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Influence of the synthesis method on the porosity, microstructure and electrical properties of $La_{0.7}Sr_{0.3}MnO_3$ cathode materials

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ABSTRACT

Lanthanum strontium manganite ($La_{1-x}Sr_xMnO_3$, LSM) has been studied as a promising material for application as a cathode in solid oxide fuel cells. In the present work $La_{0.7}Sr_{0.3}MnO_3$ nanopowders were synthesized by three different methods (combustion, citrate and solid-state) and characterized by thermal analysis, X-ray diffraction, physical adsorption of N_2 and scanning electron microscopy. All powders exhibited single LSM phase formation with crystallite sizes in the range of 12–20 nm. Nanopowders were sintered at 1100 °C to produce porous pellets. The porosity, particle size and microstructure of LSM sintered bodies are strongly dependent on the preparation methodology. The samples synthesized by combustion and citrate methods presented smaller particle sizes and higher porosity after sintering than that derived from solid-state synthesis. However, the electrical conductivity, measured by two-probe technique, was very similar for all three samples.

1. Introduction

Solid oxide fuel cells (SOFCs) are efficient, energy-saving, and environment-friendly energy conversion devices that generate electricity and heat [1,2]. The performance of SOFCs can be improved by better control of the morphology and electrochemical properties of the electrodes. This instigates research in the area of novel methods for preparation of ceramic powders used as cathode materials in SOFC.

Sr-doped $LaMnO_3$ (lanthanum strontium manganite—LSM) attracts substantial interest as a promising cathode material for SOFCs. In nanosized crystals, this material presents good properties such as chemical and thermal stabilities, high catalytic activity for oxygen reduction, a thermal expansion coefficient similar to that of the solid electrolyte (yttria-stabilized zirconia—YSZ) and high electrical conductivity [2].

Different synthesis methods have been developed for production of LSM powders, such as solid-state reaction, sol–gel technique, hydrothermal synthesis, co-precipitation, and combustion [3–5]. The solid-state reaction is a conventional method of ceramic processing, which usually involves high temperatures and leads to large particle sizes and limited chemical homogeneity [4,6]. The combustion synthesis is a simple method that consists essentially of a self-propagating high temperature synthesis, and produces nanosized, homogeneous and highly reactive powders [5,7]. The citrate method (Pechini process) is a polymerizable complex process, which involves the formation of stable metal–chelate complexes and polyesterification reactions, and is suitable for preparation of multicomponent oxides of high purity at low temperatures [8–10].

In this context, the present work is aimed to contribute to the synthesis and characterization of LSM ($La_{1-x}Sr_xMnO_3$, $x=0.3$) nanostructured powders for application as SOFC cathodes. The objective is to study the influence of different synthesis methods (combustion, citrate and solid-state) on the

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