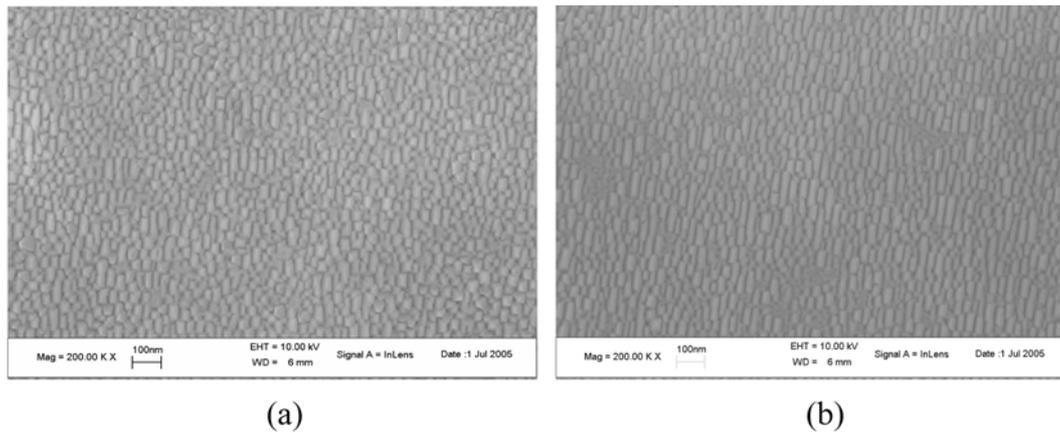
Figure 4 shows the surface morphology of the  $Y_2O_3$  films grown on the (a) Ni, (b) NiW substrates. These figures clearly indicate that the surface of  $Y_2O_3$  films is dense and smooth. Both films are crack-free and continuous.

Efforts are being made to demonstrate the growth of other epitaxial oxide films on these films.

### Conclusions

We have developed a moving deposition vacuum system to continuously deposit epitaxial buffer layers on Ni and NiW substrates.

Biaxially-textured  $Y_2O_3$  films have been successfully deposited by electron beam evaporation on metal tapes under moving tape conditions. The texture and surface



**Fig. 4.** SEM of  $Y_2O_3$  films deposited on (a) Ni substrate (b) NiW substrate.

quality of these initial  $Y_2O_3$  buffer layers are both excellent.

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