Synthesis and Characterization of model NOx Storage Materials:
BaO/TiO2/γ-Al2O3

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Introduction

The NOx storage/reduction (NSR) technology developed by Toyota Motor Corporation 1–3,4 has attracted considerable interest as a promising after treatment technology for NOx removal from gasoline-fueled automotive exhaust. The addition of metal-oxide species such as TiO2 to the Pt/Ba/γ-Al2O3 catalytic system 1, 2, * has been proposed as a successful and promising approach for improving the sulfur tolerance by suppressing the sulfur adsorption and promoting sulfur desorption on the surface.

Materials and Methods

Model NOx-storage materials were synthesized on a TiO2/γ-Al2O3 mixed oxide support surface with varying Ba loadings (8 and 20 wt. % BaO) in order to obtain a NOx-storage material with improved sulphur tolerance. The support material, TiO2/γ-Al2O3 (weight ratio TiO2: Al2O3 = 26:74) was prepared by the sol-gel method where the storage phase (BaO) was incorporated into the system by the incipient wetness impregnation. The role and the effect of Ti as a promoter in the NOx Storage Materials after thermal treatments within 423 K and 1273 K under inert argon atmosphere were investigated for the support TiO2/γ-Al2O3 and BaO/TiO2/γ-Al2O3 systems separately. For characterizing the structural, crystallographic and compositional changes of the Ba/Ti/Al system, X-ray Diffraction Spectroscopy (XRD), BET-Surface area measurement, Raman spectroscopy (RS), Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray spectroscopy (EDX) techniques were employed.

Results and Discussion

The incorporation of Ti sites into the support material results in strongly interacting mixed (overlapping) Ti-Ba domains which lead to an increase in the anatase to rutile phase transformation temperature for the 8 wt. % Ba/Ti/Al system. In addition, Ba and Ti do not form monodisperse domains on the surface. Presence of Ti sites also triggers a decrease in the phase transformation temperature of γ-Al2O3 to α-Al2O3 in the TiO2/γ-Al2O3 support material. The specific surface area of the TiO2/γ-Al2O3 support material decreases monotonically with increasing temperature due to sintering and the formation of α-Al2O3 and rutile phases. A similar behaviour is observed for the promoted Ba/Ti/Al system, due to the formation BaTiO3 and BaAl2O4 phases.

Figure 1 displays a series of Raman spectra corresponding to the uncalcined and calcined (423 - 1273 K) (8 and 20 wt. %) Ba/Ti/Al samples.

The results demonstrate that the Ba- nitrate species are completely decomposed at 873 K for both samples with different BaO loadings (8 and 20 wt. % BaO) in the presence of Ti. Therefore, the addition of TiO2 mainly in the form of anatase into the 20Ba/Al sample results in a decrease in the thermal stability of the nitrate species on the surface.

Figure 1. Raman spectra of Ba/Ti/Al samples with different Ba loadings (8 and 20 wt %) calcined at different temperatures.

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References