

Crystallisation of $\text{Pb}_{1-x}\text{Ca}_x\text{TiO}_3$ ferroelectric thin films as a function of the Ca-content

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Abstract

Different compositions of lead calcium titanate ($\text{Pb}_{1-x}\text{Ca}_x\text{TiO}_3$) (PCT) thin films with x from 0 to 0.50 were prepared by Chemical Solution Deposition (CSD) onto Si based substrates by a chemical process described elsewhere¹ and crystallised by rapid thermal processing (RTP) in air. Effect of the Ca^{2+} content on the crystallinity of the films was monitored by x-ray diffraction (XRD), using the conventional Bragg-Brentano geometry and grazing incidence. These studies showed a delay in the crystallisation of the PCT films as the Ca^{2+} content increases. Surface images of the films, obtained by Atomic Force Microscopy (AFM), indicated that this delay is accompanied by a decrease in the grain size of the films. Structure of the crystal phases formed in the films also changes with the calcium content. At low temperatures, below 450C, a second non-ferroelectric pyrochlore-type phase coexists with the ferroelectric perovskite phase, in films with very low concentrations of calcium. Increase of calcium stabilises the ferroelectric perovskite phase, whereas those films with calcium contents close to $x=0.5$ are amorphous by x-ray diffraction. Over 450C, all the films have a perovskite structure with a lattice tetragonality that decreases with the calcium content. X-ray and electron diffraction are used to monitor this evolution of the crystalline structure with the variation of the Ca^{2+} content. Dielectric and ferroelectric properties of the films also reveal the change in the crystal structure of the films with the calcium content. Variation of the permittivity with the temperature shows an increase in the diffusivity of the ferro-paraelectric transition and in the value of the permittivity at room temperature with the increase of calcium. This is accompanied by a decrease in the remanent polarisation and coercive field.

1. I.Bretos, J.Ricote, R.Jimenez, J.Mendiola and M.L.Calzada. *Integrated Ferroelectrics* (in press).