Role of TiO_2 in Enhancing Sulfur Resistance of Supported Metal Catalysts (II): Correlation between Catalyst Structure and Catalytic Performance

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The goal of this study is to improve the catalytic performance of a hydrogenation catalyst by retarding Pt aggregation during sulfur-poisoning catalyst deactivation. The improvement is motivated by the increase of metal-support interactions. The increase of metal-support interactions was enhanced by grafting titanium oxide on zeolite surface. The efficacy of the modification was examined by aging tests of a hydrogenation reaction using 200 ppm sulfur-containing tetralin as a feed. The catalyst before and after the reaction were characterized by XAS (X-ray absorption spectroscopy), synchrotron XRD (X-ray diffraction). Correlated the structure characterization results with the catalytic performance tests, the following conclusions have been drawn:

1. The morphology of grafted TiO_2 is strongly dependent on TiO_2 loading. For the 3 Wt % TiO_2 loading, isolated TiO_2 has been observed. When the loading increases to 7 %, the TiO_2 morphology become monolayer while the loading further increase to 20 %, anatase TiO_2 appear.
2. The morphology of Pt clusters on TiO_2-zeolite is affected by TiO_2 structure. Among the 3 samples, the Pt clusters on monolayer TiO_2 presents the smallest particle size.
3. The initial activity of the catalyst sample is inversely proportional to particle size during the aging tests (Figure 1).
4. Small Pt clusters do not benefit in retarding Pt agglomeration during sulfur-poisoning catalyst deactivation. In stead, the increases of metal-support interactions do help the decrease of catalyst deactivation by the decrease of Pt agglomeration rate (as shown in Figure 1and 2 the sample prepared by ion-exchange having higher dispersion, whereas the conversion at steady state is almost the same).
5. The role of the grafted TiO_2 is regarded as an anchor that inhibits the Pt clusters from migration.

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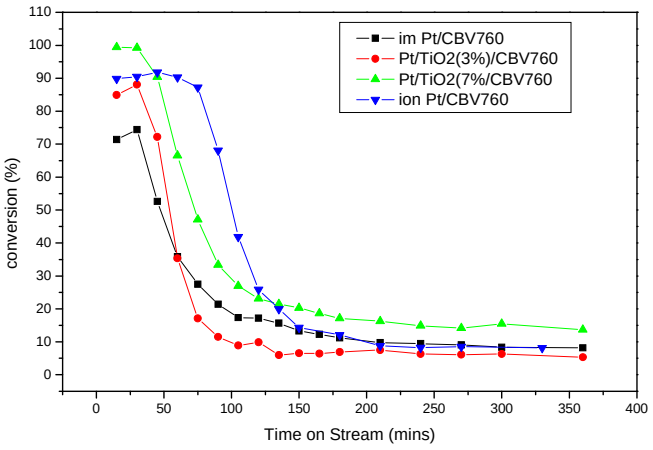

Figure 1. Comparison of the catalytic performance of the catalysts prepared by different methods, (operation conditions: Feed=200ppm sulfur containing tetralin, P=480psig, T=200℃, WHSV=12, H_2/Oil mole ratio=7).

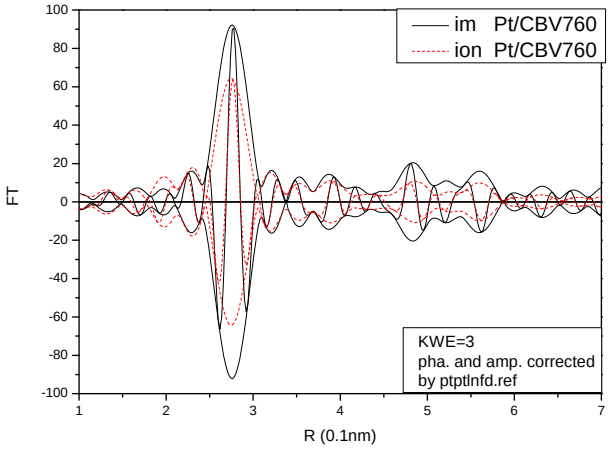

Figure 2. EXAFS characterizing Pt/CBV760 prepared from impregnation and ion-exchange technique. (k^3 weighted, Pt-Pt phase and amplitude correction, 3.5<k<14.0 $Å^{-1}$)

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