EFFECT OF IMPREGNATED AND DOPING CERIA IN CATALYSTS OF Pt/Al_2O_3 FOR VOCs COMBUSTION

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INTRODUCTION

It is widely accepted that optimum catalytic performance of the system largely depends on the synergetic interactions established between platinum and ceria. In this sense, it has been reported that ceria promotes dispersion of Pt, and that strong platinum-ceria interactions may have a profound effect on the oxygen storage capacity of ceria [1]. In the case of hydrocarbons combustion there is also a dependence of activity with particle size [2].

In a previous work [3] it was reported that ceria modified the textural properties of Pt/Al_2O_3 catalysts and also increased the activity for hydrocarbons combustion. It was also found that the measurement of the dispersion of Pt supported in alumina doped with ceria is not possible, because of a probable spillover effect that increases the amount of chemisorbed H_2. On the other hand, it was observed that in alumina-supported ceria, this can form two types of entities [4]: aggregated crystalline ceria species (3D-Ce or ceria bulk) and dispersed ceria species (2D-Ce or surface ceria), that possibly modified the textural, structural and redox properties, as well as the activity in catalytic reactions. The aim of this work is to establish the dependence in catalytic combustion of VOCs with Pt particle size, the state of ceria (doping and impregnated) and redox properties.

EXPERIMENTAL

Al_2O_3-CeO_2 materials at several concentrations were prepared by sol-gel and impregnation techniques. After calcination at 700°C, catalysts were prepared by impregnation to incipient wetness to obtain 1% wt of Pt.

The materials were characterized by means of N_2 physisorption, TGA, DTA, XRD, TPR, RMN, TEM, EDS, and test oxidation reactions of 2-propanol, benzene, ethyl acetate and MTBE.

RESULTS AND DISCUSSION

TPR of supports were used to calculate the amounts of reducible ceria species in the mixed oxide materials (Table 1). It was found that up to 10% of CeO_2, the H_2 consumption peaks correspond to surface ceria reduction. For materials with 20 and 50% wt CeO_2 there are at least two peaks for which the high temperature consumption is attributed to bulk ceria reduction.

In all samples four, five and six coordinated aluminum were detected by ^{27}Al MAS-NMR. It was found that the presence of ceria modified the amounts of pentahedral aluminum, which increased with the amount of incorporated ceria.

Catalysts TPR analyses present two principal peaks of reduction. For catalysts with ceria, an increment in the principal peak (about 295°C) and a diminution in the

second band (a shoulder at 400°C) were observed. The first is related to both the reduction of ceria and Pt^{+4}; the second, attributed to Pt with more interaction with the support, decreased with the presence of ceria, and for Pt supported in AC10 the peak was almost undetectable. The diminution in the second band is attributed to a decrease in the interactions between Pt species and alumina due to the presence of ceria-alumina interactions.

Table 1. Reducible ceria species and results of 95% conversion in benzene oxidation

Sample	A	AC2	AC5	AC10	AC20	AC50
% wt CeO_2	0	2	5	10	20	50
% CeO_2 reduced	0	0.9	3.2	7.5	17	40
Temp. (°C)	380	360	350	340	330	430

TEM images of Pt°/A and Pt°/AC2 catalysts are shown in Figures 5a,b. Pt particles in the second material presents smaller particle size, i.e., the presence of ceria well-dispersed in alumina promotes higher dispersion of Pt crystallites obtaining smaller particle sizes of about 11 nm whereas the Pt particle size in Pt°/alumina is *ca*. 26 nm. In samples with higher ceria content (10 % wt) the particle size was about 5 nm.

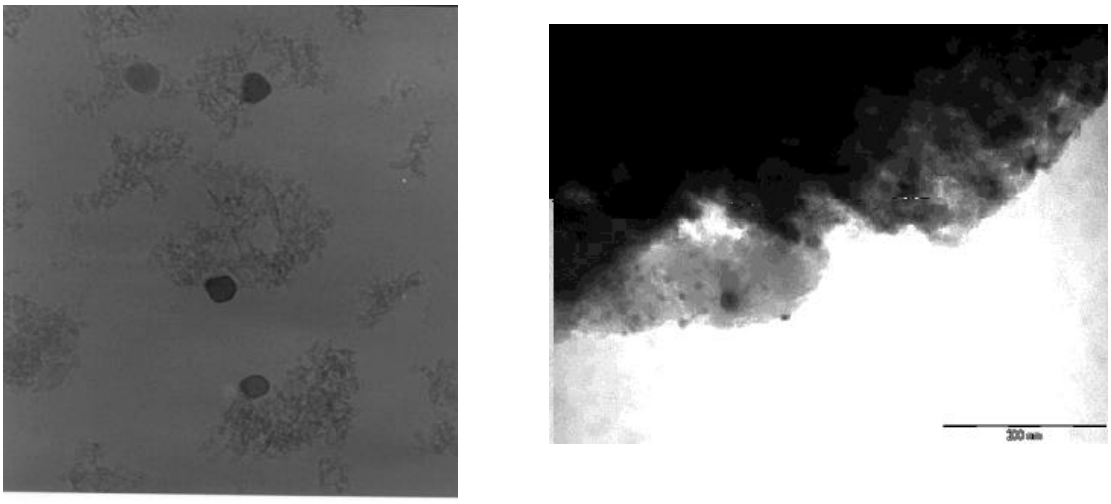

Figure 1. TEM bright field images to Pt°/A (a) and Pt°/AC2 (b) samples.

The combustion hydrocarbons occurred at lower temperatures as function of ceria content (Table 1). This fact occurs even though the Pt particle size decreases with CeO_2 content. Therefore, the presence of ceria produces higher catalysts activity probably due to its ability of releasing oxygen in demanding conditions.

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