

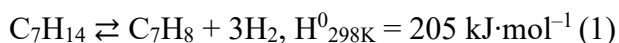
IR observation in methylcyclohexane dehydrogenation over Pt/TiO₂ and Pt/Al₂O₃ catalysts

Kei Watanabe, Yuya Bandai, Ryo Watanabe,
Yosiumi Kohno and Choji Fukuhara*

Department of Applied Chemistry and
Biochemical Engineering, Shizuoka University,
Hamamatsu, Shizuoka, Japan

*E-mail: tcfukuh@ipc.shizuoka.ac.jp

Organic chemical hydrides are promising candidate materials for hydrogen storage and transport. One of the most promising cycle is methylcyclohexane (MCH) dehydrogenation and toluene (TL) hydrogenation (eq.1).



In order to construct an efficient MCH-TL cycle process, it is required to develop a highly active and stable catalyst for MCH dehydrogenation [1]. Pt/TiO₂ is one of the high performance catalysts. The object of this study is to investigate the catalytic performance and TL adsorption state over Pt/TiO₂ catalyst in comparison with Pt/Al₂O₃ catalyst [1].

Pt/TiO₂ and Pt/Al₂O₃ catalysts were prepared by ion-adsorption method using H₂PtCl₆·6H₂O as platinum precursor. The catalysts were calcined at 500°C for 5 h. The MCH dehydrogenation performance was investigated using a fixed bed reactor. Before reaction, the catalyst was reduced by hydrogen at 350°C for 30 min. The dehydrogenation was then carried out at 350°C with LHSV 35 h⁻¹. The effluent gas was then analyzed using GC-TCD. The conversion was calculated on the basis of MCH consumption. Meanwhile, the adsorption state of TL was observed by FT-IR. TL is adsorbed at 50°C for 30 min under partial pressure of 1.0×10⁻³ atm. Prior to the introducing TL, the catalyst was oxidized at 500°C for 30 min, and followed by a reduction at 350°C. Temperature programmed desorption (TPD) measurement was then performed.

Fig.1 shows MCH conversion over Pt/TiO₂ and Pt/Al₂O₃ catalysts with time on stream. The TL selectivity of both catalysts was 100% during the reaction. The Pt/TiO₂ catalyst shows higher activity and better stability than Pt/Al₂O₃ catalyst. The amount of deposited carbon on Pt/TiO₂ and Pt/Al₂O₃ catalysts were 0.4 and 2.9

wt%, respectively. In terms of deactivation, Pt/TiO₂ catalyst showed a high tolerance to coke deposition, which might contribute to a high stability of catalyst.

Figs. 2(a) and 2(b) show TL-TPD spectra of Pt/TiO₂ and Pt/Al₂O₃ catalysts. These experiments were performed from 50°C to 350°C. In Fig. 2(a), ν(C=C) stretching band (1600, 1500 cm⁻¹) and ν(C=O) stretching band (1690 cm⁻¹), were observed at 50°C on Pt/TiO₂ catalyst [2]. The ν(C=C) band decreased with an increase in temperature. The ν(C=C) band completely disappeared at 150°C due to a desorption of TL from the catalyst surface. As for Pt/Al₂O₃ catalyst, the ν(C=C) band was also observed at 50°C. Although the band at ν(C=C) slightly decreased at 100°C, it was remained at high temperature of 350°C. This result indicated that TL was strongly adsorbed on Pt/Al₂O₃ than Pt/TiO₂. In general, strong TL adsorption causes coke deposition [1]. Therefore, Pt/TiO₂ catalyst shows the better coke resistance than Pt/Al₂O₃ catalyst.

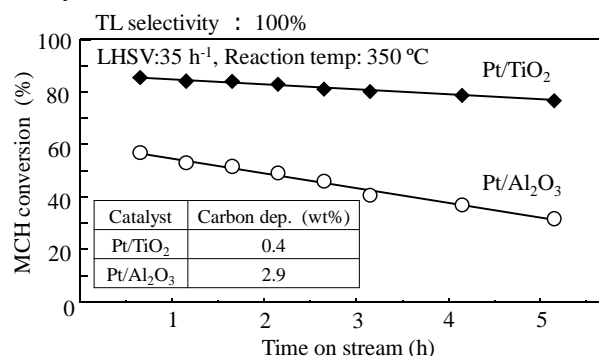


Fig. 1 MCH conversion over Pt/TiO₂ and Pt/Al₂O₃ catalysts.

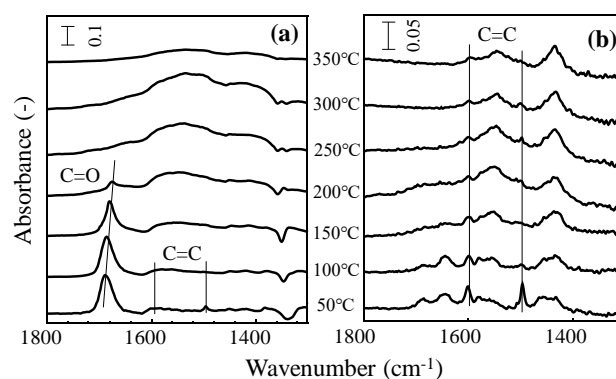


Fig. 2 IR spectra of TL-TPD over (a) Pt/TiO₂ and (b) Pt/Al₂O₃ catalysts.

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- [2] M.D. Hernandez-Alonso, I. Tejedor-tededor, J. M. Coronado and M.A. Anderson. Appl. Catal., b, 101 (2011) 283.