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Sol–gel processing of $Pb_{1-x}Ca_xTiO_3$ thin films

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Abstract

Thin films of Ca-modified lead titanate were fabricated by sol–gel processing. The complex alkoxides were prepared by reacting lead acetate and calcium chloride with titanium tri-isopropoxide mono-acetylacetonate. Titanium tri-isopropoxide mono-acetylacetonate was synthesized by addition of acetylacetone to titanium tetra-isopropoxide as a chelating agent. Thin films were deposited on Si(100), MgO(100) and Pt/MgO(100) substrates by dip-coating. X-ray diffraction analyses were carried out for thin films to investigate crystalline phases, crystallographic orientation and lattice parameters. Thin films deposited on all the substrates used exhibited perovskite single phase. Conditions for obtaining homogeneous crack-free thin films were determined.

Keywords: Sol–gel; Thin film; Chelating; Seeding; Perovskite

1. Introduction

Calcium modified lead titanate, $Pb_{1-x}Ca_xTiO_3$ (abbreviated as PCT) has been a promising candidate for pyroelectric sensor materials. It has been reported that PCT films gave better pyroelectric infrared detector performance than $PbTiO_3$ films [1]. The optimum conditions for the preparation of PCT thin films by sol–gel processing have not been thoroughly examined. Chemical modification of metal alkoxides with chelating agents has gained increasing interest in sol–gel processing, since the stability of metal alkoxides can be improved by this method [2,3]. The aim of the present research work was to optimize the processing parameters in the process utilizing chelating organic ligands in order to achieve a reproducible fabrication process for high quality thin films.

2. Experimental

A modified sol–gel process has been employed for fabrication of PCT thin films. In the conventional sol–gel process for fabrication of lead titanate based compositions, lead acetate trihydrate $Pb(CH_3COO)_2 \cdot 3H_2O$, and titanium isopropoxide (TI), $Ti[(CH_3)_2CHO]_4$, were used as precursor materials and 2-methoxyethanol $CH_3OCH_2CH_2OH$ was used as solvent [4]. In the modified process, the complex alkoxides were prepared by reacting Pb acetate and Ca chloride with titanium tri-isopropoxide mono-acetylacetonate. The mixed ligand complex, titanium tri-isopropoxide mono-acetylacetonate (TIA), Ti $(OC_3H_7)_3(CH_3COCHCOCH_3)$, was synthesized by

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