Pulsed laser depositon of biaxially textured $SrTiO_3$ buffer layer on cube textured Cu-based substrate

J. A. Padilla[1], **E. Xuriguera**[1,2], L. Rodríguez[3], A. Vannozzi[4], G. Celentano[4]

[1] IN2UB, Diopma, Materials Science and Metallurgical Engineering Department., Universitat de Barcelona, Martí i Franquès 1, 08028 Barcelona, Spain
[2] La Farga Lacambra SAU, Ctra. C17z Km. 73,5, 08508 Les Masies de Voltregà, Barcelona, Spain
[3] Departament de Física Aplicada i Òptica, Universitat de Barcelona, Martí i Franquès 1, 08028 Barcelona, Spain
[4] Supercondutivity Laboratory, ENEA FrascatiResearch Centre, Via Enrico Fermi 45, I-00044 Frascati, Roma, Italy
xuriguera@ub.edu

Abstract

Strontium titanate (STO) is of great of interest to use as buffer layer for growing perovskite thin films, since their lattice constant is closely matched to a large number of other perovskite oxides [1].

Biaxially textured STO buffer layer has been grown by pulsed laser deposition (PLD) [2] on rolling assisted biaxially textured substrates (RABiTS) made of low cost Cu-clad stainless steel substrate (by Tanaka [3]), which presents a strong cube texture.

This study presents the optimization of PLD process to grow the hightly textured (*00l*) STO films on metallic substrates using reducing atmosphere (Ar/5%H_2) to prevent the oxidation of the substrate.

STO was deposited by PLD using 248 nm radiation of the excimer laser KrF at different temperatures from 850 to 300ºC. The chamber was evacuated to a base pressure of $1x10^{-5}$mbar and then was refilled with Ar/5%H_2 to a pressure of $4\text{-}6x10^{-4}$mbar. The repetition rate and laser fluence were controlled at 10Hz and 1,5-2J/cm^2, respectively. The target-to-substrate distance ranged from 40 to 50mm and the STO films were typically deposited to reach a thickness in the range 200–300 nm.

The samples were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), atomic force microscopy (AFM) and electron backscattering diffraction (EBSD).

XRD analyses reveal that between 850º and 700ºC, the samples present random orientation or two main orientations. However, the samples exhibit strong cube texture from 600 to 300ºC. X-Ray ω-scans and ϕ-scans of the samples were performed to evaluate the quality of texture, rocking curves around rolling direction (RD) and transverse direction (TD) of (002) peak of STO and ϕ-scan at ψ=54,74º of (111)STO respectively. STO film deposited at 500ºC exhibits the best quality texture with an excellent repeatability. The full width at half maximum (FWHM) of ω-scans RD and TD of (002) STO and ϕ-scan (111) STO were 5º, 7.1º and 6.1º, respectively (Figure1).

AFM analyses on STO film show a morphology composed of rounded grains with a height around 10 nm (Figure 2). Rms roughness measured is 2.5-3.5 nm. SEM images reveal an adequate two dimensional growth of the layer and a smooth and uniform surface. EBSD analyses are in line with XRD measurements and show that STO film grows epitaxially. (Figure 3), with >97% of cube texture with 12º tolerance angle.

STO/Cu-clad stainless steel architecture prepared by this technique may provide useful templates for the growth of perovskites such as $YBa_2Cu_3O_{7-X}$ coated conductors and ferroelectrics thin films.

References

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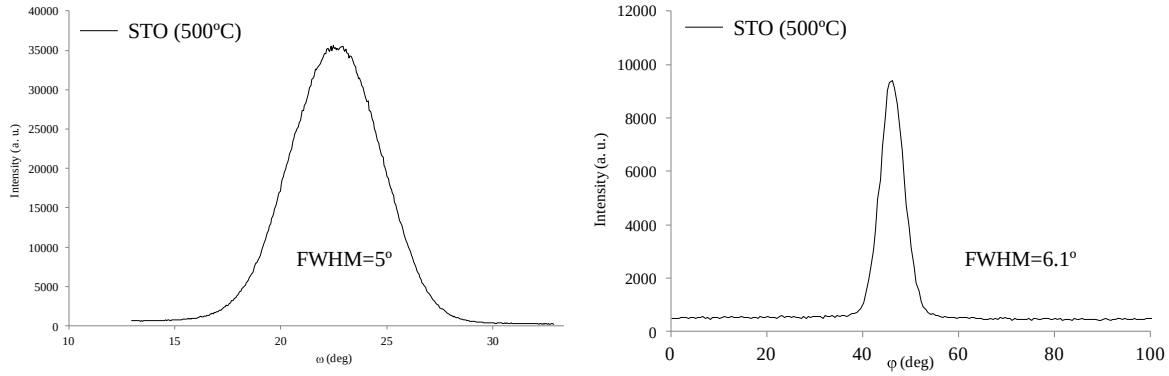
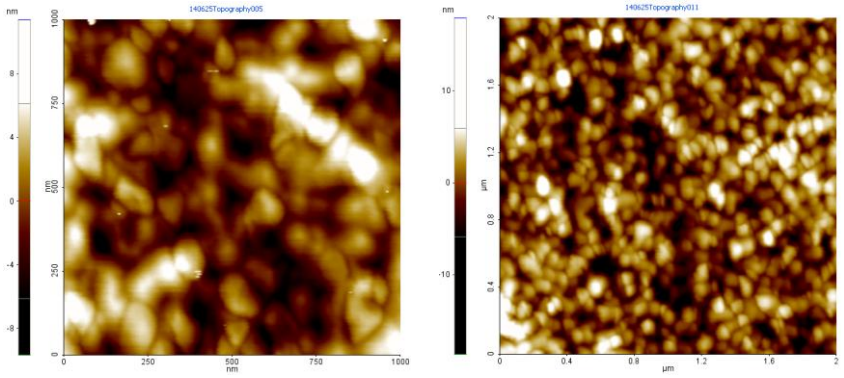
Figures



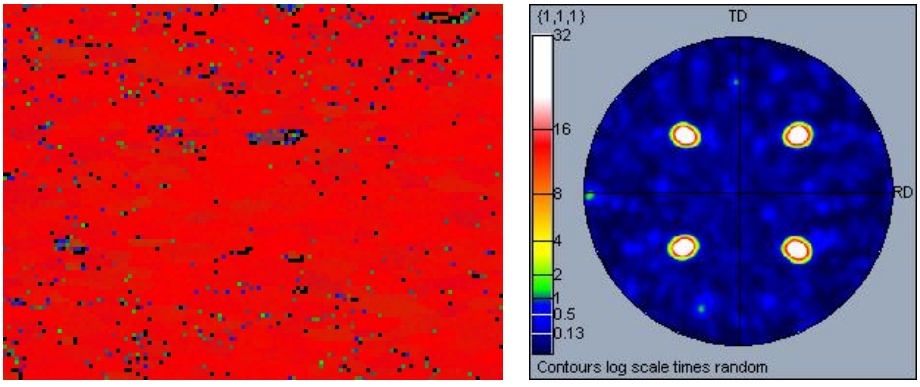
a) b)

Figure 1. a) Rocking curve around rolling direction of (002) peak of STO and b) φ-scan at ψ=54,74º of (111)STO



a) b)

Figure 2. AFM images of STO a) 1 μm^2 and b) 4 μm^2



a) b)

Figure 3. a) EBSD map of STO and b) (111) pole figure of STO obtained from EBSD measurement. The rolling direction is vertical. In the EBSD map, red, green and blue refer to (100), (110) and (111) orientation, respectively.