IMPACT OF PEROVSKITES WITH CATALYTIC ACTIVITY IN THE AUTOMOTIVE INDUSTRIES FOR REDUCTION OF POLLUTANTS

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ABSTRACT: Charges referring to the polluter pays principle are measures that aim at the reduction of pollutants. To eradicate possible taxes, this work focuses on the catalysis of volatile organic compounds through perovskite $La_{0.8}Ca_{0.2}MnO_3$, which were synthesized and characterized by thermal, structural and morphological analysis including catalytic evaluation. Through the studies the catalyst economically demonstrated contribution to the companies from the high conversion rate of 99%.

KEYWORDS: Catalyst, Automotive, Environmental, Perovskite, Pechini.

INTRODUCTION

With the growth in the emission of harmful pollutants into the atmosphere, the search for restrictive measures that contribute to their reduction has intensified. One of these measures is the Polluter Pays Principle (PPP), which consists of forcing the polluter to bear the costs of the damage caused by him to the environment [1]. Therefore, considering the environment and the profitability of companies, especially automobile companies, the use of an automotive catalytic converter is one of the methods that can be used to

reduce its impacts and eradicate possible charges related to the PPP [1]. The perovskite $La_{0.8}Ca_{0.2}MnO_3$ (LCMO) type automotive catalyst has catalytic characteristics capable of converting volatile organic compounds (VOCs) into less harmful gases [2]. Therefore, this work aims to evaluate the obtainment and efficiency of LCMO catalyst via Pechini, through the characterization techniques of thermal, structural and morphological analysis, with catalytic evaluation for applicability in automotive industries in relation to conversion and more affordable cost.

EXPERIMENTAL PROCEDURE (OR COMPUTATIONAL PROCEDURE)

The procedure consisted in the use of Vetec's regents: $La(NO_3)_{3.6}H_2O$ (98.0%), $Ca(NO_3)_{2.4}H_2O$ (98.0%) and $Mn(NO_3)_{2.6}H_2O$ (98.0%), citric acid (99.5%) and ethylene glycol (99.5%) in a 60:40 to 1:1.5 (metal : citric acid) ratio. In which, dilution of the regents slowly occurred in distilled water under stirring at 60-70 °C for 1 h until a polymeric resin was formed. These were subjected to pre-calcination for 4 h with heating rate 10 ºC/min-1 at a temperature of 350 °C to form the precursor powder. The obtained powder was characterized by ATG by Shimadzu equipment, model TGA50. Subsequently, the powders were calcined at 700 and 900 ºC for 4 h and characterized by XRD (Shimadzu XRD-6000), SEM-FEG (XL30 ESEM, Philips). The specific area and average pore size for microstructural analysis of the material were obtained by BET and BJH in a Belsorp II mini Bel Japan equipment. The evaluation of the catalytic activity was performed from the analysis of the stability and conversion into CO2 and H2O in methane combustion reactions, under the conditions with a rate of 5 °C min-1 in a range from 200 to 800 °C.

RESULTS AND DISCUSSION

The ATG (Figure 1) showed that the thermal stability of the material occurred at approximately 750 °C and there was a loss of approximately 32% mass, the first loss was related to the dehydration of the material happening around 400 °C and the second related to the decomposition of organic matter obtained in the synthesis, approximately between 400 and 700 °C [2].

The XRD (Figure 1) showed that the partially substituted perovskite phase were obtained at both calcination temperatures, at 700 and 900 °C, without the presence of secondary phases, and confirmed by the PDF 44-1040 chart, with the average crystallite size (18.79 and 33.78 nm) confirms high crystallinity, obtained by X'pert-Highscore software [2].

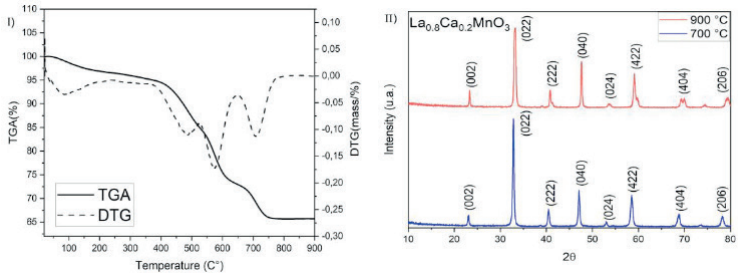

Figure 1: I) Thermogravimetric curves of precursor powders calcined at 300 ºC/4h; II) Diffractograms of specimens calcined at 700 °C/4h and 900 °C/4h

Figure 2 represents the images generated by SEM-FEG, in which we can observe the formation of homogeneous powders. The BET and BJH analyses confirmed that the surface area and the average pore diameter (mesopores) is larger at lower temperature (Table 1), a positive factor, especially at 700 °C, where the best performance is expected and for the economic issue for its applicability [2].

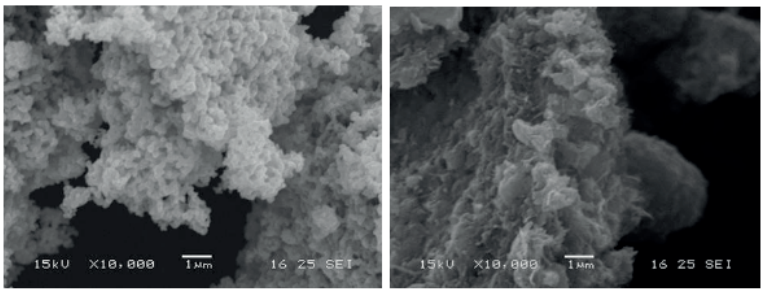

Figure 2: SEM images of samples calcined at 700 °C/4h and 900 °C/ 4h

Temperature/°C	Specific area m2/g	Average pore diameter/ nm	Average pore diameter/Å
700	12.400	2.1141	20
900	0.35638	1.806	18

Tabela 1: Specific area and average pore diameter of the compound $La_{0.8}Ca_{0.2}MnO_3$ calcined at 700 and 900 ºC/4h

The catalyst of $La_{0.8}Ca_{0.2}MnO_3$ showed a high catalytic activity in methane combustion reactions, converting approximately 100% of methane into carbon dioxide and water at a temperature of 800 °C and remained stable throughout the reaction time, this result is due to the success of the proposed synthesis method and the partial replacement of lanthanum by calcium, which generated structural defects in the network enabling the enhancement of important properties for catalysis as crystallinity, porosity, homogeneity and thermal stability. These results corroborate that the proposed method of synthesis was satisfactory to obtain the catalyst making the material viable for automotive catalysis [2].

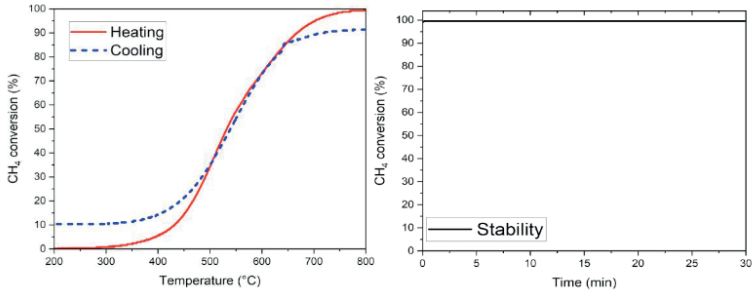

Figure 3: Heating and Cooling ramps from 200 to 800 °C of the samples calcined at 900 °C and curves of Stability

CONCLUSIONS

In view of all the results discussed, it is possible to conclude that the catalyst is effective in the conversion into CO_2 and H_2O and economically viable. Characteristics such as porosity, homogeneity, and crystallinity are of paramount importance for the proper functioning of the catalyst, and even at high temperatures, such characteristics are maintained, which causes high performance, with percentages that reach almost 100% of material efficiency.

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