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An Investigation and Analysis of Structural and Electrochemical Properties of Highly Ionic $La_{2-x}Sr_xSn_2O_{7-\delta}$ Electrolyte for SOFC Applications

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ABSTRACT

This study primarily focused on the investigation, synthesis and analysis of lanthanum and tin pyrochlores electrolyte for solid oxide fuel cell (SOFC) applications. Ceramic samples with diverse compositions of $La_{2-x}Sr_xSn_2O_{7-\delta}$ (x = 0.05, 0.1, 0.15, 0.2, 0.25 and 0.3) were synthesized by using a solid-state reaction (SSR) methods. The prepared $La_{2-x}Sr_xSn_2O_{7-\delta}$ samples were characterized by using X-ray diffraction (XRD), scanning electron microscopy (SEM) and electrochemical impedance spectroscopy (EIS) measurements. The findings were interpreted in terms of formation of high oxygen vacancy and structural disorder in the $La_{2-x}Sr_xSn_2O_{7-\delta}$ matrix. The doping of lanthanum (La^{3+}) by strontium (Sr^{2+}) had a beneficial and remarkable effect on the structural and electrical properties: the increase in the rate of Sr^{2+}decreased the lattice parameters of the crystalline phase and enhanced the creation of oxygen vacancies, which consequently increased the ionic conductivity and decreased the activation energy. Thus, it could be understood that the studied new $La_{2-x}Sr_xSn_2O_{7-\delta}$ electrolyte would be one of the potential candidates for intermediate temperature SOFC applications.

Keywords: keyword 01, keyword 02, keyword 03, keyword 04

1. Introduction

In the present study, efforts were taken to enrich the literature by studying the electrical properties of the doped $La_2Sn_2O_7$ pyrophore. The present work describes the new investigation, synthesis and characterization of LSSO pyrochlore structure based on lanthanum (La_2O_3) and tin (SnO_2) oxides having a general formula $La_2Sn_2O_7$, where 'Sr' substitutes La as an electrolyte material for SOFC. The main aim was to investigate the structural evolution of the new $La_2Sn_2O_7$ pyrophore as a function of the substitution rate of 'Sr' for the creation of oxygen vacancies to promote cation migration through the structural matrix and improve the ionic conductivity. Accordingly, in depth its morphology and electrochemical properties of the pyrophore as an electrolyte for SOFC were analyzed.

2. Experimental

The samples $La_{2-x}Sr_xSn_2O_{7-\delta}$ (x=0,05-0,3) were synthesized by SSR technique. The SnO_2 (sigma Aldrich 99.9%), La_2O_3 (sigma Aldrich 99.9%), and $SrCO_3$ (sigma Aldrich 99.9%) powders were weighed according to the stochiometric ratio.

3. Results and Discussion

The substitution of La_3+ by Sr_2+ in $La_2Sn_2O_7$ demonstrated a remarkable effect on the studied electrolyte material with respect to structural and electrical properties. The increase in the doping rate induces a modification of the microstructure. This modification reflected shows that there is decrease in the lattice parameters of the samples and improvement of their ionic conductivity. The increase in the lattice is due to the creation of oxygen vacancies due to the dopant species substitutions in the host matrix of La_{2-}

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$_xSr_xSn_2O_7$, which facilitates the process of ion migration. 'Ea' values decrease as the percentage of strontium replacement increases, which substantiate that there is lower possibility to the barrier to be overcome by an oxygen ion for migration.

4. Conclusions

The highest ionic conductivity for the studied $La_{2-x}Sr_xSn_2O_7$ for x = 0.3 was found to be 2.133×10^{-3} Scm^{-1} at 900 °C with an activation energy of 1.45 eV. Thus, from the detailed study of structural, morphological and electrochemical characterization and analysis of $La_{2-x}Sr_xSn_2O_7$ (x=0.05 to 0.3), it is concluded that the synthesized $La_{2-x}Sr_xSn_2O_7$ with x=0.3 may be one of the emerging potential candidates as a highly densed electrolyte material for SOFC applications.

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