Electronic Supporting Information

Bi-template assisted synthesis of mesoporous manganese oxide nanostructures: Tuning properties for efficient CO oxidation

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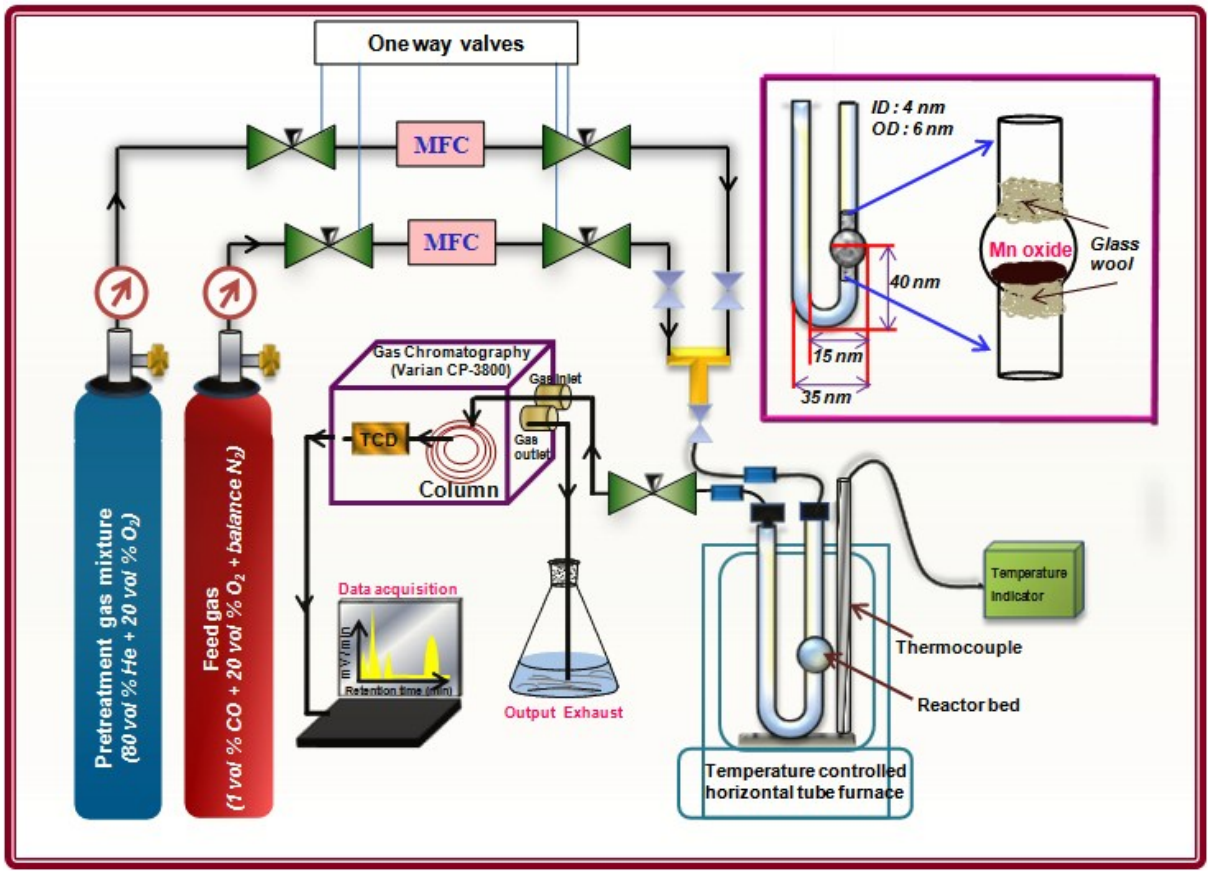

Figure S1: Schematic diagram of the experimental set-up for oxidative conversion of carbon monoxide.

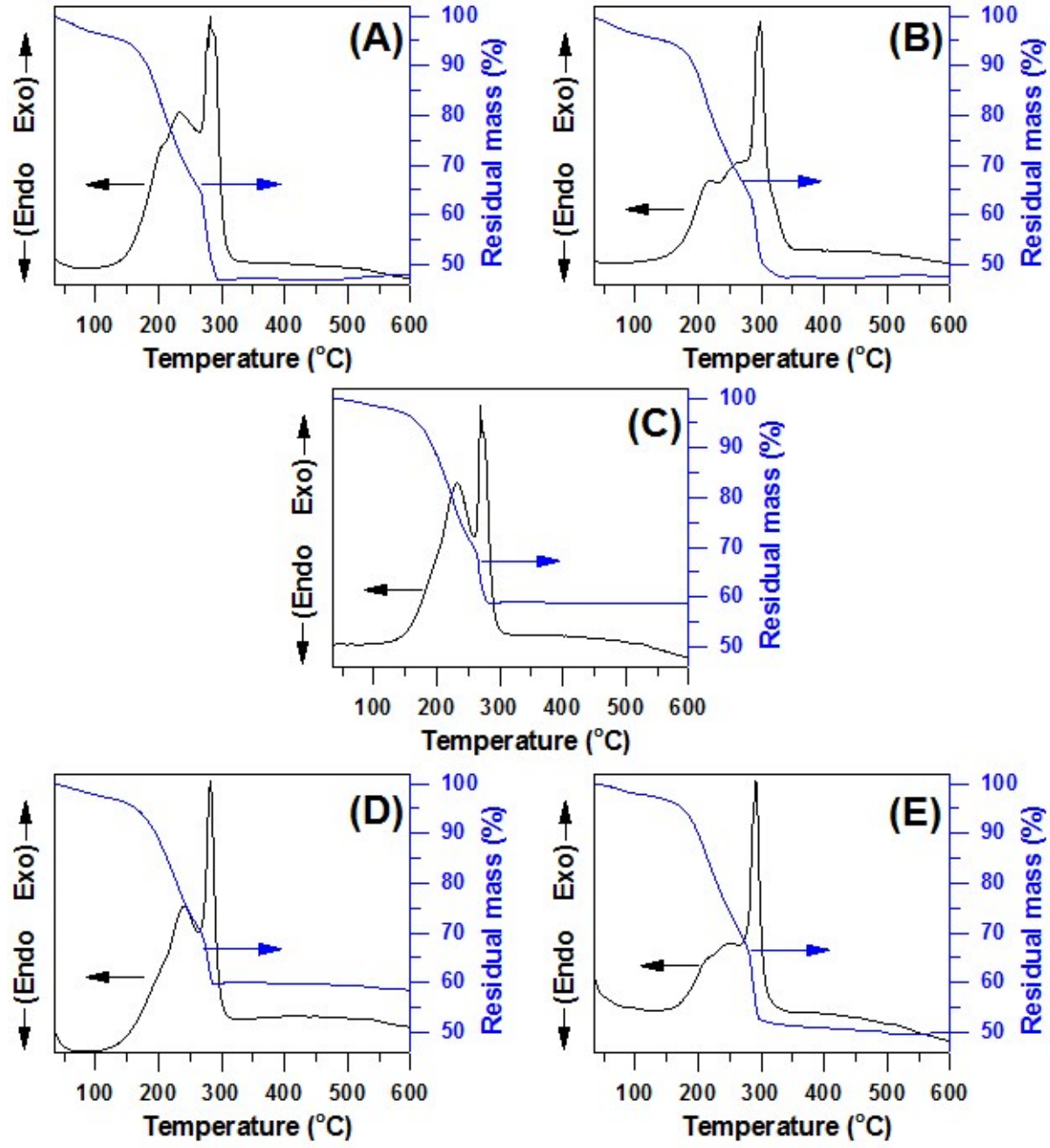

Figure S2: DTA-TG of Mn oxide samples before thermal treatment: (A) S-2@20, (B) S-2@80, (C) S-2@40, (D) S-10@40 and (E) S-20@40.

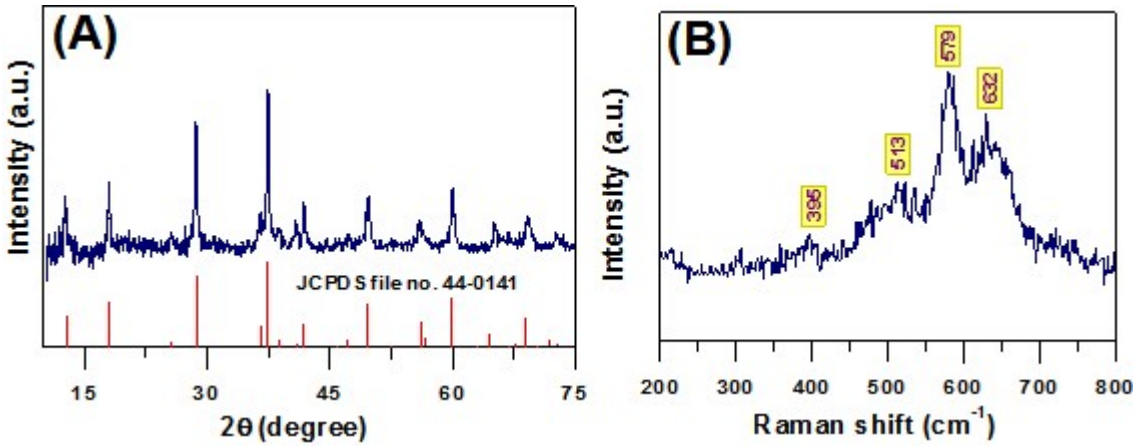

Figure S3: (A) XRD and (B) Raman spectra of Mn oxide prepared without benzaldehyde (S-2@0).

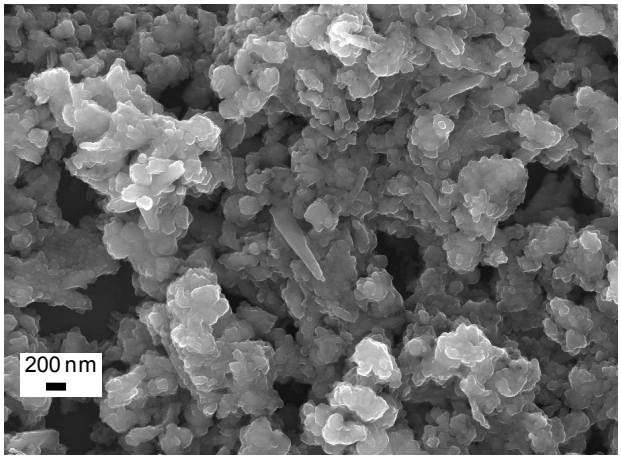

Figure S4: FESEM image of Mn oxide prepared without benzaldehyde (S-2@0).

Table S1: The phase identified by XRD and Raman spectroscopy, and AOS determined by XPS analysis of different Mn oxides.

Sample ID	Phase identified by XRD and Raman spectroscopy	ΔE_s	Average oxidation state (AOS)[a] of Mn in oxides samples
S-2@20	Mn_5O_8	5.20	3.1
S-2@80	Mn_5O_8 + MnO_2	5.30	3.0
S-2@40	Mn_5O_8	5.23	3.1
S-10@40	Mn_5O_8 + MnO_2	5.38	2.9
S-20@40	MnO_2	4.70	3.7

[a] AOS = 8.956 - 1.126ΔE_s, where ΔE_s = binding energy obtained from doublet separation of Mn3s

Table S2: The textural property of prepared Mn oxide samples

Sample ID	S_{BET} (m^2g^{-1})	$V_{p\text{-}Total}$ (cm^3g^{-1})	D [a] (nm)
S-2@20	65	0.55	34.2
S-2@80	28	0.10	15.5
S-2@40	48	0.24	19.8
S-10@40	32	0.13	16.6
S-20@40	61	0.22	14.2

[a] Average pore diameter

Table S3: The temperatures corresponding to CO oxidations with the prepared Mn oxide catalysts

Catalyst ID	**Temperature for CO conversion**			
	$\mathbf{T_{10\%}}$	$\mathbf{T_{50\%}}$	$\mathbf{T_{90\%}}$	$\mathbf{T_{100\%}}$
S-2@20	117	183	227	232
S-2@80	152	220	287	298
S-2@40	211	265	332	350
S-10@40	157	221	279	284
S-20@40	168	237	320	340

Table S4: Data of research papers regarding activation energy required for CO oxidation over Mn oxide catalysts

Type of oxide	Conditions	T_z °C	E_a (kJ/mol)	Ref. no.
Mn_2O_3	1% CO, 18% O_2; GHSV=10,000 h^{-1}	T_{50} = 423	46.05	1
α-MnO_2	1% CO, 16% O_2; D_{total} =100 $mlmin^{-1}$; m=150 mg	T_{90} = 399	–	2
δ-MnO_2	5% CO, 21% O_2; D_{total} =21 mL min^{-1}; m = 1 g	T_{45} = 353	20.93	3
3DOM Mn_2O_3	1% CO, 20% O_2; GHSV=20,000 h^{-1}; m=500 mg	T_{90} = 180	80	4
α-Mn_2O_3	1% CO, 20% O_2; D_{total} = 50 mL min^{-1}; m = 50 mg	T_{50} = 407	37	5
MnO_x	2% CO, 2% O_2; D_{total} = 50 $mlmin^{-1}$; m=20 mg	T_{90} = 410	17	6
Non-stoichiometric Mix phase (Mn_5O_8+MnO_2)	1% CO, 20% O_2; D_{total} = 40 $mlmin^{-1}$; m=50 mg	T_{90} = 279	17	Present work

References:

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