Electronic Supplementary Material (ESI) for Catalysis Science & Technology
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Electronic Supplementary Information (ESI)

Enhanced Catalytic Performance of V_2O_5-WO_3/Fe_2O_3/TiO_2 Microspheres for Selective Catalytic Reduction of NO by NH_3

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1. The morphology of 1V10W3FeTMS catalysts

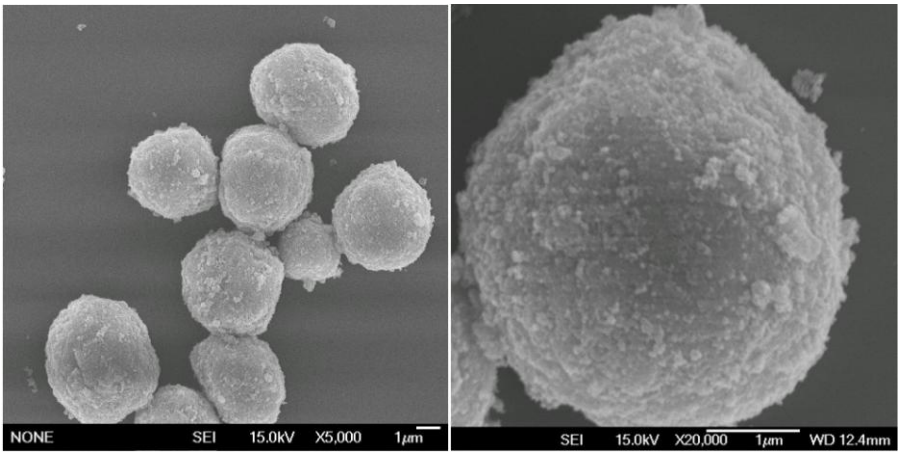

Fig. S1 SEM images of the 1V10W3FeTMS catalyst.

As shown in Fig. S1, after the TMS was impregnated with tungsten and vanadium precursor and calcination at 550 ^oC, they still maintained the spherical shape, and showed the uniform size distribution with the average diameter of 3 μm. This is a characteristic structural feature of the titania microspheres [1, 2].

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2. The NH_3-TPD profiles of 1V10WTMS and 1V10WFeTMS catalysts

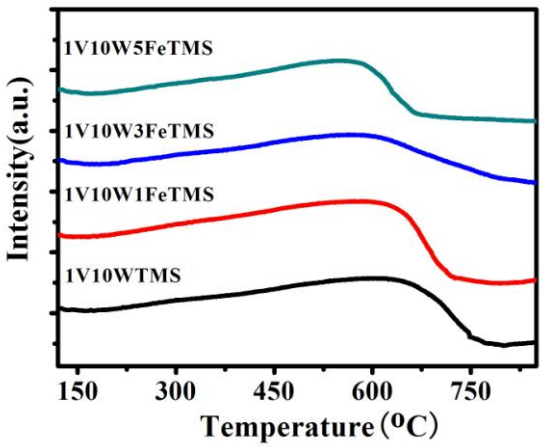

Fig. S2 NH_3-TPD profiles of 1V10WTMS and 1V10WFeTMS catalysts.

The NH_3-TPD results of the different catalysts are showed in Table 1 and discussed in the main text.

3. Effect of the different components

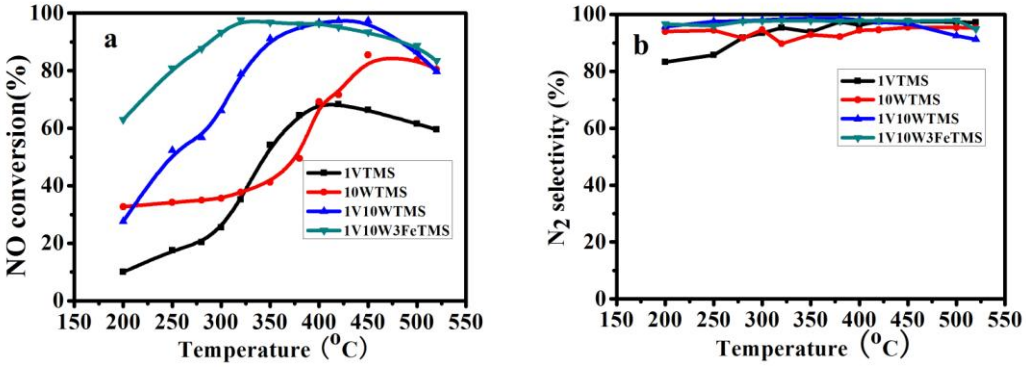

Fig. S3 (a) NO conversion against temperature under SCR condition over different samples (b)N_2 selectivity against temperature under SCR condition over different samples: (B)1VTMS; (D)10WTMS;(F) 1V10WTMS; (H)1V10W3FeTMS.

To know the effect of each element in the ternary VWFeTMS catalyst, the SCR

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activity of monadic and binary catalysts was investigated. The results are provided in Fig. S3. When one or two elements among V, W, and Fe were removed from V1W10Fe3Ti in the catalyst preparation, the NO conversion decreased. Monadic catalyst V1Ti showed higher NO conversion when the temperature is higher than 380 °C, whereas W10Ti showed higher NO conversion with temperature higher than 400°C. Binary catalysts V1W10Ti increased the NO conversion below 300 °C. Ternary VWFeTMS catalyst increases further the NO conversion below 300 °C. These results indicate that Fe, V, and W elements supported on TiO_2 have a positive synergetic interaction and accelerate the SCR reaction.

4. Effect of the supports

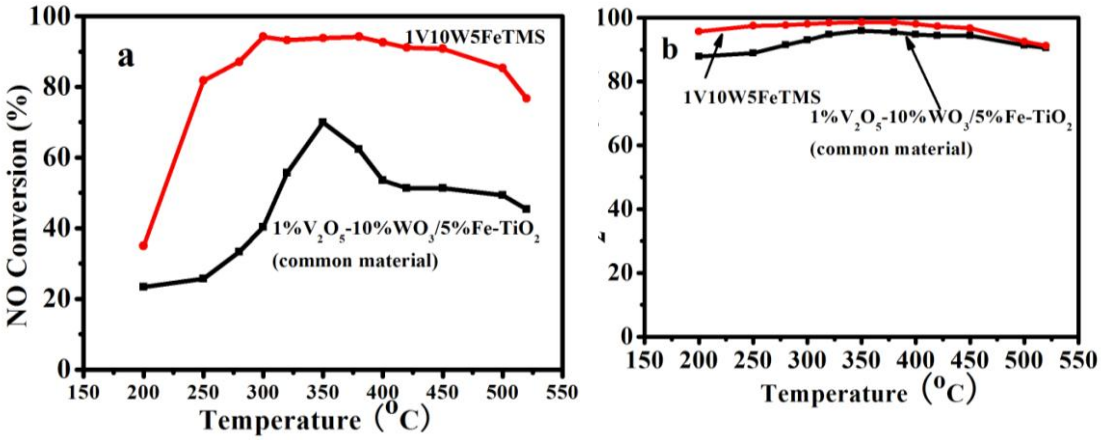

Fig. S4 (a) NO conversion against temperature under SCR condition over different samples (b)N_2 selectivity against temperature under SCR condition over different samples: (B) 1V10W5FeTMS; (D) 1%V_2O_5-10%WO_3/5%Fe-TiO_2 (common material).

The results of SCR over 1V10W5FeTMS, and TiO_2(common material) are shown in Fig. S4. Comparison of 1%V_2O_5-10%WO_3/5%Fe-TiO_2 (common material)

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reveals that the performance of 1V10W5FeTMS is higher than that of 1%V_2O_5-10%WO_3/5%Fe-TiO_2 (common material) . This phenomenon uncovers that the mesoporous spheres and the unique stucture of TiO_2 (microshpere) are more favorable for the title reaction than the TiO_2 (common material) counterpart.

5. Effect of the calcination temperature

Fig. S5 characterizes the effect of calcination temperature on the catalytic behavior of the 1V10W3FeTMS catalyst. The catalyst exhibited its best performance at a calcination temperature of 550℃. Calcination temperatures above or below 550 ◦C led to decreased activity. These results can be explained by the gradual decomposition of the intrinsic structure of the active species on the catalyst at calcination temperatures of 650℃. Thus, 550℃ was chosen as the optimum calcination temperature for the 1V10W3FeTMS catalyst, because the vanadium oxide species, tungsten oxide species and iron oxides species could not be fully activated at lower calcination temperature.

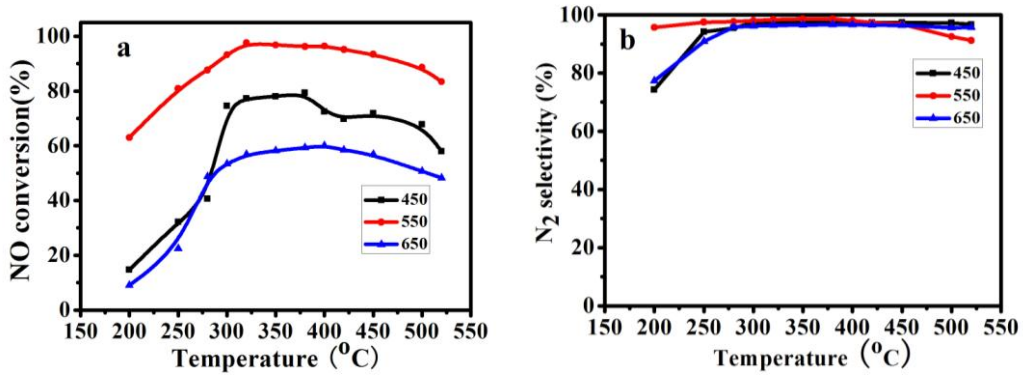

Fig. S5 (a) NO conversion against temperature under SCR condition over different samples (b)N_2 selectivity against temperature under SCR condition over different samples: (B)

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1V10W3FeTMS-450℃; (D) 1V10W3FeTMS-550℃ (D) 1V10W3FeTMS-650℃.

6. The reusability of 1V10W3FeTMS catalyst

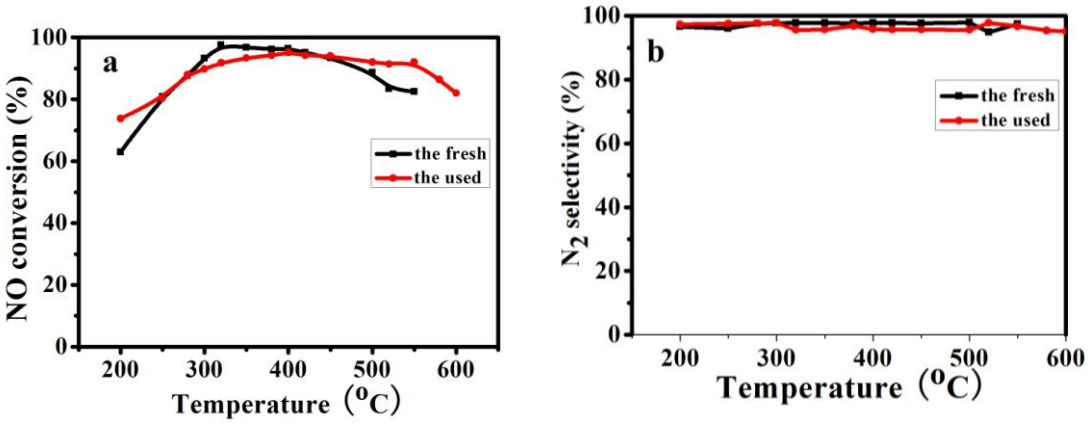

Fig. S6 (a) NO conversion against temperature under SCR condition over the 1V10W3FeTMS and the used catalysts (b)N_2 selectivity against temperature under SCR condition over the 1V10W3FeTMS and the used catalysts.

The reusability of 1V10W3FeTMS is also listed in Fig. S5. The NO conversion and selectivity of N_2 over the 1V10W3FeTMS catalyst still keep above 80% and 92% after the second cycle. This finding clearly indicates that the 1V10W3FeTMS catalyst shows good stability.

7. The conversion of NO to NO_2 over the different catalysts

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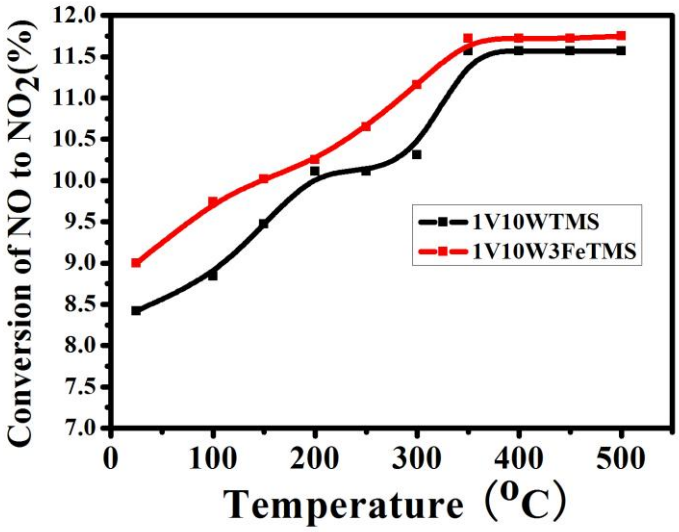

Fig. S7 Oxidation activity of NO to NO_2 by O_2 over the 1V10WTMS and 1V10W3FeTMS catalysts.

The conversion of NO to NO_2 over the different catalysts was measured and listed in **Fig. S7**. It is obvious that the introduction of Fe additive to the catalyst increases the oxidation activity of NO to NO_2. It has been accepted that NO is more readily reduced to N_2 along with portion NO_2 than single NO by NH_3. The introduction of iron oxide increases the oxidation rate of NO to NO_2, which increase the SCR activity.

References

[1] C. W. Guo, Y. Cao, S. H. Xie, W. L. Dai, K.-N. Fan, *Chem. Commun.*, 2003, 700.

[2] X.L. Yang, W.L. Dai, C. Guo, H. Chen, Y. Cao, H. Li, H. He, K. Fan, *J. Catal.*, 2005, **234**, 438.