

Supporting information

Regeneration of potassium poisoned catalysts for the selective catalytic reduction of NO with NH₃

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Methods

1 wt.% K-poisoned catalyst were washed with two kinds of H₂SO₄ solutions, namely, 0.5M and 0.05M under continuous stirring. At regular intervals, concentrations of K, W and V in the solution were checked using the ICP-MS method. The leaching rate for each element was calculated as follows:

$$\text{Leaching rate (\%)} = \frac{v \cdot c}{m \cdot w} \times 100 \quad (s1)$$

where v and m are the solution volume and initial sample weight, respectively, and c and w stand for the solution concentration and initial element content.

X-ray photoelectron spectroscopy (XPS) was employed to check the valence variations of each element in the catalysts with ESCALab220i-XL (VG Scientific). The binding energies (BEs) for were calibrated reference to the C1s peaking at 284.8 eV.

Results

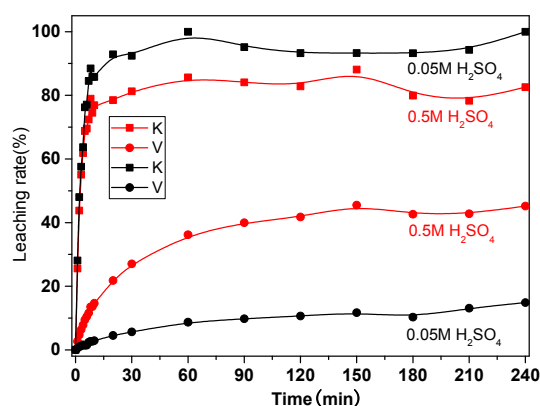
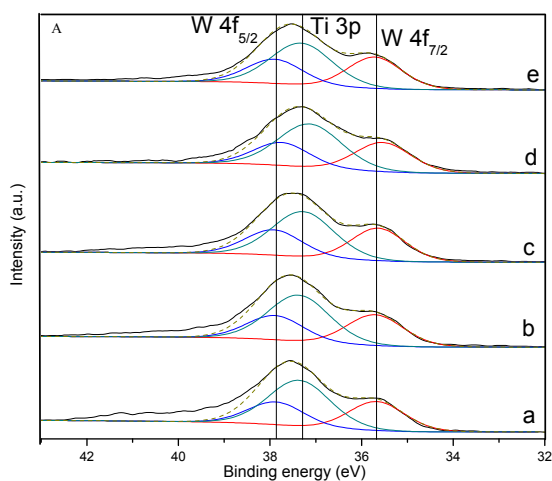


Fig. 1s. Leaching rate of K and V using different H₂SO₄ solutions.

Fig.1s illustrates the leaching rate of K and V during acid washing. Since in any time the rate of W was always below 0.1%, results isn't shown here for briefness. It is evident that upon acid introduction, both K and V were dissolved into the solution simultaneously but with different rates. In the first 30 min, the curves of K reached maximum values and levelled off while those of V needed more time to approach stable values. Also, it is interesting to note that diluted acid promoted the K leaching while suppressed the dissolution of V.



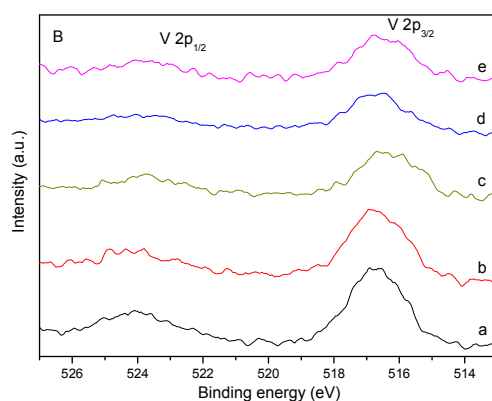


Fig. 2s. XPS spectra of V, W, Ti of the (a): Fresh; (b): 0.5K; (c): 0.5K-0.5SA; (d): 0.5K-10CeO₂; (e): 0.5K-0.5SA-5CeO₂.

The XPS spectra of V, W and Ti of the fresh, 0.5K, 0.5K-0.5SA, 0.5K-10CeO₂ and 0.5K-0.5SA-5CeO₂ catalysts are presented in Fig. 2s. Fig. 2sA shows the W 4f_{5/2}, W 4f_{7/2} and Ti 3p XPS spectra of different samples. The binding energies at 35.7 eV and 37.8 eV are belonged to W 4f_{7/2}, W 4f_{5/2} respectively, while the binding energy at 37.2 eV is assigned to Ti 3p. Fig. 2sB displays the V 2p_{3/2} and V 2p_{1/2} electron for different samples. Because of the O 1s satellite and the V 2p_{3/2} peaks overlap, it is difficult to analysis the catalysts with low vanadia concentration. A binding energy at near 517 eV of V 2p_{3/2} was detected. It is found that there is no change of the binding energy of V 2p_{3/2}, W 4f_{7/2}, W 4f_{5/2} and Ti 3p between the fresh and 0.5K catalyst. Therefore, it can be concluded that the potassium additives had no influence on the V, W and Ti binding energies. And the binding energy of V 2p_{3/2}, W 4f_{7/2}, W 4f_{5/2} and Ti 3p between the fresh and 0.5K-0.5SA-5CeO₂ catalysts were also similar. Comparing the fresh, 0.5K-0.5SA and 0.5K-0.5SA-5CeO₂ catalysts, the intensity of the V 2p_{3/2} band decreased after washed by H₂SO₄ and deionized water. This means that H₂SO₄ and deionized water could remove the active phase when remove the potassium additives,

favorably consistent with previous ICP results, which showed a 1/3 reduction of V after acid washing.