

Synthesis of Sr-doped LaCrO₃ powders by combustion method

Influence of the fuel agent

Adney Luís A. da Silva · Guilherme G. G. Castro ·
Mariana M. V. M. Souza

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Abstract Lanthanum strontium chromite (LSC) powders were synthesized by the combustion method, using five different fuels (urea, glycine, ethylene glycol, α -alanine, and citric acid). The ignition of the reagent mixture with urea takes a longer time, and more gases are released by combustion. A calcination step is essential for a good crystallization of the perovskite phase. X-ray diffraction patterns showed formation of perovskite phase and a small amount of SrCrO₄ for the sample synthesized with urea after calcination. The crystallite sizes are in the range of 23–33 nm. Scanning electron microscopy revealed the porosity of the powders and the presence of agglomerates, formed by fine particles of different shapes. Thermogravimetric analysis showed a large mass loss for the sample synthesized with citric acid, probably caused by the absence of ignition, with primary polymerization of the precursor reagents.

Keywords Doped lanthanum chromites · Combustion synthesis · Flame temperature · X-ray diffraction

Introduction

Perovskites are mixed ceramic oxides with ABO₃-type crystal structure where cations with a large ionic radius have 12 coordination to oxygen atoms and occupy A-sites, and cations with smaller ionic radius have 6 coordination and occupy B-sites [1]. A and O form a cubic packing, and

B is contained in the octahedral voids in the packing. The perovskite structure may undergo atomic distortion leading to orthorhombic or rhombohedral unit cells [2].

Perovskite-like lanthanum chromites are interesting materials for application in solid oxide fuel cells (SOFCs) due to chemical and thermal stability, mechanical strength, and high electrical conductivity [2, 3]. The electrical conductivity of these materials can be enhanced by substituting a lower valence ion, such as Sr, on the La site. Sr-doped LaCrO₃ (LSC) is currently the preferred material for interconnect in SOFC [3, 4].

Different synthesis methods have been developed for the production of perovskite powders, like solid-state reaction, sol–gel technique, hydrothermal synthesis, co-precipitation, and combustion [5–8]. Combustion synthesis is characterized by fast heating rates, high temperatures, and short reaction times [9, 10]. It is a straightforward preparation process to produce homogeneous, very fine, crystalline, and unagglomerated multicomponent oxide powders, without intermediate decomposition steps [11]. In the solution combustion synthesis, an aqueous solution of the desired metal salts is heated together with a suitable organic fuel, until the mixture ignites and a fast combustion reaction takes off [9, 12].

Various fuels have been used in the combustion synthesis of perovskites, like glycine, urea, oxalyl-hydrazine, citric acid, and sucrose [8, 13–15]. All these fuels serve two purposes: (i) they are the source of C and H, the reducing elements, which form CO₂ and H₂O on combustion and liberate heat; and (ii) they form complexes with the metal ions facilitating homogeneous mixing of the cations in solution [9]. The fuels differ in the reducing power, the combustion temperature, and the amount of gases they generate, which affects the characteristics of the reaction product [12]. The properties of ceramic materials for

A. L. A. da Silva · G. G. G. Castro · M. M. V. M. Souza (✉)
Escola de Química—Universidade Federal do Rio de Janeiro
(UFRJ), Centro de Tecnologia, Bloco E, sala 206, Rio de
Janeiro, RJ CEP 21941-909, Brazil
e-mail: mmattos@eq.ufrj.br