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Formation of $LaFeO_3$ and thermal decomposition reactions in lanthanum(III) oxalate–iron(II) oxalate crystalline mixture

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Abstract Thermal processes involved during the decomposition course of $La_2(C_2O_4)_3{\cdot}10H_2O$–$FeC_2O_4{\cdot}2H_2O$ (1:2 mole ratio) mixture up to 750 °C, in an atmosphere of air, were monitored by thermogravimetry and differential thermal analysis. X-ray diffraction and Mössbauer spectroscopy were used to characterize the intermediates and the final product. The results showed that a microcrystalline or possibly amorphous iron(III) oxide with a paramagnetic nature was appeared in the early stages of decomposition at 250 °C. By increasing the temperature, a well crystalline hematite with ferromagnetic properties was obtained. XRD pattern of the mixture calcined at 1100 °C shows the formation of $LaFeO_3$ single phase in consistent with the hyperfine magnetic splitting (one sextet of lines) characteristic of $LaFeO_3$ obtained in the Mössbauer spectra of the mixture calcined at the same temperature.

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Introduction

At high temperature the rare earth oxide, R_2O_3 (where R is yttrium or rare earth element) can react with iron(III) oxide to form orthoferrites; $RFeO_3$ with perovskite structure exhibiting weak ferromagnetism which have found important applications in modern telecommunications and electronic devices [1]. The Mössbauer spectroscopy, in combination with the other techniques has been used for the studying of the different properties of rare earth orthoferrites [2–4].

$LaFeO_3$ possesses very interesting properties, which make it particularly interesting for technological applications as a material for sensors. It has been proposed for the detection of humidity [5], alcohol [6], oxygen [7], CO [8] and NO [9]. The properties and the potential applications for which $LaFeO_3$ is used have generated a lot of research especially aimed at preparation and characterization. The properties of the final materials obtained are strongly dependent on the preparation method, as for most applications, the controlled synthesis of high purity $LaFeO_3$ powder is necessary for obtaining reproducible properties.

Although the conventional preparation method based on the solid-state reaction between La_2O_3 and Fe_2O_3 at high temperatures is a simple operation and uses inexpensive starting materials, it has some drawbacks such as secondary phase formation, crystal growth and limited degree of chemical homogeneity [10]. Development concerning new methods, especially solution techniques, namely thermal decomposition of wet chemically precipitated precursors, have been applied to lower the reaction temperature, improve synthesis conditions for obtaining pure phases and to prepare finer and homogeneous powder [11–14]. The