Advanced Materials Research Vol. 975 (2014) pp 75-80
© (2014) Trans Tech Publications, Switzerland
doi:10.4028/www.scientific.net/AMR.975.75

Influence of the Zn Dopant in Structural and Electrical Properties of the $La_2Ni_{1-x}Zn_xO_4$

C. A. Silva[a], Joeliton B. Silva[b], M. C. Silva-Santana[c], Petrucio Barrozo[d] and N. O. Moreno[e]

Departamento de Física, Universidade Federal de Sergipe, S. Cristóvão, SE, Brazil 49.100-000

[a]claudia.dsilvam@gmail.com, [b]joeliton.ufs@gmail.com, [c]marcoscleison@gmail.com, [d]petruciobarrozo@gmail.com, [e]nomoreno@ufs.br

Keywords: La_2NiO_4, electrical resistivity, Zn doping, combustion synthesis.

Abstract. In this work, we present results of synthesis, electric and structural characterization of Ruddlesden- Popper $La_{n+1}Ni_{n-x}Zn_xO_{3n+1}$ (n =1.0 < x < 0.4) compounds. The samples were synthesized by the combustion reaction method, using citric acid as fuel. The precursors obtained from this reaction were thermally treated for 12 h at 1100°C in air for a good crystallization. The polycrystalline samples were characterized by X-ray diffraction (XRD) and electric resistivity measurements. The XRD results indicate that the obtained samples were single phase with tetragonal symmetry and space group I4*/mmm*. Scanning electron microscopy showed the presence of agglomerates formed by fine particles of different shapes. The preliminary results suggest that the Zn-doping plays an important role on the charge transport modifying the arrangement of holes in the system.

Introduction

The Rudllesden-Popper series are compounds with the general formula $A_{n+1}B_nO_{3n+1}$ (A= Rare earth and/or alkaline metal, B=transition metal) (n = 1, 2, 3). The La_2NiO_4 compound is a nickel-based Rudllesden-Popper (n = 1) phase. Its crystalline structure is perovskite-type ($LaNiO_3$) layer separated by a single rock-salt-type (LaO) layer [1], this structure is also known as K_2NiF_4. La_2NiO_4 compound is isostructural to La_2CuO_4 known as a high temperature superconducting material [2]. Recent works have shown that its mixed conduction mechanism makes these materials promising for developing solid oxide fuel cell (SOFS) cathodes and ceramic membranes used in oxygen separation and partial oxidation of light hydrocarbons [3,4].

At high temperature, the electrical properties of the La_2NiO_4 can be described by a simple band gap model with a thermally activated process defined by the Arrhenius equation and activation energy of 1.3 eV [5].

Electrical resistivity studies show that La_2NiO_4 is a semiconductor below room temperature [4,6,7]. The single crystalline compound exhibits an in situ metallic transition in the temperature range 600-650 K when the current flows along the basal plane [8]. It is well known that, depending on the conditions of preparation, La_2NiO_4 crystallizes with an oxygen excess (δ) that strongly influences its physical properties [1,9]. The thermal dependence of the conductivity of the $La_2NiO_{4+\delta}$ ($0 < \delta < 0.05$) has been described either by Arrhenius laws or in terms of Mott variable range hopping [10-12].

The influence of Zn doping in this compound has been previously studied for small amounts (less than 2%). When the Zn atoms are introduced in the structure Zn^{2+} directly replace Ni^{2+} in randomly NiO_2 planes. The Zn^{2+} ions induce transverse stripe fluctuations when the concentration of Zn is < 2%, then the conduction is assumed to become as a variable range hopping (VRH) conduction mode (tunnel effect) [13]. It has been shown that the Zn atoms induce the transverse stripe fluctuations because different Zn atoms compete to pin the stripes. In this way, Zn-doping plays a similar role to Sr stripes [14]