

Enhanced CO oxidation with cobalt-impregnated porous single crystal manganese oxides

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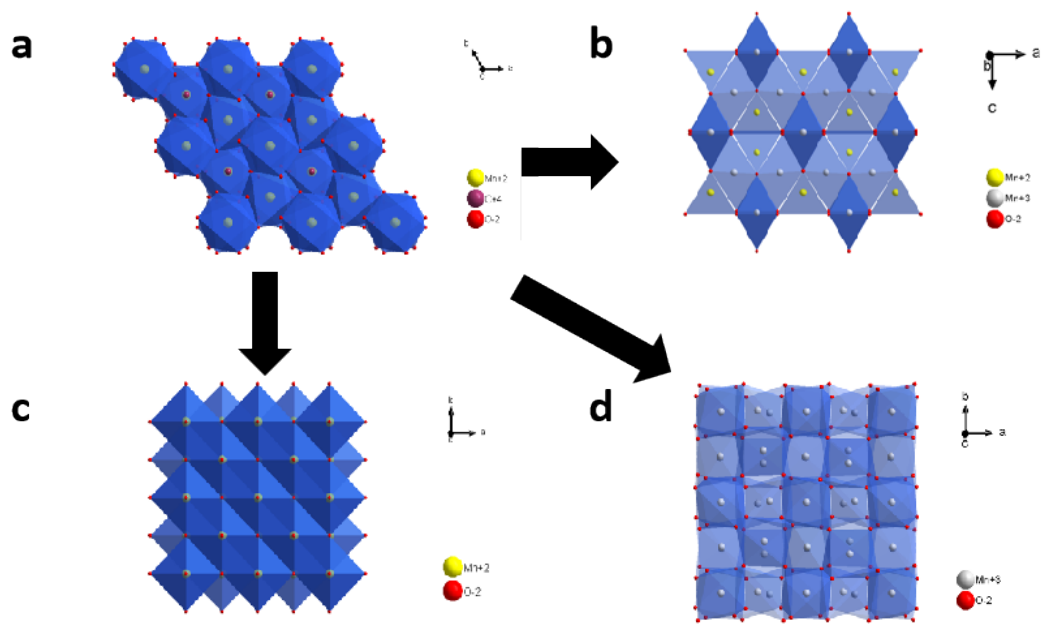


Fig. S1 Crystal structure simulation diagram (a) MnCO₃, (b) Mn₃O₄, (c) MnO, (d) Mn₂O₃

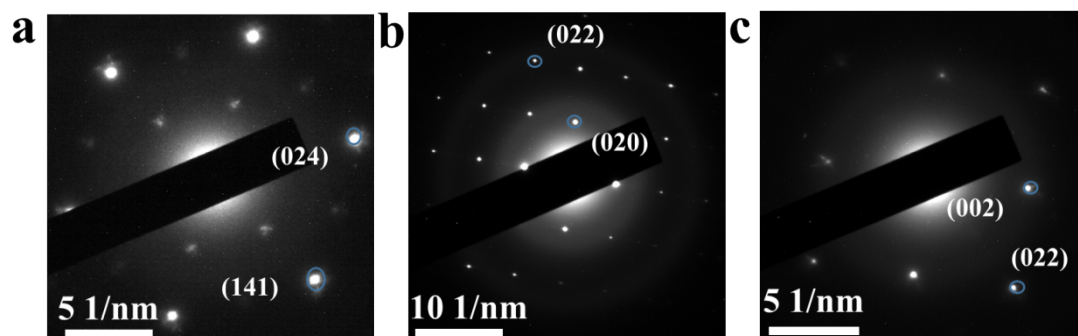


Fig. S2 SAED patterns of (a) Co-Mn₂O₃, (b) Co-Mn₃O₄, (c) Co-MnO. (The loading amount of Co: Co-Mn₂O₃, 6% ; Co-Mn₃O₄, 6% ; Co-MnO, 6%)

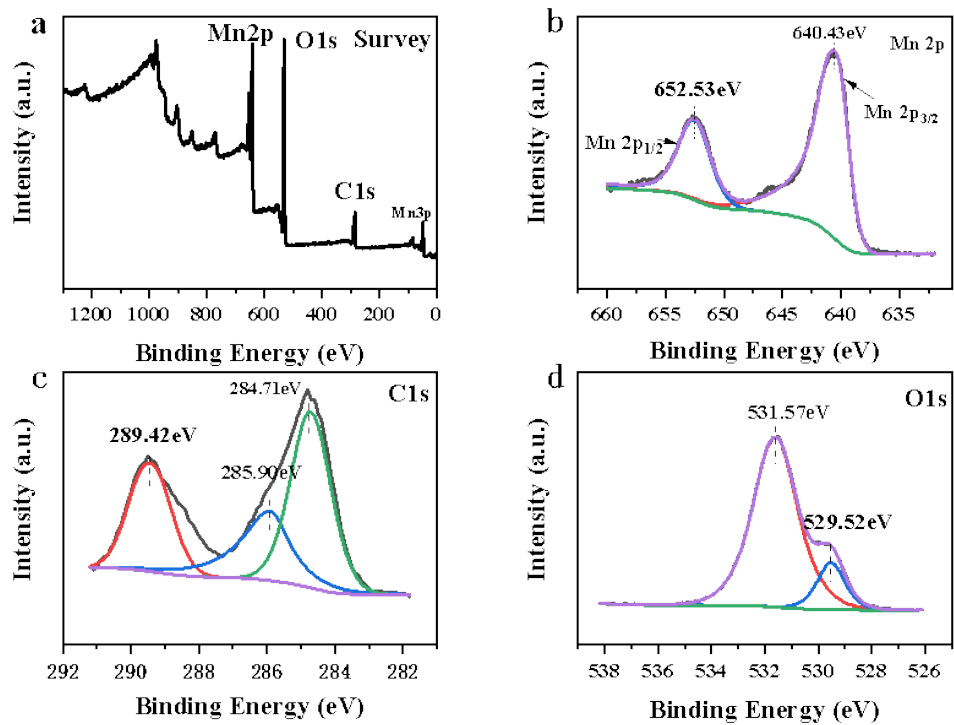


Fig. S3 MnCO₃ XPS photoelectron spectroscopy (a) the integral XPS spectrum of MnCO₃ (b) Mn 2p (c) C 1s (d) O 1s

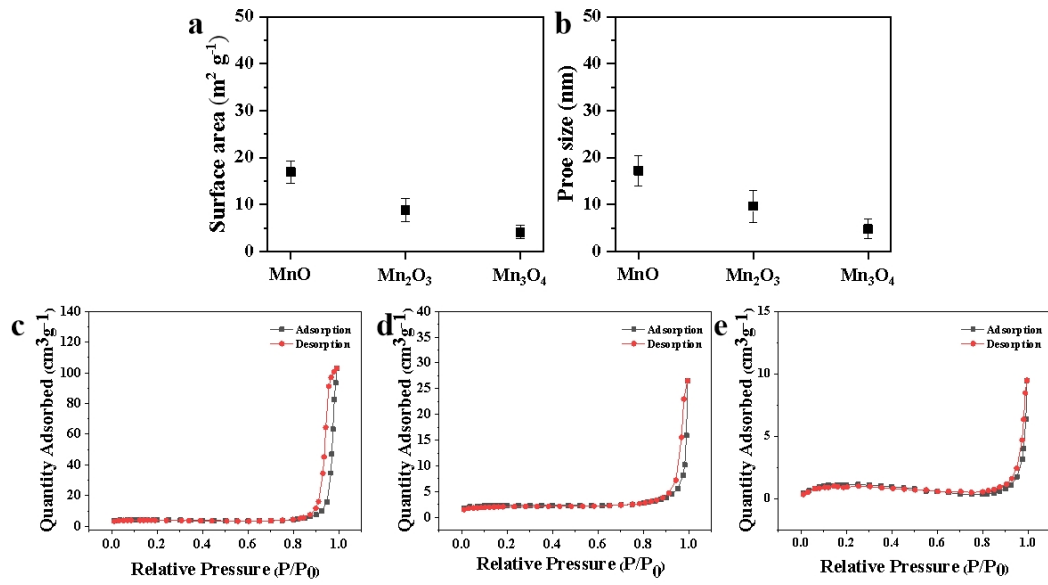


Fig. S4. (a, b) The surface specific area and BJH average pore size of MnO and Mn₂O₃ and Mn₃O₄ ; (c,d,e) N₂ adsorption-desorption isotherms (c) MnO, (d) Mn₂O₃, (e) Mn₃O₄

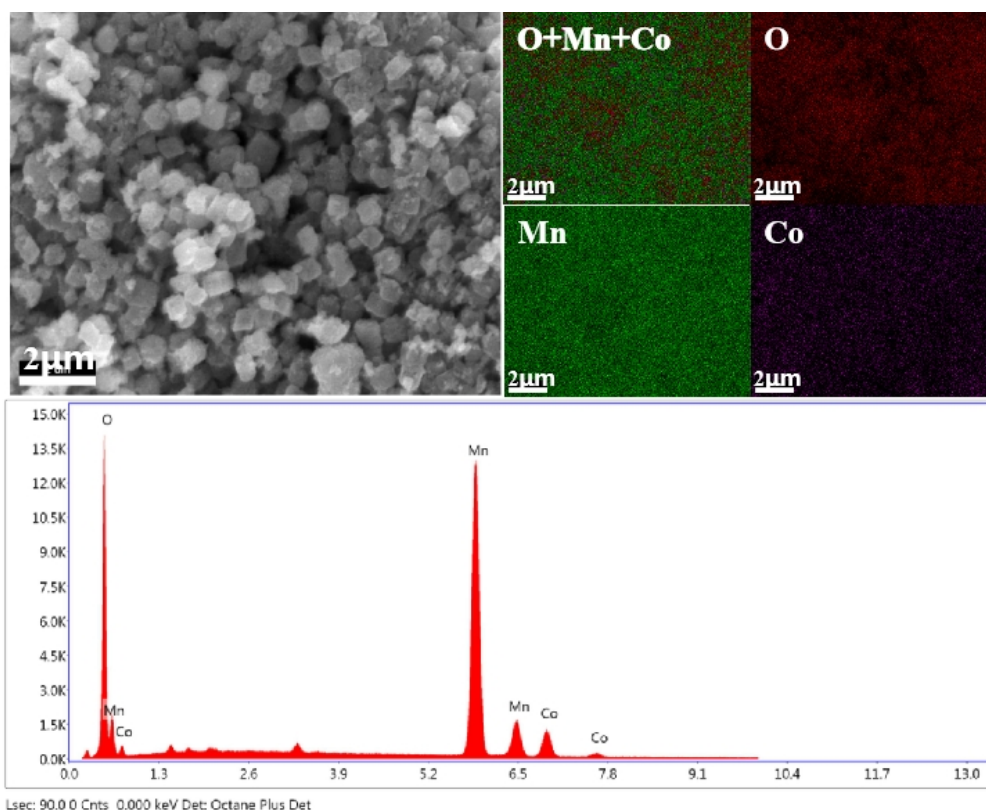


Fig. S5 EDS mapping images of Co-Mn₂O₃ and the element analysis of Co-Mn₂O₃. (The loading amount of Co: Co-Mn₂O₃, 6%)

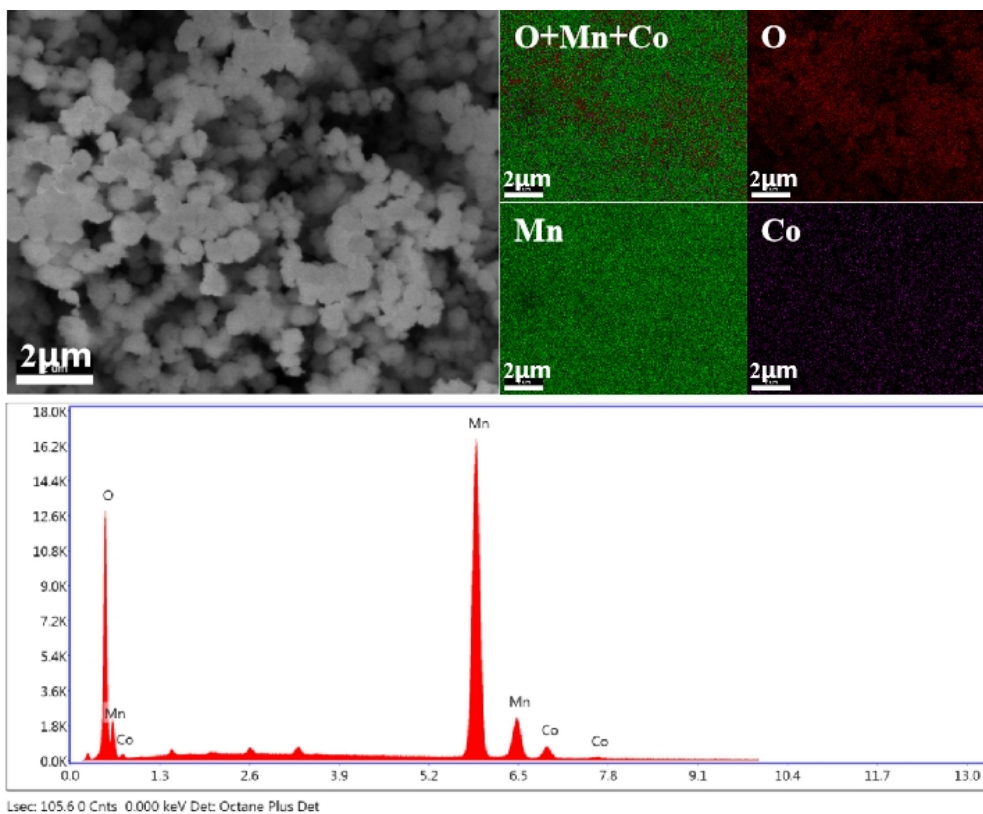


Fig. S6 EDS mapping images of Co-Mn₃O₄ and the element analysis of Co-Mn₃O₄. (The loading amount of Co: Co-Mn₃O₄, 6%)

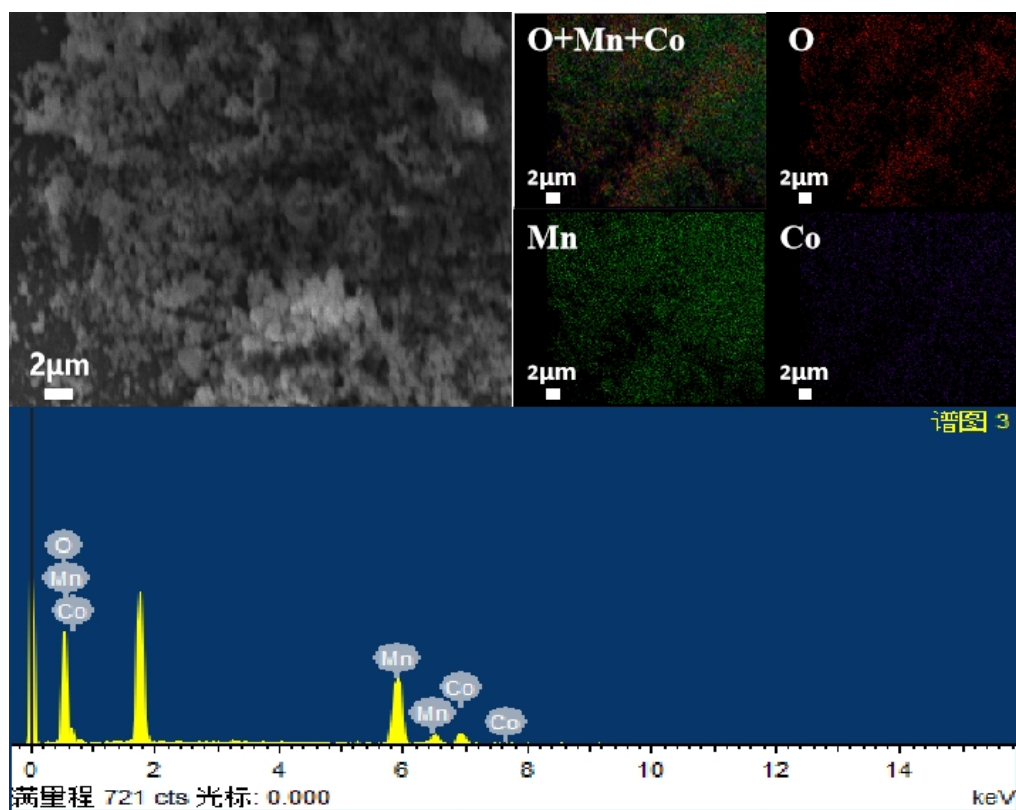


Fig. S7 EDS mapping images of Co-MnO and the element analysis of Co-MnO. (The loading amount of Co: Co-MnO, 6%)

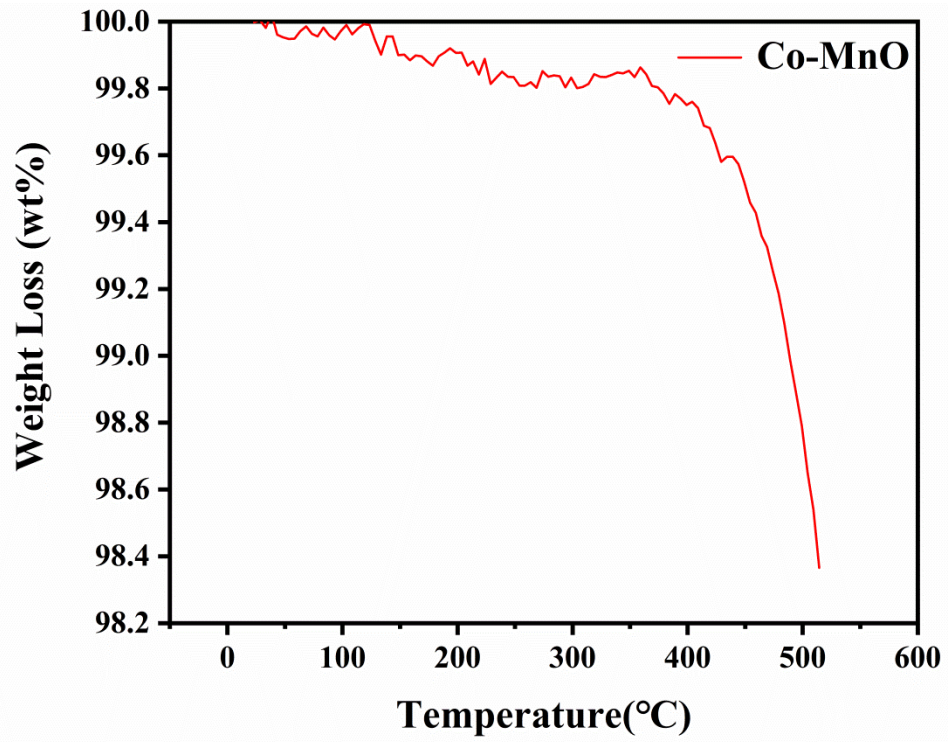


Fig. S8 TGA results of Co-MnO (after inactivation) in N₂ atmosphere. (The loading amount of Co: Co-MnO, 6%)

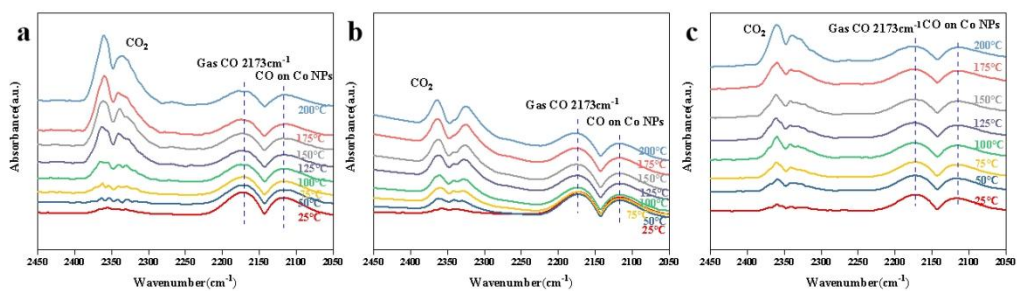


Fig. S9 (a-c) *In situ* FT-IR of CO oxidation with oxygen using Co-doped manganese oxides. (a) Co-Mn₂O₃ (b) Co-Mn₃O₄ (c) Co-MnO (The loading amount of Co: Co-Mn₂O₃, 6% ; Co-Mn₃O₄, 6% ; Co-MnO, 6%)

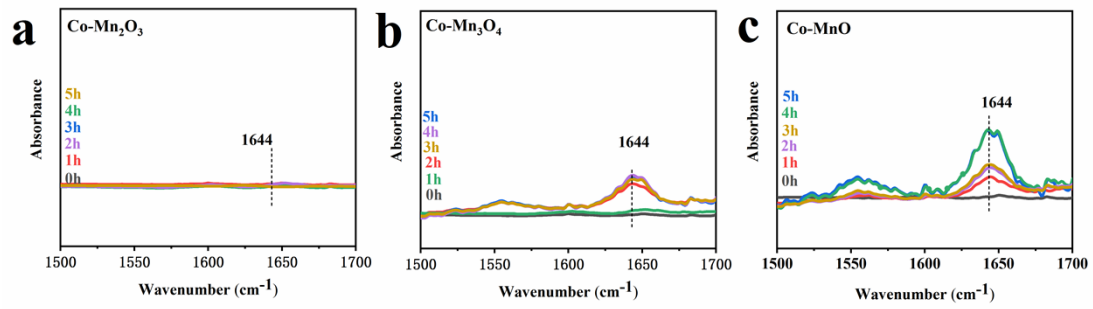


Fig. S10 (a-c) *In situ* FT-IR of CO oxidation of Co-doped manganese oxides at 200 ° C for 5 hours. (a) Co-Mn₂O₃ (b) Co-Mn₃O₄ (c) Co-MnO (The loading amount of Co: Co-Mn₂O₃, 6%; Co-Mn₃O₄, 6%; Co-MnO, 6%)

Table. S1 The proportions of Mn and Co in various valence states and O species before and after reduction. (The loading amount of Co: Co-Mn₂O₃, 6% ; Co-Mn₃O₄, 6% ; Co-MnO, 6%)

	Mn ²⁺	Mn ³⁺	Co ²⁺	Co ³⁺	Before Reduction		After Reduction	
					O _{latt} /(O _{latt} +O _a ds)	O _{ads} /(O _{latt} +O _a ds)	O _{latt} /(O _{latt} +O _a ds)	O _{ads} /(O _{latt} +O _a ds)
Co-Mn ₂ O ₃		100%	30.34%	69.65%	59.52%	40.47%	51.52%	48.47%
Co-Mn ₃ O ₄	37.58%	62.41%	39.82%	60.17%	59.34%	40.66%	57.54%	42.45%
Co-MnO	100%		100%		52.16%	47.84%	41.17%	58.82%

Table. S2 Comparison of CO oxidation performance of different manganese oxides

Catalyst	Load content	Reaction gas	Flow Rate	Amount of catalyst used	Reaction temperature	Reference
MnO ₂	CuO	0.5% CO, 99.5% Air	500 ml/min	1g	T90=180°C	[1]
Cu-Mn mixed oxides		CO 0.5%-O ₂ 0.25%	100 ml/min	50 mg	T90=420°C	[2]
MnO ₂		1% CO 20% O ₂ in Ar	50 ml/min	50 mg	T50=135°C	[3]
MnO _x	ZrO ₂	2.5% CO + 2.5% O ₂ + He	200 ml/min	100 mg	T90=300°C	[4]
OMS-2	Co ₃ O ₄	1% CO, 10% O ₂ ,	100 ml/min	250 mg	T50=165°C	[5]
Mn ₃ O ₄	Cu	1% CO, 1% O ₂ and 98% N ₂	100 ml/min	100 mg	T90=225°C	[6]
γ-MnO ₂		1% CO, 10% O ₂	20 ml/min	160 mg	T90=220°C	[7]
MnO _x		1% CO 21%O ₂	50ml/min	100 mg	T90=180°C	[8]
Mn ₂ O ₃	Co ₃ O ₄	1% CO 21%O ₂	50ml/min	50mg	T90=170°C	This work
Mn ₃ O ₄	Co ₃ O ₄	1% CO 21%O ₂	50ml/min	50mg	T90=180°C	This work
MnO	CoO	1% CO 21%O ₂	50ml/min	50mg	T90=220°C	This work

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