Supporting information

Facile preparation, catalytic performance and reaction mechanism of $Mn_xCo_{1-x}O_\delta$/3DOM-m $Ti_{0.7}Si_{0.2}W_{0.1}O_y$ catalysts for the simultaneous removal of soot and NO_x

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(a: 3DOM-m TiSiWO, b: MnO_δ/3DOM-m TiSiWO, c: $Mn_{0.8}Co_{0.2}O_\delta$/3DOM-m TiSiWO, d: $Mn_{0.6}Co_{0.4}O_\delta$/3DOM-m TiSiWO, e: $Mn_{0.5}Co_{0.5}O_\delta$/3DOM-m TiSiWO, f: $Mn_{0.4}Co_{0.6}O_\delta$/3DOM-m TiSiWO, g: $Mn_{0.2}Co_{0.8}O_\delta$/3DOM-m TiSiWO, h: Co_3O_4/3DOM-m TiSiWO)…….**S13**

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(Reaction conditions: (A) 1000 ppm NO, 1000 ppm NH_3, 5% O_2, 5% H_2O, balance N_2, flow rate = 300 ml min^{-1}; (B) 1000 ppm NO, 1000 ppm NH_3, 5% O_2, 5% H_2O, balance N_2, flow rate = 100 ml min^{-1}…..……**S16**

Table S1 Textural properties of as-prepared catalysts

Catalyst	Surface area($m^2\ g^{-1}$)[a]	Total pore volume($cm^3\ g^{-1}$)[b]	Pore size(nm)[c]
3DOM-m TiSiWO	167.7	0.260	6.3
MnO_δ/3DOM-m TiSiWO	56.2	0.109	7.2
$Mn_{0.8}Co_{0.2}O_\delta$/3DOM-m TiSiWO	57.9	0.118	7.3
$Mn_{0.6}Co_{0.4}O_\delta$/3DOM-m TiSiWO	58.2	0.117	7.3
$Mn_{0.5}Co_{0.5}O_\delta$/3DOM-m TiSiWO	56.5	0.114	7.4
$Mn_{0.4}Co_{0.6}O_\delta$/3DOM-m TiSiWO	59.1	0.134	8.6
$Mn_{0.2}Co_{0.8}O_\delta$/3DOM-m TiSiWO	62.9	0.161	9.8
Co_3O_4/3DOM-m TiSiWO	61.5	0.125	7.9

[a]Calculated by BET method. [b]Calculated by BJH desorption cumulative volume of pores between 1.7 nm and 300 nm diameter. [c]Calculated by BJH desorption average pore diameter.

Table S2. Performance of various catalysts for SCR reaction

Catalyst	Feed composition				GHSV (h^{-1})	TOF(s^{-1}) $\times10^{-3}$	Temperature (^oC)[a]	X_{NO} (%)	Ref.
	NO (ppm)	NH_3 (ppm)	O_2 (vol %)	H_2O (vol %)					
Co-Mn/TiO_2	500	500	5	5	120,000	-	150-200 200[b]	80 92[b]	[1]
17%Mn_7Ce_3-CM	500	550	5	10	20,000	-	125-225 175[b]	80 75[b]	[2]
Mn8/SEP-S	600	600	3		30,000	0.3 (200 ^{o}C)	-	-	[3]
Hierc-$MnFe_{0.6}Co_{0.4}O_x$	500	500	5	5	60,000	0.583 (100 ^{o}C)	110-250 180[b]	90 90[b]	[4]
MnO_2-Co-0.8	500	500	5	5	50000	-	240-280 110[b]	100 75[b]	[5]
α-Mn_2O_3(111)	500	500	5	-	36000	3.5 (510 ^{o}C）	480-620	80	[6]
MnO_x-ZSM-5（150）	500	500	4	-	30000	0.293 (100 ^{o}C)	190-290	100	[7]
Mn/TiSi(3:1)	900+100NO_2	1000	10		80000	-	250	75	[8]
MnO_x/TiO_2(NS)	1000	1100	4	2.5	50000	0.7 (160 ^{o}C）	150[b]	62[b]	[9]
CoMn/ZSM-5	500	500	5	5	50000	-	100-250[b]	80[b]	[10]
$Mn_{0.5}Co_{0.5}O_\delta$/3DOM-m TiSiWO	1000	1000	5	5	20000	0.57 (100 ^{o}C)	216-426	90	This work

a. Temperature or temperature window corresponding to conversion of NO.

b. NO conversion and corresponding temperature window of the catalysts in the presence of water.

Table S3. Performance of various catalysts for soot removal

Catalyst	Feed composition			Flow rate (ml min^{-1})	Catal/ soot	TOF(s^{-1}) $\times 10^{-3}$	T_{10} [a] (^oC)	T_{50} [a] / T_m [b] (^oC)	T_{90} [a] (^oC)	Ref
	NO (ppm)	O_2 (vol%)	H_2O (vol%)							
$Mn_xCe_{1-x}O_\delta/SiO_2$	2000	10	10	50	10		-	350	-	[11]
α-Mn_2O_3	2500	5	10	80	10		-	420	-	[12]
α-MnO_2-Co_3O_4/ AISI304	500	6	10	100	2.5		302	354	395	[13]
Ce_1MnO_x	2000	10	10	50	10	0.89 (250 ^{o}C)	272	329	362	[14]
K-OMS-2-M2	2000	10	10	50	10	0.91 (253 ^{o}C)	266	332	428	[15]
Ag/$SmMn_2O_5$	500	10	5	500	10		350			[16]
$Mn_{0.5}Co_{0.5}O_\delta$/3DOM-m TiSiWO	1000	5	5	100	10	1.47 (350 ^{o}C)		448		This work

a. T_{10}, T_{50} and T_{90} represented temperatures for soot conversion at 10%, 50% and 90%, respectively.

b. T_m represented the temperature of the maximum CO_2 concentration.

Table S4. Performance of various catalysts for or simultaneous removal of soot and NO_x

Catalyst	Feed composition				Flow rate (ml min^{-1})	Catal /soot	T(^oC)[a]	X_{NO} (%)	T_m (%)	Ref.
	NO (ppm)	NH_3 (ppm)	O_2 (vol%)	H_2O (vol%)						
$La_{0.7}Ag_{0.3}MnO_3$ -MW	2000	-	10	-	100	9/1	325	60	400	[17]
4CoAlO-800	2500	-	5	-	80	20/1	318[c]	3.5[c]	290 (T_i)[b]	[18]
$Co_{2.5}Mg_{0.5}Al_{0.92}Ce_{0.08}$	600		20 10		150	20/1	160	15.4	449	[19]
$Ce_{0.8}Mn_{0.1}Zr_{0.1}O_2$	1000	1000	3	-	100	10/1	374–512	100	402	[20]
Fe_1–Mn_3–O_x	1000	1000	3	-	50	10/1	302–485	80	487	[21]
$(La_{1.7}Rb_{0.3}CuO_4)20$ /nmCeO_2	2000	-	5	-	50	5/1	401[c]	26.8[c]	401	[22]
$La_{1-x}K_xMnO_3$	1000	-	0.5	-	70	10/1	300	53	270	[23]
$Mn_{0.5}Co_{0.5}O_\delta$/3DOM-m TiSiWO	1000	1000	5	5	100	10/1	216-426	97	470	This work

a. Temperature or temperature window corresponding to conversion of NO.

b. T_i and T_m represented initial combustion temperature and the temperature of the maximum CO_2 concentration.

c. N_2 formation of related catalyst and corresponding to temperature.

Table S5 The reaction rate (r) for NH_3-SCR/soot combustion and the amount of active oxygen species (O_{amount}) for soot combustion

Catalyst	$r_{NO}\times10^{-5}$ (mol $g^{-1}s^{-1}$)	$r_{soot}\times10^{-8}$ (mol $g^{-1}s^{-1}$)	$O_{amount}\times10^{-5}$ (mol g^{-1})
MnO_δ/3DOM-m TiSiWO	0.71 (100 ℃)	5.35	4.86
	1.60 (125 ℃)		
	2.59 (150 ℃)		
$Mn_{0.5}Co_{0.5}O_\delta$/3DOM-m TiSiWO	1.08 (100 ℃)	4.45	3.02
	2.14 (125 ℃)		
	3.13 (150 ℃)		
Co_3O_4/3DOM-m TiSiWO	0.76 (100 ℃)	3.75	3.01
	1.75 (125 ℃)		
	2.75 (150 ℃)		

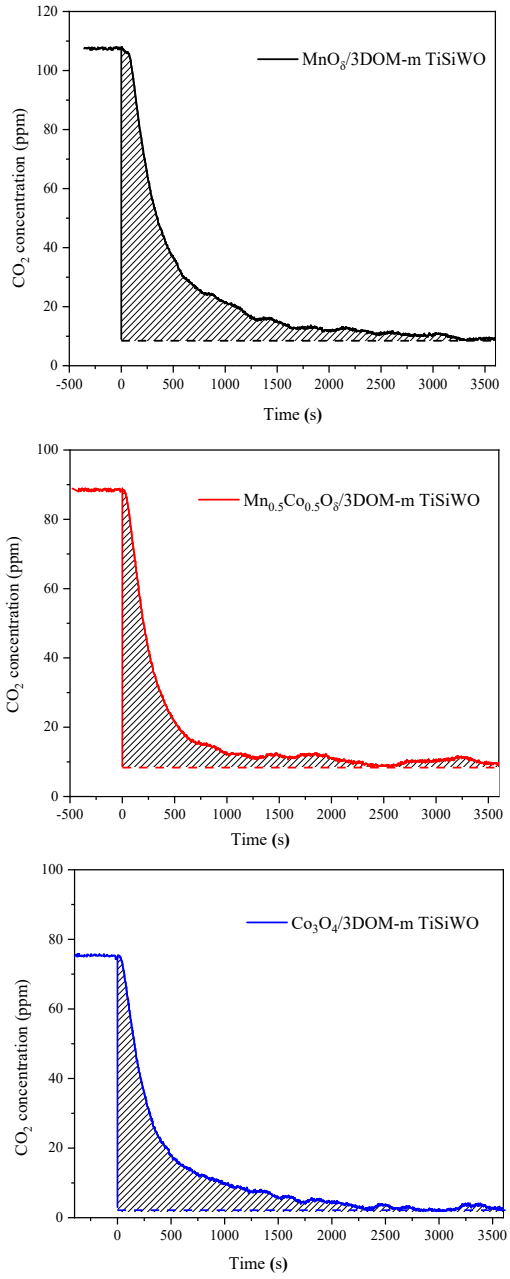


Fig. S1 CO_2 concentrations at 350 ℃ as a function of time over catalysts before and after O_2 is removed from the reactant feed.
(Reaction conditions: 1000 ppm NO, 1000 ppm NH_3, 5% O_2, 5% H_2O, balance N_2, flow rate = 150 ml min^{-1})

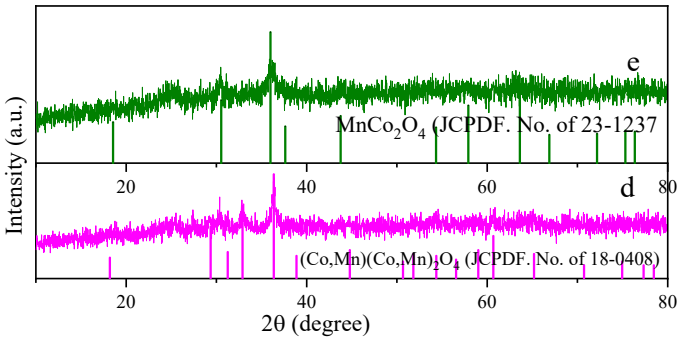
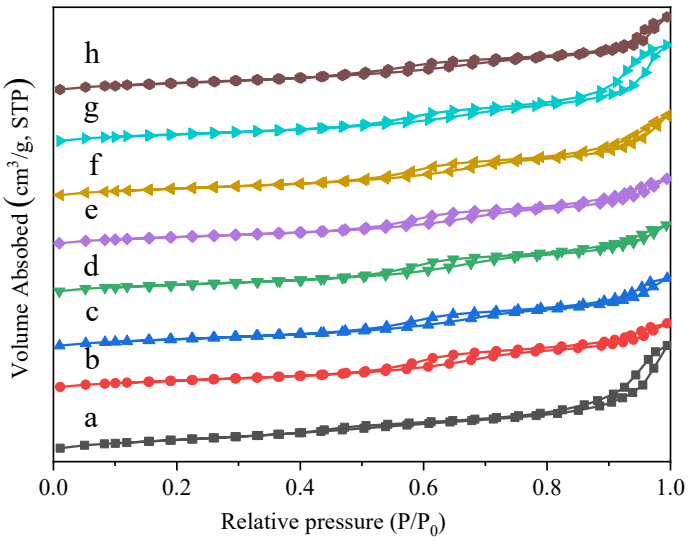


Fig. S2. X-ray diffraction patterns of $Mn_xCo_{1-x}O_\delta$/3DOM-m TiSiWO catalysts with different x values. (d: $Mn_{0.6}Co_{0.4}O_\delta$/3DOM-m TiSiWO, e: $Mn_{0.5}Co_{0.5}O_\delta$/3DOM-m TiSiWO)



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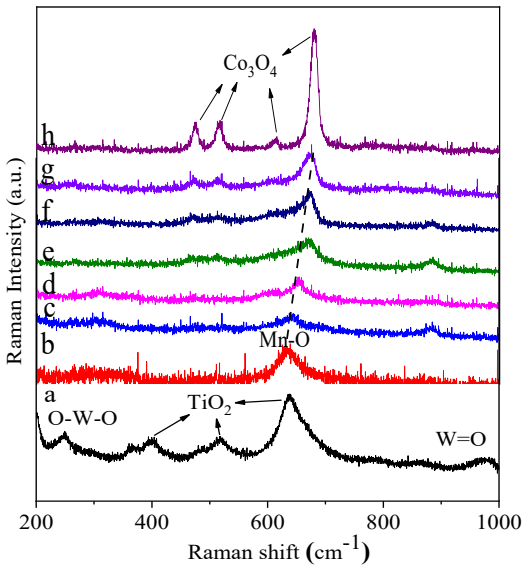
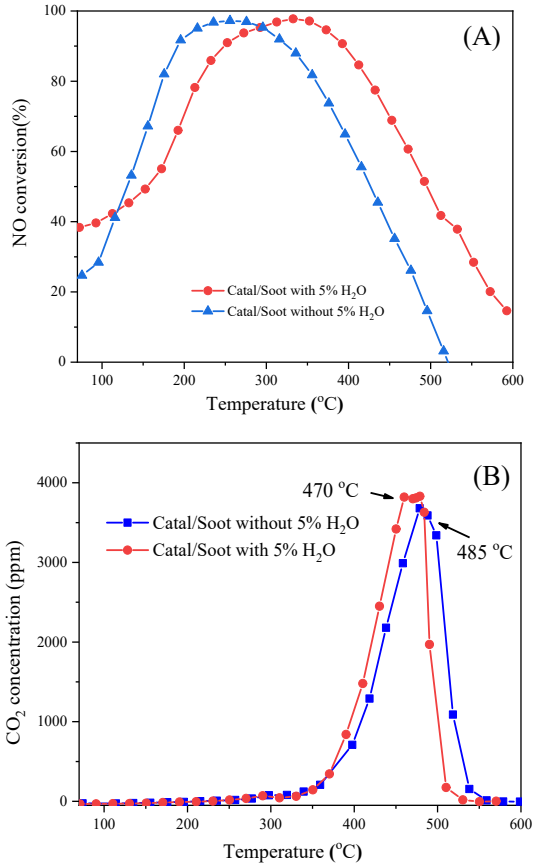


Fig. S4. Raman spectra of $Mn_xCo_{1-x}O_\delta$/3DOM-m TiSiWO catalysts with different x values (a: 3DOM-m TiSiWO, b: MnO_δ/3DOM-m TiSiWO, c: $Mn_{0.8}Co_{0.2}O_\delta$/3DOM-m TiSiWO, d: $Mn_{0.6}Co_{0.4}O_\delta$/3DOM-m TiSiWO, e: $Mn_{0.5}Co_{0.5}O_\delta$/3DOM-m TiSiWO, f: $Mn_{0.4}Co_{0.6}O_\delta$/3DOM-m TiSiWO, g: $Mn_{0.2}Co_{0.8}O_\delta$/3DOM-m TiSiWO, h: Co_3O_4/3DOM-m TiSiWO)



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(Reaction conditions: 1000 ppm NO, 1000 ppm NH_3, 5% O_2, 5% H_2O, balance N_2.)

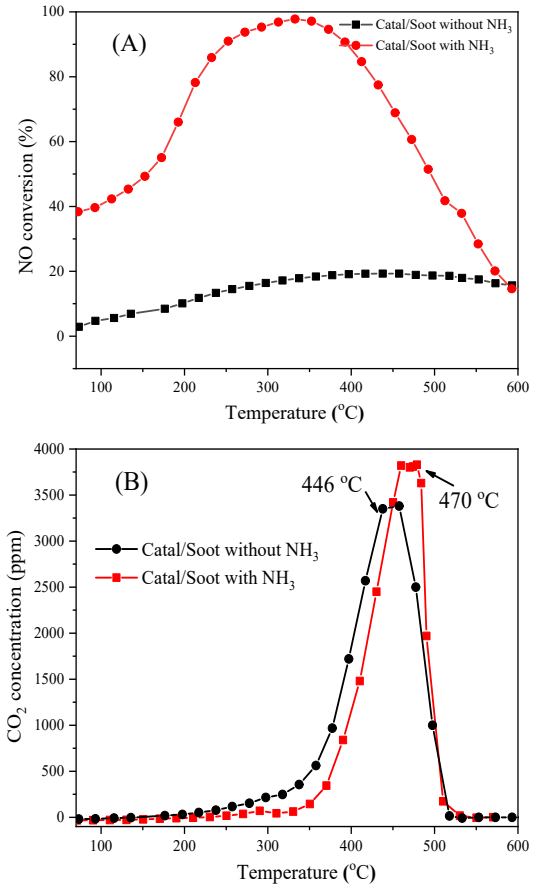

Fig. S6. (A) NO conversion and (B) CO_2 concentration of $Mn_{0.5}Co_{0.5}O_{\delta}$/3DOM-m TiSiWO catalyst in the presence or absence of NH_3.
(Reaction conditions: 1000 ppm NO, 1000 ppm NH_3, 5% O_2, 5% H_2O, balance N_2.)

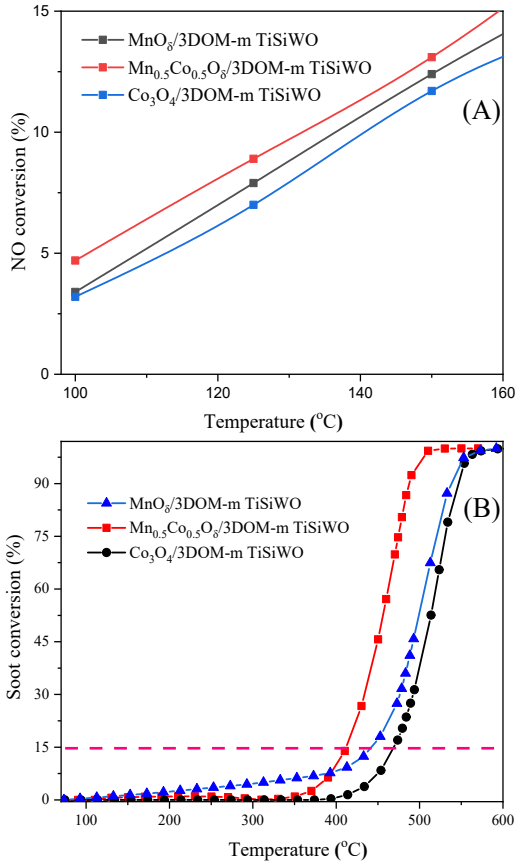

Fig. S7. (A) NO conversion and (B) Soot conversion of the catalysts (Reaction conditions: (A) 1000 ppm NO, 1000 ppm NH_3, 5% O_2, 5% H_2O, balance N_2, flow rate = 300 ml min^{-1}; (B) 1000 ppm NO, 1000 ppm NH_3, 5% O_2, 5% H_2O, balance N_2, flow rate = 100 ml min^{-1};)

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