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

Supporting information

Polyoxometalate catalysts with co-substitution of VO^{2+} and transition metals and their catalytic performance in isobutane oxidation

Yanchun Liu,[a] Jingfang He,[a,b] Wenling Chu,[*a] Weishen Yang,[*a]

Supplementary Figures and Tables

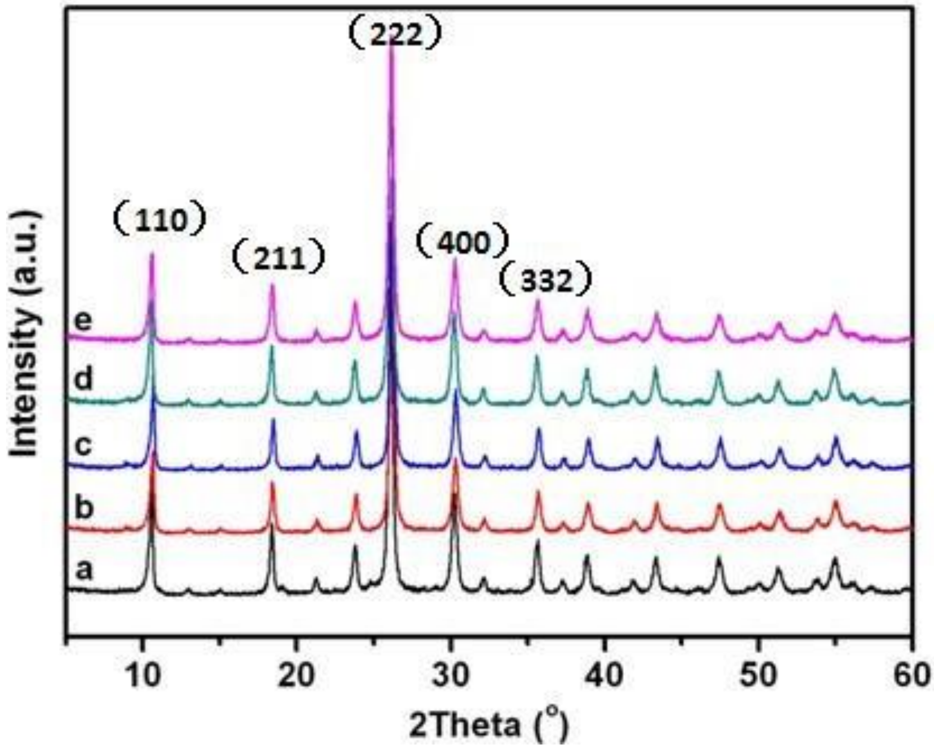

Figure.S1 XRD patterns of V-containing Cs-salt of HPCs with the incorporation of different transition metals. a: $Cs_{2.0}V_{0.3}Cu_{0.2}PMo_{12}O_{40}$; b: $Cs_{2.0}V_{0.2}Fe_{0.2}PMo_{12}O_{40}$; c: $Cs_{2.0}V_{0.2}Ce_{0.2}PMo_{12}O_{40}$; d: $Cs_{2.0}V_{0.3}$Ni0.2$PMo_{12}O_{40}$; e: $Cs_{2.0}Cu_{0.2}PMo_{11}VO_{40}$

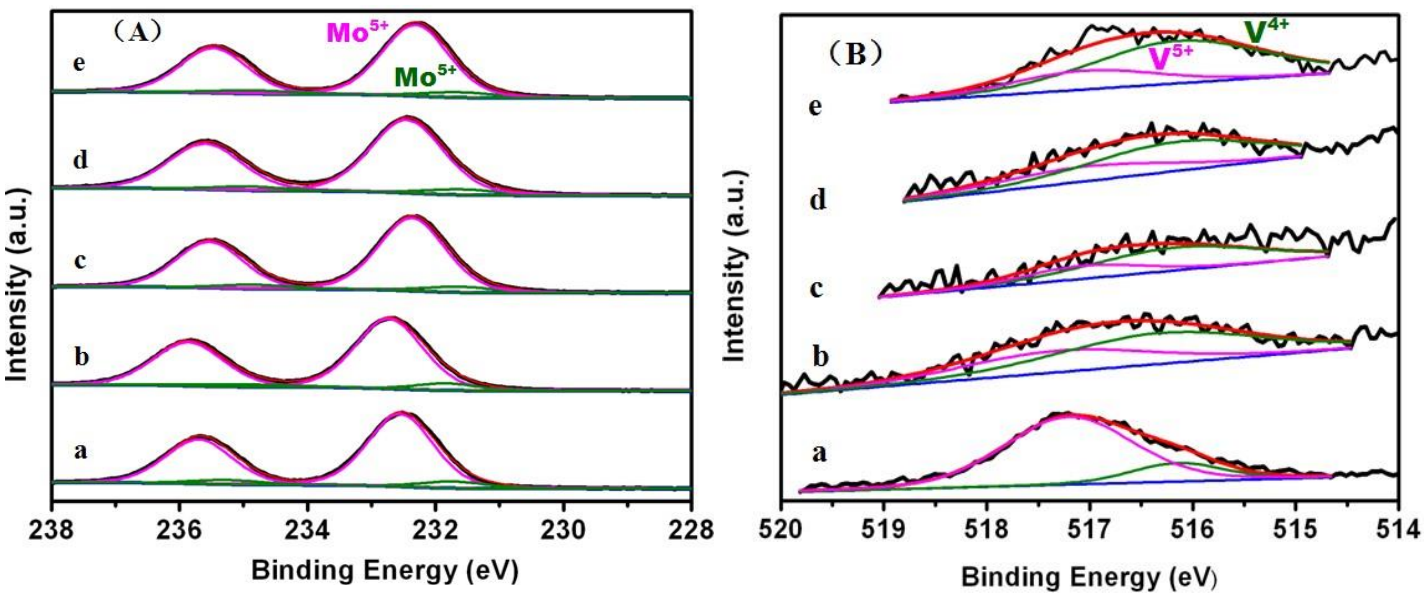

Figure S2 XPS spectra of Mo *3d* (A) and V *2P* (B) for V-containing Cs-salt of HPCs with the incorporation of different transition metals. a: $Cs_{2.0}Cu_{0.2}PMo_{11}VO_{40}$; b: $Cs_{2.0}V_{0.3}Cu_{0.2}PMo_{12}O_{40}$; c: $Cs_{2.0}V_{0.2}Fe_{0.2}PMo_{12}O_{40}$; d: $Cs_{2.0}V_{0.2}Ce_{0.2}PMo_{12}O_{40}$; e: $Cs_{2.0}V_{0.3}$Ni0.2$PMo_{12}O_{40}$

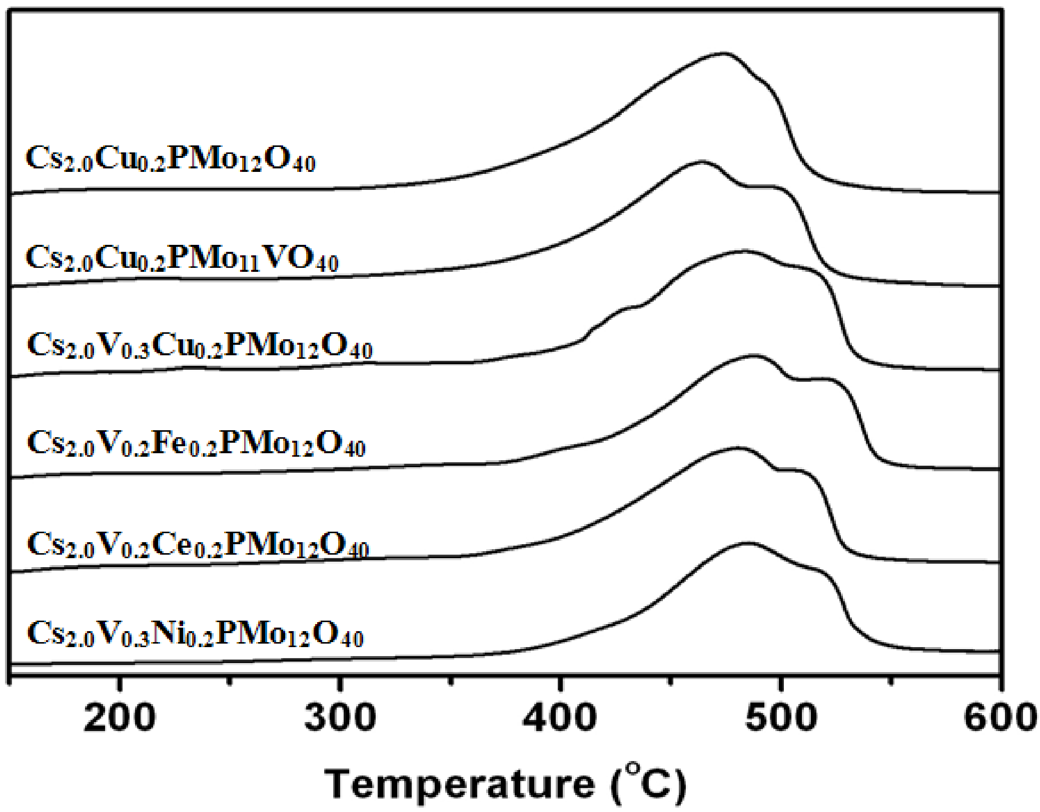

Figure.S3 NH_3-TPD patterns of Cs salt of V-containing HPC with the incorporation of different transition metals.

Table S1 Chemical analysis of the catalysts after calcination at 300°C

Catalysts	Atomic ratio			
	Cs/P	M/P (M=Cu, Fe, Ni, or Ce)	V/P	Mo/P
$Cs_{2.0}V_{0.3}Cu_{0.2}PMo_{12}O_{40}$	2.02	0.21	0.30	11.6
$Cs_{2.0}Cu_{0.2}PMo_{11}VO_4$	2.00	0.24	1.10	11.0
$Cs_{2.0}V_{0.3}Ni_{0.2}PMo_{12}O_4$	1.94	0.22	0.29	11.6
$Cs_{2.0}V_{0.2}Fe_{0.2}PMo_{12}O_4$	1.99	0.24	0.22	12.1
$Cs_{2.0}V_{0.2}Ce_{0.2}PMo_{12}O_4$	1.90	0.23	0.24	12.8

Table S2 Adsorption amount of NH_3 on the surface of Cs salt of V-containing HPC with the incorporation of different transition metals.

Catalysts	Adsorption amount of NH_3 (mmol/g)			Total acidity
	150~350 °C	350~450 °C	450~600 °C	(mmol/g)
$Cs_{2.0}Cu_{0.2}PMo_{12}O_{40}$	0.1094	0.5714	0.7437	1.4245
$Cs_{2.0}V_{0.3}PMo_{12}O_{40}$*	0.0294	0.5732	0.5610	1.1636
$Cs_{2.0}V_{0.3}Cu_{0.2}PMo_{12}O_{40}$	0.1191	0.6248	0.9018	1.6457
$Cs_{2.0}Cu_{0.2}PMo_{11}VO_4$	0.1676	0.5255	0.7240	1.4171
$Cs_{2.0}V_{0.3}Ni_{0.2}PMo_{12}O_4$	0.0565	0.3888	0.9349	1.3802
$Cs_{2.0}V_{0.2}Fe_{0.2}PMo_{12}O_4$	0.1133	0.3417	0.9512	1.4052
$Cs_{2.0}V_{0.2}Ce_{0.2}PMo_{12}O_4$	0.1548	0.4059	0.8314	1.3921

*：From our previous study in Appl. Catal. A. Gen., 2018, 556:104-112