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

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\section*{A B S T R A C T}

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 IrO\(_2\).\textsuperscript{\textsuperscript{27}}\textsuperscript{Al} 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.

\section*{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 synth-
esis 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 partic-
ular, 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 he-
ptane 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 forma-
tion of cracked products. The role of platinum in the \( H_2 \) 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 zirco-
nia 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 neces-
sary 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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