

Catalytic properties tuning of γ -Al₂O₃ supported catalysts via χ - and α -phases incorporation

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Introduction

Al₂O₃ is widely used as supports for supported catalysts in number of reactions. For example, CO oxidation and selective acetylene hydrogenation are important reactions to eliminate toxic gases. These reactions require different characteristic properties of the catalyst. High active site causes high activity for CO oxidation; in contrast selective acetylene hydrogenation lead to lower selectivity [1, 2].

In this article, the catalytic properties for CO oxidation and selective acetylene hydrogenation were tuned by mixed different χ - and α -phases into γ -Al₂O₃ supported catalysts.

Materials and methods

Mixed χ - γ - and α - γ -Al₂O₃ phases were synthesized by solvothermal method [3] and by calcination of commercial γ -Al₂O₃ (JRC-ALO-2) [4], respectively. Incipient wetness impregnation was used to prepare Pt (0.3 wt%) supported on χ - γ -Al₂O₃ and Pd (1 wt%) supported on α - γ -Al₂O₃. CO oxidation (0.2% CO, 0.9% O₂, balanced He) with GHSV 16,000 h⁻¹ and selective acetylene hydrogenation (1.5% C₂H₂, 1.7% H₂, balanced C₂H₄) with GHSV 12,385 h⁻¹ were tested for Pt/ χ - γ -Al₂O₃ and Pd/ α - γ -Al₂O₃ catalysts, respectively.

Results and discussion

The content of χ - and γ -phases was calculated by XRD and the metal dispersion was determined via CO pulse chemisorption of the catalysts as summarized in Table 1.

Table 1. Physical and chemical properties of Al₂O₃ supported catalysts.

Catalyst	χ -Phase (%)	α -Phase (%)	% Metal Dispersion	C ₂ H ₄ desorption (μ mole/geat.)
Pt/ χ -0	0	-	38.9	-
Pt/ χ -50	50	-	42.5	-
Pt/ χ -70	70	-	42.8	-
Pt/ χ -100	100	-	38.1	-
Pd/ α -0	-	0	59.2	174
Pd/ α -14	-	14	53.8	68
Pd/ α -64	-	64	18.5	42
Pd/ α -100	-	100	12.5	32

Pt dispersion increased to 42.5 and 42.8% when mixed χ -phase at 50 and 70%, respectively. In contrast to Pd dispersion, it decreased from 59.2 to 12.5% with increasing of α -phase content from 0 to 100%.

The plot of temperature at 50% CO oxidation conversion against χ -phase content of Pt/Al₂O₃ catalysts is given in Figure 1a and the plot of ethylene gain against α -phase content of Pd/Al₂O₃ is shown in Figure 1b. Mixed χ -phase improved the catalytic performance of CO oxidation as observed by decreasing the temperature at 50% conversion, consistent with the increasing of Pt dispersion. Mixed α -phase enhanced the ethylene gain in selective acetylene hydrogenation due to the decreasing of ethylene amount adsorbed on the catalyst surface.

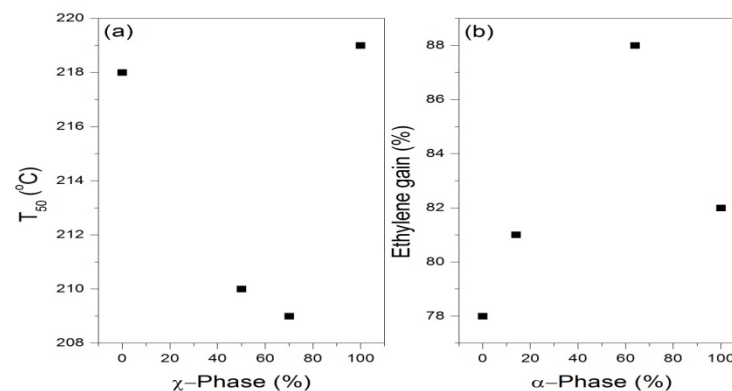


Figure 1. Catalytic performance: CO oxidation (a), selective acetylene hydrogenation (b).

Significance

Catalytic properties of metal supported on Al₂O₃ could be suitably adjusted for specific reaction by tuning phase content of mixed-phase Al₂O₃ support.

References

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