Synthesis and Characterization of model NO_x Storage Materials: $BaO/TiO_2/\gamma\text{-}Al_2O_3$

Stanislava M. Andonova [1], Göksu S. Şentürk [1], Emine Kayhan [1], Emrah Ozensoy [1, 2, *]
[1] *Bilkent University, Chemistry Department, 06800 Bilkent, Ankara, Turkey*
[2] *Institute of Material Science and Nanotechnology, 06800 Ankara, Turkey*
ozensoy@fen.bilkent.edu.tr

Introduction

The NO_x storage/reduction (NSR) technology developed by Toyota Motor Corporation[1,2] has attracted considerable interest as a promising after treatment technology for NO_x removal from gasoline–fueled automotive exhaust.

The addition of metal-oxide species such as TiO_2 to the $Pt/Ba/\gamma\text{-}Al_2O_3$ catalytic system[3,4] has been proposed as a ssuccessful and promising approach for improving the sulfur tolerance by suppressing the sulfur adsorption and promoting sulfur desorption on the surface.

Materials and Methods

Model NO_x-storage materials were synthesized on a $TiO_2/\gamma\text{-}Al_2O_3$ mixed oxide support surface with varying Ba loadings (8 and 20 wt. % BaO) in order to obtain a NO_x-storage material with improved sulphur tolerance. The support material, $TiO_2/\gamma\text{-}Al_2O_3$ (weight ratio TiO_2: Al_2O_3 = 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 $TiO_2/\gamma\text{-}Al_2O_3$ and $BaO/TiO_2/\gamma\text{-}Al_2O_3$ 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 $\gamma\text{-}Al_2O_3$ to $\alpha\text{-}Al_2O_3$ in the $TiO_2/\gamma\text{-}Al_2O_3$ support material. The specific surface area of the $TiO_2/\gamma\text{-}Al_2O_3$ support material decreases monotonically with increasing temperature due to sintering and the formation of $\alpha\text{-}Al_2O_3$ and rutile phases. A similar behaviour is observed for the promoted Ba/Ti/Al system, due to the formation $BaTiO_3$ and $BaAl_2O_4$ 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 TiO_2 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.

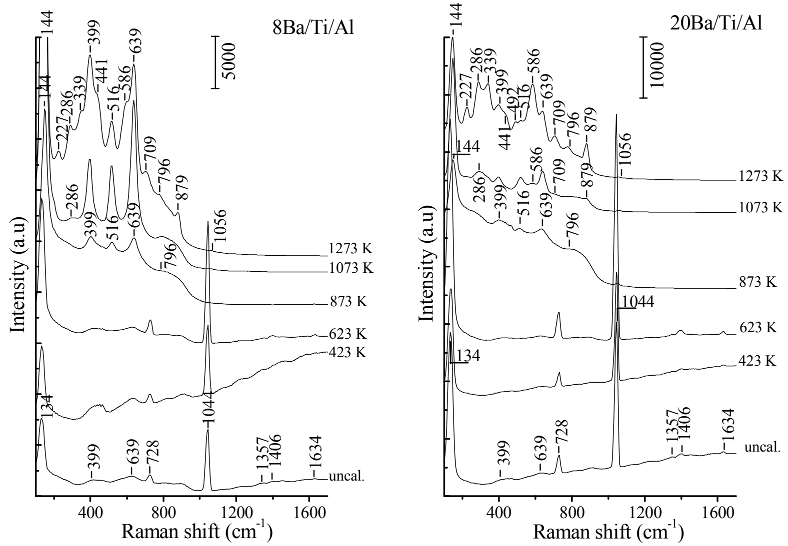

Figure 1. Raman spectra of Ba/Ti/Al samples with different Ba loadings (8 and 20 wt %) calcined at different temperatures.

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References

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