Characterization of $Ba_{1-x}Sr_xTiO_3$ (BST) nanopowders obtained by stearic acid gel method

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Abstract

High purity $Ba_{1-x}Sr_xTiO_3$ (x = 0.3) nanopowders were prepared in wet routes through stearic acid gel (SAG) method using barium stearate, strontium stearate, tetrabutyl titanate as Ba, Sr and Ti sources and stearic acid as chelating reagent. Thermal analysis including both DTA and TG, Fourier transform infrared spectrometry (FTIR), X-ray diffraction (XRD) and transmission electron microscopy (TEM) were used to characterize the crystallization process and the particle size and morphology of the calcined powders. The present results indicate that $Ba_{1-x}Sr_xTiO_3$ crystallites were initially formed after calcining the dried gel at 550 °C for 2 h. This method could produce $Ba_{1-x}Sr_xTiO_3$ (x = 0.3) nanopowders with a tetragonal perovskite structure, while they had different grain size distributions within 40-80 nm.

Keywords: Ba1-xSrxTiO3; Sol–gel synthesis; chemistry synthesis; Nanopowders, X-ray diffraction, TEM, FTIR

1. Introduction

Barium strontium titanate (i.e., $Ba_{1-x}Sr_xTiO_3$ or BST) is one of the most interesting materials due to its pyroelectric, ferroelectric and piezoelectric characteristics, has been widely used in the preparation of high dielectric capacitors, PTC resistors, transducers and ferroelectric memories [1–6]. BST powders are usually prepared by solid-state reaction [8,9] with calcination temperatures in the range of 1300–1450 °C which can produce large BST particles with uncontrolled and morphologies due to their inherent problems such as high reaction temperature, heterogeneous solid phase reaction, etc. By contrast with the traditional methods, the wet-chemistry synthesis techniques, including the hydrothermal method [10] sol–gel [13, 14],], the precipitation method [11], metalorganic solution deposition (MOSD) technique [12]combustion synthesis, chemical coprecipitation, and hydrothermal synthesis, offer many distinctive advantages over traditional methods and are able to provide high chemical purity, precise composition, uniform microstructure and a lower formation temperature of the perovskite phase in the production of powders.

In this study, we chose one typical wet-chemistry synthesis method, stearic acid gel (SAG), to try to prepare high purity BST nanopowders and decrease impurity formation. In this route, the carboxylic acid group and long carbon chain in stearic acid endow it with strong ability to disperse metal precursors. Moreover, this synthetic process is easily controlled and convenient in comparison with other methods.

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