Influence of Catalyst Synthesis Method on Selective Catalytic Reduction (SCR) of NO by NH₃ with V₂O₅-WO₃/TiO₂ Catalysts

Scientific Achievement
First investigation to compare impregnated and co-precipitated V₂O₅-WO₃/TiO₂ SCR catalysts side-by-side to determine the differences and similarities between the two preparation methods.

Significance and Impact
Characterization of co-precipitated catalysts identified for the first time the formation of new mono-oxo surface VO₄ and WO₄ sites that are anchored to surface defects on the TiO₂ support. Increased activity of co-precipitated catalysts was observed for the SCR reaction and is correlated with the presence of new surface WOₓ sites associated with surface defects on the TiO₂ support.

Research Details
- V₂O₅-WO₃/TiO₂ catalysts made by co-precipitation of aqueous vanadium and tungsten oxide precursors with TiO(OH)₂ and by incipient wetness impregnation of aqueous precursors on a reference crystalline TiO₂ support.
- Analysis included: XRD, High Sensitivity-Low Energy Ion Scattering (HS-LEIS), in situ Raman and IR spectroscopy, and TPSR spectroscopy.
- V₂O₅-WO₃/TiO₂ catalysts made by co-precipitation have two distinct surface VOₓ and WOₓ sites not observed in impregnated catalysts.
- Co-precipitated catalysts have higher ammonia capacity than incipient wetness analog and are more active in SCR of NO by NH₃.

Preparation of VOₓ-WOₓ/TiO₂ catalysts using co-precipitation method creates additional O=VO₃ and O=WO₄ sites anchored to defects in the TiO₂ support. New species provide more sites for NH₃ adsorption and thus higher SCR activity.

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- Surface WO$_x$ sites are low activity redox sites and serve mainly as acid sites to adsorb NH$_3$.
- Surface VO$_x$ sites are the catalytic active redox sites.
- Co-precipitated catalysts more active (~20%) than impregnated ones. All V-containing catalysts exhibit the same SCR kinetics (TOF).

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\text{NO} + \text{NH}_3 \rightarrow \text{N}_2 + \text{H}_2\text{O}
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New type of VO$_x$-WO$_x$ species present on co-precipitation made catalyst, possibly associated with defects on TiO$_2$.

New VO$_x$-WO$_x$ species provide more sites for NH$_3$ ads and thus higher activity.