



IR study of iridium bonded to perturbed silanol groups of Pt-HZSM5 for *n*-pentane isomerization

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ABSTRACT

The Ir/Pt-HZSM5 catalyst was prepared by impregnation of iridium on Pt-HZSM5. The activity of Ir/Pt-HZSM5 was tested for *n*-pentane isomerization under hydrogen stream. The introduction of iridium did not change the bands observed at 3740, 3665 and 3610 cm⁻¹ indicating that neither non-acidic terminal silanol groups nor acidic bridging hydroxyl groups interacted with the iridium. Additionally, the peaks corresponding to the perturbed silanol groups at 3700 and 3520 cm⁻¹ decreased significantly. X-ray photoelectron spectroscopy (XPS) analysis revealed that the iridium is in the form of IrO₂. ²⁷Al MAS NMR confirmed the elimination of distorted tetrahedral aluminum. The presence of iridium slightly increased the acidity of Pt-HZSM5 and its selectivity for iso-pentane. Hydrogen adsorption FTIR indicated that iridium enhanced the formation of protonic acid sites which may participate in the isomerization, and inhibited the formation of hydroxyl groups at 3380, 3600 and 3680 cm⁻¹ which may participate in the enhancement of the cracking reaction.

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1. Introduction

In recent years, bifunctional transition metal-loaded catalysts employing metal [1–6], mesoporous [7] and microporous solid oxide materials [8–12] as supports have drawn much attention due to their efficiency for isomerization of alkanes and for the synthesis of high octane gasoline. Among the available supports, zeolites appear to be promising because they are known to have a high surface area, high thermal stability and strong acidity required, for a stable, regenerable and active catalyst. Currently, zeolites are of industrial importance and contribute to the production of a majority of the world's gasoline by catalyzing the fluidized catalytic cracking (FCC) of petroleum [13].

The presence of promoters such as platinum [9,10,14], gallium [15,16] and zinc [17–19] in zeolites may favor the activity and selectivity for isomerization over the cracking activity. In particular, platinum supported on MFI-type zeolite (HZSM5) was found to be active and stable for the isomerization of *n*-alkanes [9]. The isomerization of light paraffins such as pentane, hexane and heptane proceeds due to the promotive effect of hydrogen that has migrated or spilled-over from a noble metal site onto the acidic

oxide support. This catalyst behavior is referred to the hydrogen spillover effect [20]. Fujimoto et al. [9] reported that Pt/HZSM5 can enhance the selectivity for iso-pentane and decrease the formation of cracked products. The role of platinum in the H₂ spillover mechanism was confirmed by the reduction in the conversion of *n*-pentane in the absence of hydrogen, which hence allows the oligomerization reactions to occur.

The hydrogen spillover phenomenon has only been observed for a limited class of catalysts. In addition to zeolites, sulfated zirconia can also be utilized as a support and as a hydrogen spillover catalyst after being impregnated with several metals [2,21]. In certain cases, the introduction of a second metal is sometimes necessary to increase the activity of the support and suppress the production of cracked products [22,23]. In addition to platinum, gallium and zinc, iridium has been incorporated as a co-promoter to give this effect. In catalytic reforming, iridium species are well known co-promoters that are added to catalysts because of their stability during the coke removal process [24–26]. Yang and Woo [27] reported that Pt-Ir/NaY maintained better activity for the *n*-heptane reforming reaction than the Pt/NaY catalyst due to a decrease in the formation of coke. They also found that the activity for the *n*-heptane reforming reaction was enhanced over Pt-Ir/NaY. Additionally, Aboul-Gheit et al. [28] reported that Ir loaded on Pt-HZSM5 enhanced the catalytic activity for *n*-hexane hydroconversion.

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