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One step synthesis of LaFeO3-xNx thin film by dual reactive magnetron sputtering

Emile HAYE[1], Fabien CAPON[2], Silvère BARRAT[2], Jean-François PIERSON[2]

[1]Institut Jean Lamour, Nancy, France [2]Institut Jean Lamour, NANCY, France

emile.haye@univ-lorraine.fr

Oxynitride perovskite materials with $ABO_{3-x}N_x$ formula present interesting properties in various applications (pigment, photocatalysis, …), due to bandgap tuning by controlling nitrogen amount. However, the mains oxynitride perovskite synthesis are reported for B cations with stable high valency state (in order to keep electroneutrality), such as $LaTiO_2N$, $LaTiO_xNy$, $LaVO_{3-x}N_x$, $CaTaO_2N$, etc.
The nitrogen doping of perovskites with rare earth element and transition metal cation without stable high valency state (such as iron) is almost not reported yet, but should lead to similar results.
We have studied the case of one-step $LaFeO_{3-x}N_x$ thin film synthesis, by magnetron sputtering using O_2 and N_2 as reactive gas and two La and Fe metallic targets. A large effort has been carried out to optimize deposition conditions: sputtering of La and Fe metallic targets has been studied in presence of nitrogen and/or oxygen, together and separately, to identify elemental and compound regimes. It has permitted to establish a stability diagram of La-Fe sputtering in presence of N_2 and O_2.
Then, two multilayers with different deposition atmospheres (different Ar/O2/N2 flow rate ratios, with 21/1/x and 21/7/x) have been synthesized and analyzed with Secondary Ion Mass Spectroscopy. The in-depth profiles of O and N content into the film have been studied and correlated to target voltage variation during deposition.
The in-situ (targets voltage variation) and post-synthesis (SIMS, deposition rate, UV-Visible spectrophotometry and resistivity) measurements have shown that a direct control of nitrogen content into the film is possible, and that it exists an optimal window where amount of nitrogen into the film is maximized.
Structural and optical measurements have also been performed on as-deposited and annealed films to reveal effect of nitrogen doping.

Keywords
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perovskite
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