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Large polaron hopping phenomenon in Lanthanum doped Strontium titanate

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Abstract

A few compositions of La doped strontium titanate, $\text{La}_x\text{Sr}_{1-x}\text{TiO}_{3-\delta}$ ($x = 0.0, 0.1, 0.2, 0.3$, and 0.4) were synthesized via solid state reaction route. The XRD patterns of the compositions with $x \leq 0.2$ showed single phase whereas for $x \geq 0.3$ compositions, secondary phases were observed. The Rietveld refinement of the XRD data for all compositions indicated cubic structure with space group $\text{Pm}\bar{3}\text{m}$ at room temperature. The SEM micrographs for $x = 0.0$ showed large grains, whereas the compositions with $0.0 < x \leq 0.2$ showed small grains and for $x \geq 0.3$, irregular morphologies with porosity were observed. The conductivity spectra of the investigated systems were described using Jonscher's power law. The scaling behaviour of the systems was understood through Ghosh scaling model. The scaling properties showed that the conduction mechanism is independent of temperature. A systematic study of conduction mechanism of the system revealed that conduction mechanism is changing from small polaron hopping to large polaron hopping as the composition changes from $x = 0.0$ to $x = 0.1$. The large polaron hopping has also been confirmed through Modulus spectroscopy and Photoluminescence analysis in lanthanum substituted samples. Further, the observed change in conduction mechanism was correlated with the hopping polaron size and lattice parameter.

1. Introduction:

Strontium titanate (SrTiO_3) having perovskite structure is one of the promising materials for widespread applications in electronics, energy storage devices, catalysts, dielectric amplifiers [1-5], oxygen sensors, humidity sensors [6,7] and anodes or interconnects for solid oxide fuel cells (SOFCs) [8-11]. The structure of SrTiO_3 is stabilized in a cubic unit cell with space group $\text{Pm}\bar{3}\text{m}$ at room temperature. The ionic radii of the elements under doping play an important role [12] in order to maintain a cubic structure. The substitution of donor

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