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Catalytic oxidation of formaldehyde over different silica supported platinum catalysts

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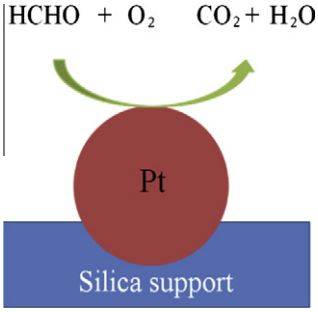
HIGHLIGHTS

- The nature of silica supports can affect the chemical states and catalytic properties of Pt nanoparticles.
- Fumed silica supported platinum catalyst is highly active for HCHO oxidation.
- Fumed silica supported platinum catalyst contains more metallic Pt species.
- The activation of molecular oxygen can be achieved at room temperature.

GRAPHICAL ABSTRACT



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ABSTRACT

Three kinds of silica materials, including fumed SiO_2, porous granular SiO_2 and mesoporous SBA-15, were adopted to prepare supported Pt catalysts by impregnation method. The catalytic properties of these silica supported Pt catalysts (Pt/SiO_2) were investigated for the complete oxidation of formaldehyde (HCHO). Among them, fumed SiO_2 supported Pt catalyst ($Pt/f\text{-}SiO_2$) shows very high catalytic activity, which could completely oxidize HCHO even at ambient temperature. According to the results of catalyst characterization, it was proposed that the nature of silica supports could affect the particle size and the chemical states of platinum species and then further influence the redox property of Pt/SiO_2 catalysts. Compared with other silica supported Pt catalysts, $Pt/f\text{-}SiO_2$ catalyst possesses higher ratio of metallic Pt species, which might be a key factor in improving its capability to activate molecular oxygen and consequently to oxidize HCHO at low temperature.

1. Introduction

Formaldehyde (HCHO) is regarded as a major indoor pollutant emitted from buildings, furnishing materials and consumer products. Considerable efforts have been made to reduce the indoor emission of HCHO for satisfying the stringent environmental regulations. As one of the most attractive approach, low-temperature catalytic oxidation of HCHO to CO_2 and H_2O has received considerable attentions [1–9]. Among the tested catalysts, noble metal catalysts exhibit relatively high catalytic activity at low temperatures. Especially, significant progresses on improving the low temperature activity of HCHO oxidation have been made recently over a few kinds of supported Pt catalysts [1,5–7,9].

For the supported noble-metal catalysts, the nature of supports is one of the key factors affecting their catalytic performance although the concreted role of supports is still under debate [10–13]. So far only a few reducible metal oxides, such as TiO_2, MnO_2–CeO_2 and Fe_2O_3, have been reported to be suitable supports to prepare highly active Pt-based catalysts for low-temperature

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