Effect of preparation methods on VO\textsubscript{x}/CeO\textsubscript{2} catalysts for the selective catalytic reduction of NO\textsubscript{x} with NH\textsubscript{3}

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Figure S1 exhibits the NH$_3$-SCR activity over VO$_x$/CeO$_2$ with different loadings prepared by the homogeneous precipitation method. With the increase of VO$_x$ loading, NO$_x$ conversion increased obviously, especially in the temperature window of 150-300 °C. 3% wt.% VO$_x$/CeO$_2$ showed higher catalytic activity than 1%, 0.5%, and 0.1%. Due to the toxicity of vanadium to the human body, a vanadium-based catalyst with too high loading was not preferred. Therefore, we chose the 3% VO$_x$/CeO$_2$ catalyst to investigate rather than catalysts with higher loading.

![Figure S1 NH$_3$-SCR activity over VO$_x$/CeO$_2$ with different loadings.](image)

**Figure S1 NH$_3$-SCR activity over VO$_x$/CeO$_2$ with different loadings.**

Reaction conditions: $[\text{NO}] = [\text{NH}_3] = 500$ ppm, $[\text{O}_2] = 5$ vol. %, N$_2$ balance, total flow rate 500 ml/min and GHSV = 50 000 h$^{-1}$.

The N$_2$ selectivity of VO$_x$/CeO$_2$ catalysts prepared by different methods is shown in Figure S2. All the catalysts presented higher than 90% N$_2$ selectivity and only a little N$_2$O was produced at the temperatures we investigated.
Figure S2. The N$_2$ selectivity in NH$_3$-SCR reaction over VO$_x$/CeO$_2$ catalysts prepared by different methods.

The NH$_3$-SCR performance of VO$_x$/CeO$_2$ catalysts after SO$_2$ poisoning for 24 h is shown in Figure S3. After SO$_2$ poisoning, the activity of all the catalysts decreased noticeably. However, the activity of VO$_x$/CeO$_2$(P) was still higher than that of other catalysts. 100% NO$_x$ conversion could be obtained on the VO$_x$/CeO$_2$(P) catalyst at 250 °C and 70% on VO$_x$/CeO$_2$(S). This proved again that the VO$_x$/CeO$_2$(P) catalyst showed the strongest SO$_2$ resistance.
Figure S3. NH$_3$-SCR activity of VO$_x$/CeO$_2$(P) and VO$_x$/CeO$_2$(S) catalysts after 100 ppm SO$_2$ poisoning for 24 h.

Reaction conditions: [NO] = [NH$_3$] = 500 ppm, [O$_2$] = 5 vol. %, N$_2$ balance, total flow rate 500 ml/min and GHSV = 50 000 h$^{-1}$.

The separate oxidation activities of NO and NH$_3$ on VO$_x$/CeO$_2$ catalysts are shown in Figure S4. The NO oxidation activity of VO$_x$/CeO$_2$(P) was a little higher than that of VO$_x$/CeO$_2$(S). It has been reported that the enhancement of NO oxidation to NO$_2$ could significantly promote the low temperature SCR activity due to the occurrence of “fast SCR”: NO and NO$_2$ react with NH$_3$ to form N$_2$ and H$_2$O.$^{1-2}$ Higher catalytic activity over the VO$_x$/CeO$_2$(P) catalyst could be related to its slightly higher NO oxidation activity.

The VO$_x$/CeO$_2$(P) catalyst showed a bit higher NH$_3$ oxidation activity than VO$_x$/CeO$_2$(S) in the temperature range investigated. This indicates that the VO$_x$/CeO$_2$(P) catalyst adsorbed and activated NH$_3$ more easily and therefore achieved higher NH$_3$-SCR activity than the VO$_x$/CeO$_2$(S) catalyst.
Figure S4. NH$_3$/NO conversion in separate NH$_3$ or NO oxidation reactions over VO$_x$/CeO$_2$(P) and VO$_x$/CeO$_2$(S) catalysts.

Reaction conditions: [NO] = 500 ppm or [NH$_3$] = 500 ppm, [O$_2$] = 5 vol. %, N$_2$ balance, total flow rate 500 ml/min and GHSV = 50 000 h$^{-1}$.

The changes in band intensities of nitrate species on NO$_x$ pre-adsorbed catalysts during the introduction of NH$_3$ are shown in Figure S5. When NH$_3$ was introduced, the intensity of the bands attributed to monodentate nitrate and bridging nitrate species decreased slightly. The amount of bidentate nitrate species increased markedly, which may be due to the transformation of monodentate and bridging nitrate to bidentate nitrate.
Figure S5. The band intensities of nitrate species calculated from DRIFT spectra (Figure 9) centered at 1542 cm$^{-1}$ (monodentate nitrate), 1203 cm$^{-1}$ (bridging nitrate) and 1245 cm$^{-1}$ (bidentate nitrate) of VO$_x$/CeO$_2$(P) (A) and VO$_x$/CeO$_2$(S) (B).

References
