Strontium-doping effects in solution derived lead-free ferroelectric $K_{0.5}Na_{0.5}NbO_3$ thin films

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Potassium sodium niobate, $K_{0.5}Na_{0.5}NbO_3$ (KNN) is an environment-friendly lead-free alternative to highly efficient lead-based piezoelectrics. The poor functional properties of the KNN thin films prepared by chemical solution deposition are frequently related to the volatilisation of alkali species during processing, which hinders control over the stoichiometry, contributes to formation of secondary phases and deterioration of the microstructure. The problem can be overcome by adding alkalis in excess and/or by partial substitution of the A- and B- site atoms, such as in the case of the solid state synthesized KNN ceramics. Therefore, in this contribution, the influence of the alkaline-earth A- site dopant, Sr^{2+} on the microstructure, structure, and functional properties were examined for the solution-derived KNN thin films with alkaline excess.

Liquid precursors of $(K_{0.5}Na_{0.5})_{1-y}Sr_yNbO_3$ (KNN-ySr) thin-films, where the Sr- dopant content was set at y = 0, 0.005, 0.01, were prepared from potassium and sodium acetates and niobium ethoxide in 2-methoxyethanol solvent with 5 mol% of potassium acetate excess. Strontium was introduced as acetate or nitrate. The approximately 250 nm thick KNN-ySr thin films on $Pt/TiO_x/SiO_2/Si$ substrates were obtained by rapid thermal annealing at 650 ^oC for 5 min.

According to X-ray diffraction analysis, all synthesized KNN thin films crystallize in pure perovskite phase with random orientation. The surface and cross-section microstructure analysis, performed by the field emission scanning electron microscopy, reveals that the KNN-ySr films consist of equiaxed grains, the average size of which gradually decreases from about 90 nm to a few tens of nm by increasing the Sr-dopant content. In the contribution we discuss the influence of the chemical modification on the functional response, i.e., dielectric properties versus frequency and temperature, polarisation – electric field dependence, leakage current and piezoelectric response of the as-prepared films.