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Author:  [ADVANCED](#) | Volume  Page   
Keyword:



[TOP](#) > [Available Issues](#) > [Table of Contents](#) > [Abstract](#)

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[\[PDF \(482K\)\]](#) [\[References\]](#)

## FT-IR Spectroscopic Study of the Reaction Mechanism for Selective Reduction of NO over Sol-gel Prepared $\text{In}_2\text{O}_3\text{-Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$ Catalysts

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The catalytic activity of  $\text{Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$  for the selective reduction of NO with propene was inhibited by the presence of  $\text{H}_2\text{O}$ , whereas the catalytic activity of  $\text{In}_2\text{O}_3\text{-Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$  was significantly promoted. Both  $\text{Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$  and  $\text{In}_2\text{O}_3\text{-Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$  promoted the formation of  $\text{NO}_3^-$ , acetate, formate, nitrile, isocyanate and amino species in the absence of  $\text{H}_2\text{O}$  in the reaction gas mixture under the reaction conditions. Adsorption of organic nitro compounds, which are possible intermediates in the NO reduction, onto  $\text{Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$  and  $\text{In}_2\text{O}_3\text{-Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$  at the reaction temperature was detected as IR bands due to nitro, nitrite, carbonyl and isocyanate species, which were also observed in the NO reduction with propene. Surface  $\text{NO}_3^-$  species were highly reactive with propene, leading to the formation of the surface species of acetate, formate, isocyanate and amino species, as well as  $\text{N}_2$  and  $\text{CO}_2$ . On the basis of these findings, the following reaction mechanism was proposed: organic nitro compounds are first produced through the reaction of  $\text{NO}_3^-$  formed by NO oxidation on the catalyst surface with propene, and then decomposed to -NCO species, and the surface -NH species generated by hydrolysis of the -NCO species react with  $\text{NO}_x$  species to produce  $\text{N}_2$ . Although the presence of  $\text{H}_2\text{O}$  suppressed the

formation of  $\text{NO}_3^-$  species as the initial reaction intermediate on  $\text{Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$  and  $\text{In}_2\text{O}_3\text{-Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$ , the formation and subsequent decomposition (hydrolysis) of the -NCO species was promoted by  $\text{H}_2\text{O}$  over  $\text{In}_2\text{O}_3\text{-Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$ . Such contrasting behavior of the -NCO species is related to the different catalytic characteristics of  $\text{Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$  and  $\text{In}_2\text{O}_3\text{-Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$  for NO reduction by propene in the presence of  $\text{H}_2\text{O}$ .

**Keywords:** [Nitrogen monoxide](#), [Selective reduction](#), [Propene](#), [Gallium oxide catalyst](#), [Indium oxide catalyst](#), [FT-IR](#)

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