

# Synthesis of MnOOH and its application in supporting hexagonal Pd/C catalyst for oxygen reduction reaction

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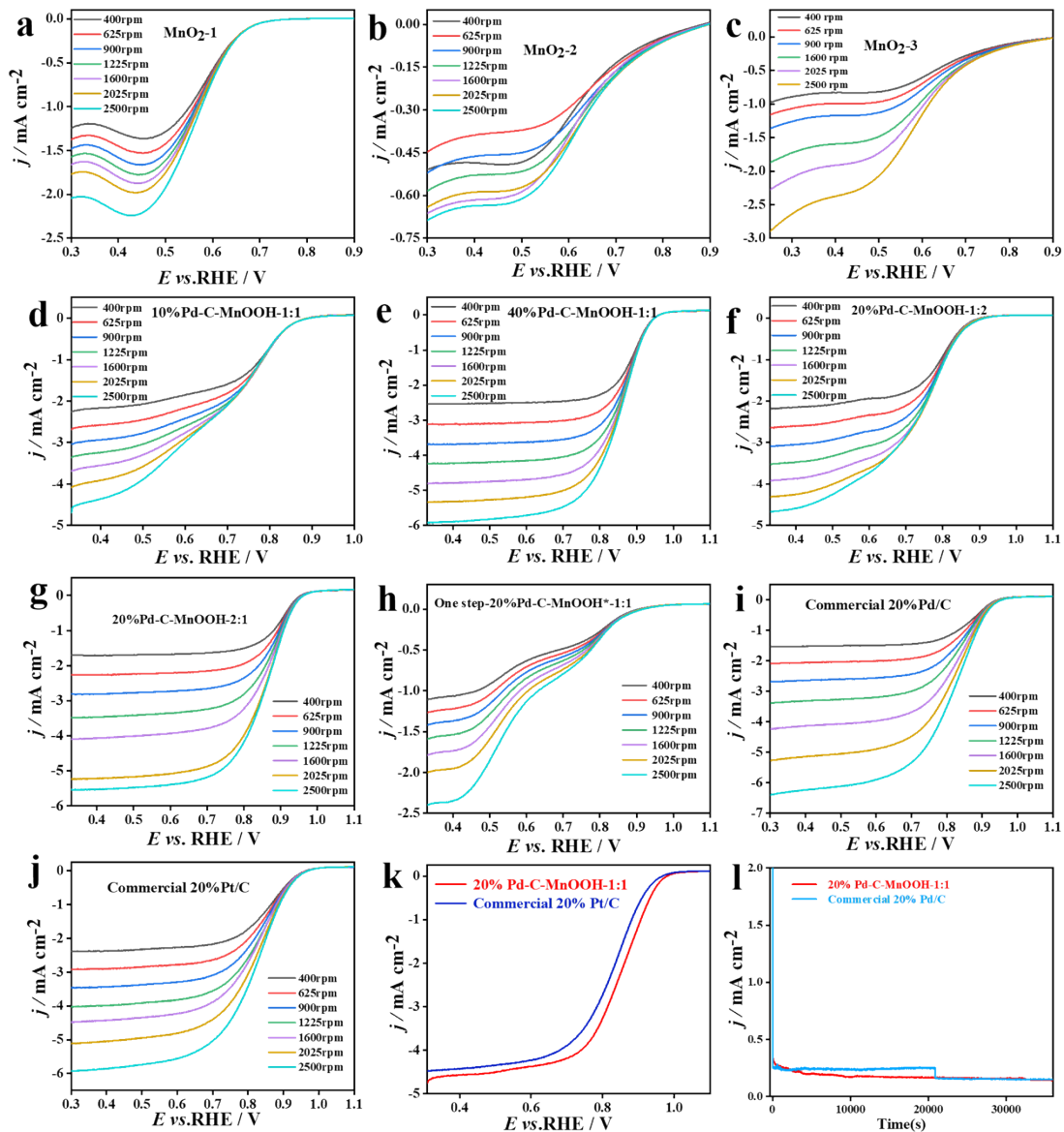


Fig. S1. LSV curves of (a)  $\text{MnO}_2\text{-1}$ , (b)  $\text{MnO}_2\text{-2}$ , (c)  $\text{MnO}_2\text{-3}$ , (d) 10%Pd-C-MnOOH-1:1, (e) 40%Pd-C-MnOOH-1:1, (f) 20%Pd-C-MnOOH-1:2, (g) 20%Pd-C-MnOOH-2:1, (h) 20%Pd-C-MnOOH\*-1:1, (i) commercial Pd/C catalysts and (j) commercial Pt/C catalysts with different speed in an oxygen-saturated 1.0 M KOH solution, (k) 20%Pd-C-MnOOH-1:1 and commercial Pt/C catalysts at 1600 rpm in an oxygen-saturated 1.0 M KOH solution, (l) The *i-t* images of 20%Pd-C-MnOOH-1:1 and Pd/C were tested under saturated oxygen atmosphere in 0.1M KOH solution for 10 hours.

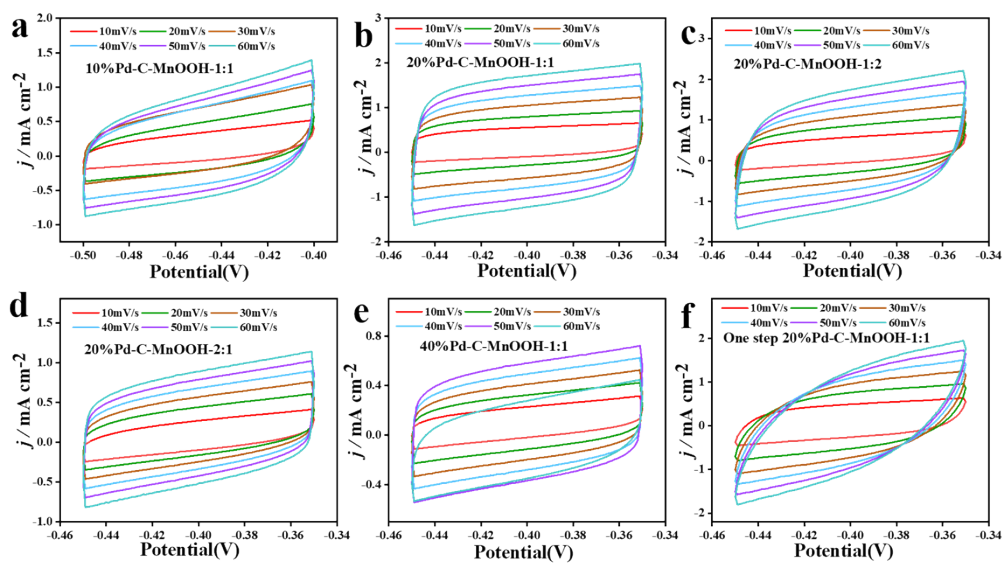


Fig. S2. CV curves of different Pd-C-MnOOH catalysts between -0.45 and -0.35 V (vs SCE) in 1.0 M KOH solution with different scan rates.

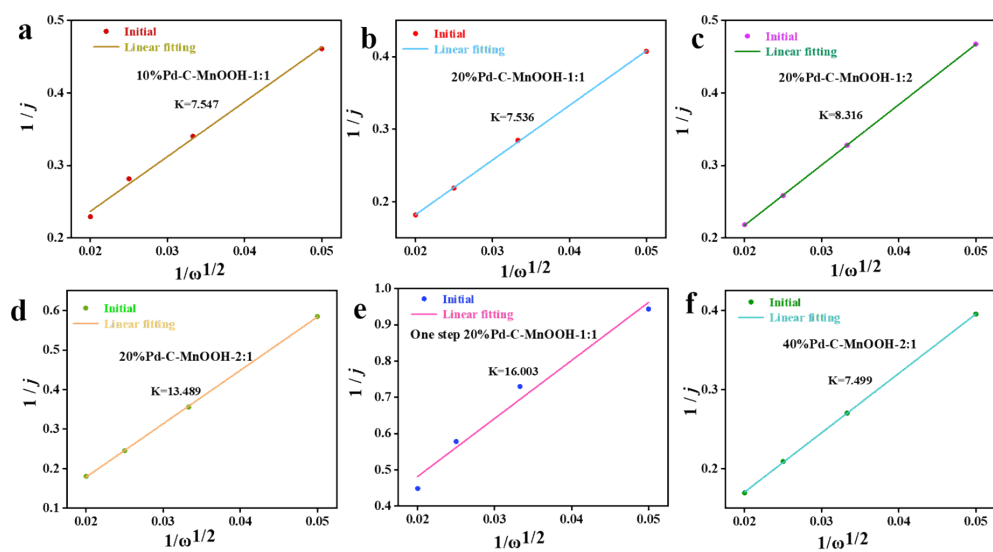


Fig. S3. Electrochemical active area (CdI) curves of different Pd-C-MnOOH catalysts. (a) 10%Pd-C-MnOOH-1:1, (b) 20%Pd-C-MnOOH-1:1, (c) 40%Pd-C-MnOOH-1:1, (d) 20%Pd-C-MnOOH-1:2, (e) 20%Pd-C-MnOOH-2:1, (e) 20%Pd-C-MnOOH\*-1:1, (f) commercial Pd/C catalysts.

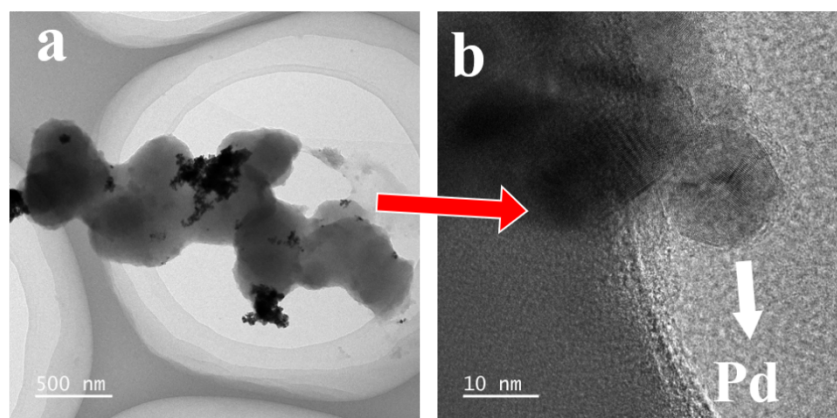


Fig. S4. (a)TEM and (b) HRTEM images of 20%Pd-C-MnOOH-1:1 catalyst after use.

**Table S1** ORR activity comparison table of similar palladium-based catalysts

Catalyst	$j$ (mAcm <sup>-2</sup> )	$E_{1/2}$ (V)	Electrolyte	Rotational speed(rpm)	Reference
MnO <sub>2</sub>	-3.78	0.52	0.1 M KOH	2500	8
MnOOH	-3.83	0.74	0.1 M KOH	1600	1
MnO <sub>2</sub> /C	-5.51	0.61	0.1 M KOH	2500	8
MnO <sub>2</sub> /C-3:7	-2.58	0.66	0.1 M KOH	1600	2
10%Pd/MnO <sub>2</sub>	-4.72	0.78	0.1 M KOH	1600	2
Pd/MnO <sub>2</sub>	-5.52	0.67	0.1 M KOH	1600	3
Pd/MnO <sub>2</sub>	-3.75	0.76	0.5 M NaOH	1600	5
Pd/MnO <sub>2</sub>	-4.56	0.83	0.1 M KOH	1600	7
Pd/ $\alpha$ -MnO <sub>2</sub>	-4.38	0.67	0.1 M KOH	1600	6
Pd-HSAG	-4.20	0.84	0.1 M KOH	1600	4
Pd/MnO <sub>2</sub> -CNT	-6.48	0.72	0.1 M KOH	1600	3
8.7%Pd/MnO <sub>2</sub>	-5.82	0.68	0.1 M KOH	2500	8
8.7%Pd/Mn-C	-6.70	0.74	0.1 M KOH	2500	8
20%Pd/C/MnOOH	-4.78	0.84	0.1 M KOH	1600	This work

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