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Synthesis of $Ca_{1-x}Sr_xSnO_3$ thin films by Pulsed Laser Deposition

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Abstract - $Ca_{1-x}Sr_xSnO_3$ films were prepared by Pulsed Laser Deposition on different substrates (R-cut Sapphire, (100) $SrTiO_3$ and silica). Films were characterized by X-ray diffraction (θ-2θ, omega- and phi- scans) and scanning electron microscopy. Different behaviours (orientation and morphology) were observed according to the film composition and the nature of the substrate.

Alkaline earth stannates $MSnO_3$ (M = Ca, Sr, or Ba), belonging to perovskites family, are of particular interest from both fundamental and materials technology point of view due to their unusual dielectric and semiconducting properties [1]. The literature has usually reported the preparation of bulk $CaSnO_3$ and $SrSnO_3$ by solid-state reactions. Several other processes were also used for the synthesis of these compounds, such as sol–gel and polymeric precursor method [2]. However, needs for miniaturization and integration of electronic devices require materials in thin film form with controlled orientation.

In this work, $SrSnO_3$ and $CaSrO_3$ thin films were deposited at 700° C by Pulsed Lase r Deposition (PLD) on various substrates (R-cut sapphire, (100) $SrTiO_3$ and silica). The samples were characterized by X-Ray Diffraction (θ-2θ, omega- and phi-scans) and Scanning Electron Microscopy (SEM).

$SrSnO_3$ thin films present a (h00) oriented growth on sapphire. On silica substrate, the films are amorphous, but after a post -annealing under O_2 flow at 800° C for 2h, they become crystallized. T he films deposited on both substrates present similar microstructure, displaying difference in the grain size. Moreover, the deposition on $SrTiO_3$ substrate promotes a significant change in the type of growth and consequently in the microstructure: the $SrSnO_3$ films are (h00) oriented with a high crystalline quality ($\Delta\omega$=0.18°) and the in-plane ordering was evidenced by phi-scan XRD patterns, signature of an epitaxial growth.

For $CaSnO_3$ thin films, a different behaviour was observed compared to $SrSnO_3$: on sapphire, whereas $SrSnO_3$ film presented a textured growth, $CaSnO_3$ films are amorphous. Meanwhile, a post-annealing at 800° C for 1h under O_2 flow leads to the crystallized phase with a slight oriented growth. On $SrTiO_3$ substrate, $CaSnO_3$ films present a (110) oriented growth and the SEM images revealed an homogeneous microstructure with small grains.

All these results showed that the film composition and the nature of the substrate strongly influence the structural and microstructural characteristics of the thin films.

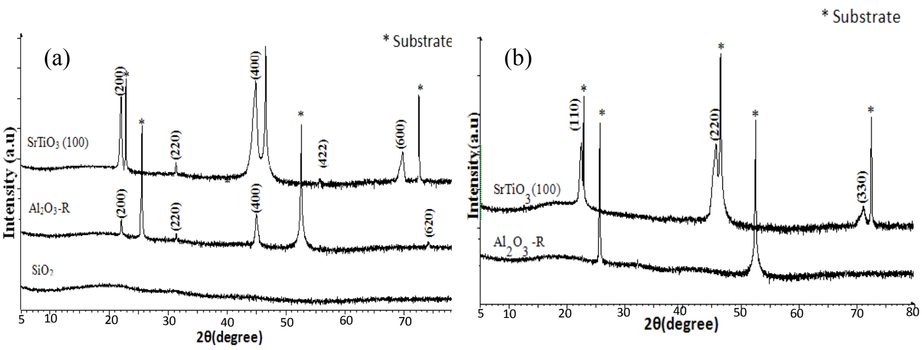

Figure 1 – XRD patterns of thin films (a) $SrSnO_3$ and (b) $CaSnO_3$ deposited by PLD at 700 °C on different substrates

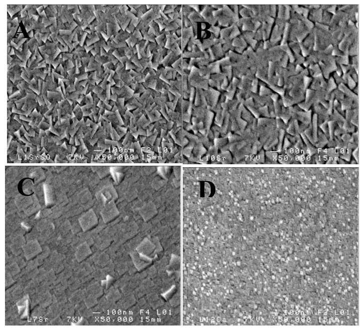

Figure 2 – SEM images of thin films (a) $SrSnO_3$ on sapphire, (b) $SrSnO_3$ on silica after post-annealing, (c) $SrSnO_3$ on $SrTiO_3$ (45° tilted) and (d) $CaSnO_3$ on $SrTiO_3$

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