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# Effect of strontium and cerium doping on the structural characteristics and catalytic activity for $C_3H_6$ combustion of perovskite $LaCrO_3$ prepared by sol–gel

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ABSTRACT

Two series of Sr- or Ce-doped $La_{1-x}M_xCrO_3$ ($x$ = 0.0, 0.1, 0.2 and 0.3) catalysts were prepared by thermal decomposition of amorphous citrate precursors followed by annealing at 800 °C in air atmosphere. The effect of Ce and Sr on the morphological/structural properties of $LaCrO_3$ was investigated by means of thermogravimetric/differential thermal analysis (TG/DTA) of the precursors decomposition under air, X-ray diffraction (XRD), electron paramagnetic resonance (EPR), transmission electron microscopy–X-ray energy dispersive spectroscopy (TEM–XEDS), $S_{BET}$ determination, scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS) techniques. The characterization results are employed to explain catalytic activity results for $C_3H_6$ combustion. It is shown that the lanthanum chromite perovskite structure is obtained upon thermal treatment of the sol–gel derived precursors at $T >$ ca. 800 °C. The presence of the dopant generally induces the formation of segregated oxide phases in the samples calcined at 800 °C although some introduction of the Sr in the perovskite structure is inferred from EPR measurements. The oxidation activity becomes maximised upon formation of such doped perovskite structure.

## 1. Introduction

The lanthanum chromite perovskite $LaCrO_3$ and compositions derived from it by substituting lanthanum by other metal cations ($La_{1-x}M_xCrO_3$) present a high mechanical and chemical stability while displaying high melting points, large electrical conductivity and a relatively high catalytic oxidation activity [1–6]. Such properties make them most interesting for their application to various environmental issues as components of solid oxide fuel cells, in which they can be employed as interconnect or electrode materials, as well as for catalytic applications requiring highly refractory materials (high temperature treatment of exhaust gases, furnace electrodes, etc.) [7–13].

The ideal $ABO_3$ perovskite structure belongs to the cubic group $Pm3m$. Upon changing the size of the cation at the A position with respect to the ideal situation, the $BO_6$ octahedra become rotated about the cubic crystallographic axis, which affects the structural stress as a result of changes in the B–O–B bond angle; in turn, changes in the coordination number of the A cations, with associated generation of structural defects, can also occur [1,14]. Structural defects can also arise upon partial substitution of the cation in the A position by other metal cations; such defects (typically oxygen vacancies) can result beneficial from a catalytic point of view since their presence could favour reactants chemisorption or other relevant catalytic steps (oxygen transport, electron transfer processes, etc.) [1,5,13,15–20].

Perovskite-type oxides are usually synthesized by a variety of methods including ceramic solid state reaction, co-precipitation, spray drying, freeze-drying and sol–gel (in particular, employing amorphous citrate complexes) ones [1]. Among them, high surface area along with high chemical homogeneity at structural level can in principle be achieved by the freeze-drying and sol–gel amorphous citrate methods [17]. In this context, the present work aims to explore the catalytic properties for the combustion of propene (chosen as representative of hydrocarbon exhaust gases) of two series of, respectively, Sr- or Ce-doped $LaCrO_3$ perovskite materials prepared by a sol–gel method; it may be noted that results on the catalytic properties of this specific type of perovskites appear relatively scarce despite their significant technological potential. For the mentioned purpose, the evolution of the sol–gel derived catalyst precursor has been investigated by TGA–DTA in order to select optimum preparation parameters for

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