Indian Journal of Pure & Applied Physics
Vol. 60, November 2022, pp. 909-913
DOI: 10.56042/ijpap.v60i11.65819

Structural, Dielectric and Electrical Properties of Homovalent Doped $SrSn_{1-x}Ti_xO_3$ ($0 \leq x \leq 0.08$) System

Aditya Kumar[a], Manoj K Singh[b], Minakshi Sharma[c] & Upendra Kumar[d*]

[a]Department of Physics, School of Science, IFTM University Moradabad-244 102, U.P. India
[b]Centre of Material Sciences, University of Allahabad, Prayagraj 211 002, India
[c]Department of Physical Sciences, Banasthali Vidyapith, Banasthali-304 022, Rajasthan India
[d]Advanced Functional Materials Laboratory, Department of Applied Sciences, IIIT Allahabad, Prayagraj, 211 015, India

Received: 23 August 2022; accepted 18 October 2022

The samples $SrSn_{1-x}Ti_xO_3$ with composition $0 \leq x \leq 0.08$ have been prepared using sol-gel chemical route by sintering at 1173 K. All the samples are found to be single phase crystallized in orthorhombic structure. The dielectric properties indicate the existence of interfacial and orientation polarization in samples found to be stable up to 300 °C. Thermal dependence of electrical conductivity represents two conduction regions with activation energy (0.77-0.94) eV in region-1 and (0.19-0.27) eV in region-2 respectively. The plot of dc conductivity with hopping frequency results unit slope representing that the charge carriers remain same in both processes. DC conductivity of samples are found to be increased with Ti^{4+}, due to reduction in polaron size. The present materials can be potentially used in thermally stable capacitor and mixed ionic and electronic conductors (MIECs) applications.

Keywords: $SrSn_{1-x}Ti_xO_3$; Sol-gel preparation; Electrical properties; Defects

1 Introduction

$SrSnO_3$ belongs to the perovskite family, characterized by general chemical formula ABO_3 with cations (A/B) and anion O. The modification made in $SrSnO_3$ either at Sr/Sn-site or both sites simultaneously tuned for various electronic devices, gas sensors, photocatalyst and transparent conducting oxide applications[1–3]. The modifications in $SrSnO_3$ can be done in two ways: (i) Homovalent (the dopant and host having same valency), (ii) Hetrovalent (the dopant has either higher or lower valency than host known as donor and acceptor respectively)[4]. Donor (M) type doping at Sr/Sn-site leads to an excess negative charge denoted as a positive defect ($M_{Sr}^{\cdot}, M_{Sn}^{\cdot}$) that would be compensated either by creating electron or cationic vacancy. Based on this modification, $SrSnO_3$ has been explored as proton conductor, gas sensor, and electrochemical devices *etc*.[5,6]. However, acceptor type (M) modification made at Sr/Sn-site leads an excess of positive charge denoted as negative defect (M_{Sr}', M_{Sn}') that would be compensated either by creating hole or oxygen vacancy[7]. Transition metal and rare earth modified (as acceptor) $SrSnO_3$ were explored as electrochemical devices, gas sensors, mixed ionic and electronic conductors (MIECs) in intermediate temperature solid oxide fuel cell (IT-SOFCs) applications[5,6,8,9]. Moreover, homovalent modified $SrSnO_3$ improved their dielectric properties due to generation of lattice strain[10]. Surprisingly, no detailed investigation on electrical properties of Ti^{4+} modified $SrSnO_3$ is still available in literature.

In present work, single phase $SrSn_{1-x}Ti_xO_3$ ($0 \leq x \leq 0.08$) was synthesized using sol-gel route by calcining at 1073 K and sintering at 1173 K for 10 h. The obtained powders were characterized using X-ray diffraction (XRD) to identify the phase of samples. The dielectric properties of silver coated pellets were recorded as a function of frequency (100 Hz to 100 KHz) within temperature range (25–530) °C.

2 Experimental

The samples of $SrSn_{1-x}Ti_xO_3$ (x=0, 0.02, 0.04, 0.06, 0.08) were synthesized using chemical route as described in elsewhere[10]. The phase of obtained samples was identified using Bruker D8 advance (U.S.A.) X-ray diffractometer employing Cu-Kα ($\lambda = 1.5418$ Å) radiation. The electrical properties of silver coated pellets were studied using a high precision Alfa-A high-frequency Nova-Control impedance analyser as a function of frequency (100 Hz to 1 MHz) within temperature range (25–530) °C.

*Corresponding authors: (Email: upendra.bhu512@gmail.com)

Aditya Kumar