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Short communication

Effect of propellant on the combustion synthesized Sr-doped $LaMnO_3$ powders

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Abstract

Lanthanum strontium manganite (LSM) powders of composition $La_{0.7}Sr_{0.3}MnO_3$ are good candidates for cathode application in solid oxide fuel cells. This paper reports the synthesis of LSM powders from nitrate precursors by the combustion method, using two different propellants (urea and glycine) and varying the propellant/nitrate ratio. Thermogravimetric analysis (TGA) revealed two or three decomposition stages of the as-synthesized samples, with complete burn out of organics at about 850–900 °C. X-ray diffraction (XRD) patterns showed formation of only LSM phase for the sample synthesized with excess of urea, whereas $SrCO_3$ and $MnCO_3$ phases were also found for the samples prepared from glycine. The powder is better crystallized when a homogeneous gel is formed before burning. The crystallite size calculated using the Scherrer equation is in the range of 15–20 nm. Scanning electron microscopy (SEM) revealed the presence of agglomerates, formed by fine particles of different shapes.

Keywords: A. Powders: chemical preparation; B. X-ray methods; D. Perovskites; E. Fuel cells

1. Introduction

Solid oxide fuel cells (SOFCs) are promising, efficient, and environmentally friendly energy conversion devices that generate electricity and heat [1]. These features have stimulated research on developing ceramic powders for cathode materials used in SOFCs. Sr-doped $LaMnO_3$ (lanthanum strontium manganites—LSM) has particularly attracted substantial interest as a promising material for cathode in SOFCs. This material has good properties such as chemical and thermal stability, and high catalytic activity for oxygen reduction. Additionally, it has a thermal expansion coefficient similar to that of a solid electrolyte (yttria-stabilized zirconia, YSZ), and high electrical conductivity [2].

A number of preparation methods such as solid-state reaction, sol–gel technique, hydrothermal synthesis, spray-drying, co-precipitation, and combustion, have been used for perovskite synthesis [3]. The combustion method is particularly useful in the production of ultrafine ceramic powders with a small average particle size. This is a simple method with the advantage of using inexpensive precursors and of producing nano-sized, homogeneous, highly reactive powders.

The most commonly used fuels in the combustion process for the synthesis of LSM are glycine and urea. However, citric acid, oxalyl-hydrazine and sucrose have also been recently employed as complexing agents and fuels in the combustion synthesis [4–6]. The combustion synthesis technique consists in bringing a saturated aqueous solution of the desired metal salts and a suitable organic fuel to boil, until the mixture ignites and a self-sustaining and fast combustion reaction takes off, resulting in a dry, usually crystalline, fine oxide powder [7]. The large amounts of gases formed can result in the appearance of a flame, which can reach temperatures above 1000 °C [7].

This work focuses on the preparation of LSM powder materials by the combustion method. Our aim is to assess the influence of the nature and amount of two different propellants (urea and glycine) and the formation of a gel before burning on the structural and morphological properties of the prepared powders.

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