



Modification of the catalytic properties of $\text{MoO}_{2-x}(\text{OH})_y$ dispersed on TiO_2 by Pt and Cs additives

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Pt

Cs

TiO_2

Bifunctional catalyst

1-Heptene

n-Heptane

Methylcyclohexane

ABSTRACT

Addition of 5% Pt or alkali metals such as K or Cs each separately to the bifunctional $\text{MoO}_{2-x}(\text{OH})_y$ catalyst results in modification of the chemical structure of this system, especially in the case of alkali metals. A new $\text{MoO}_{2-x}(\text{OA})_y$, A=K, Cs, monofunctional structure having only metallic properties is formed. In the case of Cs for example, the Mo–OCs bond formation takes place in the course of the reduction process of MoO_3 to MoO_2 by hydrogen hinders the acidic Brønsted Mo–OH formation, which usually is formed in this system. Characterization by surface XPS–UPS, ISS and FT-IR spectroscopic techniques as well as catalytic activity carried out at the same experimental conditions confirm the presence of this monofunctional $\text{MoO}_{2-x}(\text{OCs})_y$ system. On the contrary, platinum addition enhances the metallic character of the $\text{MoO}_{2-x}(\text{OH})_y$ bifunctional system in terms of slight improvement in the conversion of 1-heptene and n-heptane as well as dehydrogenation of methylcyclohexane to toluene.

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1. Introduction

Relative strength of the metal–acid (dual) or each function separately, plays an important role in diverse catalytic processes. For example, finely dispersed Pt particles on chlorinated alumina or zeolites are widely used in petroleum chemistry as bifunctional catalysts for the hydroisomerization of C5–C7 alkanes into branched species in order to enhance the gasoline pool efficiency by improving the octane number [1–6]. Several problems are encountered using Pt based catalysts. Possible replacement of Pt catalysts is a subject of interest [7–9]. In this respect, we have introduced bifunctional (metal–acid) catalysts based on Mo and W oxides [10–12]. Controlled hydrogen treatment as a function of temperature of molybdenum or tungsten oxides produces MO_2 (M=Mo or W) phase having metallic character in the form of delocalized

π -electrons over M atoms along the c-axis of the deformed rutile structure of MO_2 [13,14]. This metallic function enables to dissociate hydrogen and generate Brønsted acidic function (M–OH) via surface oxygen atoms. As a result, both metallic and acidic functions (bifunctional) are made available on the sample surface. The bifunctional character of the partially reduced molybdenum oxide has also been observed by Meunier et al. [15,16]. These catalytic systems have been supported on TiO_2 in order to increase the surface area of the active structure and add mechanical strength to the catalyst. Different catalytic reactions, such as hydroisomerization of alkanes, dehydrogenation of paraffins and hydrogenation of olefins, were performed using these metal oxide systems [11,12].

In order to optimize the catalytic performances of the $\text{MoO}_{2-x}(\text{OH})_y/\text{TiO}_2$ system and gain more information concerning the nature and strength of both metallic and acidic functions, Pt and alkali metal additives are sought. Addition of alkali metal ions seems to affect acidic function(s) exposed on metal oxide surfaces [17,18]. Such modification, if any, could be identified using the most appropriate spectroscopic techniques of X-ray (XPS) and Ultraviolet

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