

Supporting Information

A mild reduction of Co-doped MnO_2 to create abundant oxygen vacancies and active sites for enhanced oxygen evolution reaction

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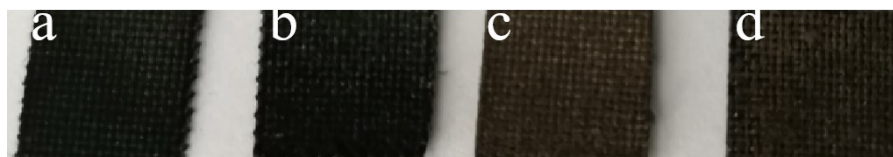


Figure S1. Photographs of (a) MnO_2 , (b) $\text{MnO}_2@\text{Mn}_3\text{O}_4$, (c) Co-doped- MnO_2 , (d) Co-doped- $\text{MnO}_2@\text{MnCo}_2\text{O}_{4.5}$.

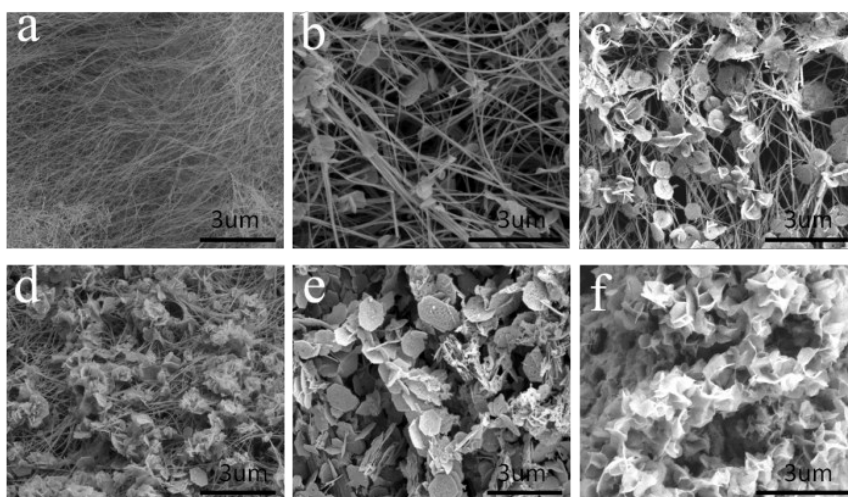


Figure S2. SEM images of Co-doped $\text{MnO}_2@ \text{MnCo}_2\text{O}_{4.5}$ samples at different time (a) 0h, (b) 8h, (c) 12h, (d) 16h, (e) 20h, (f) 24h.

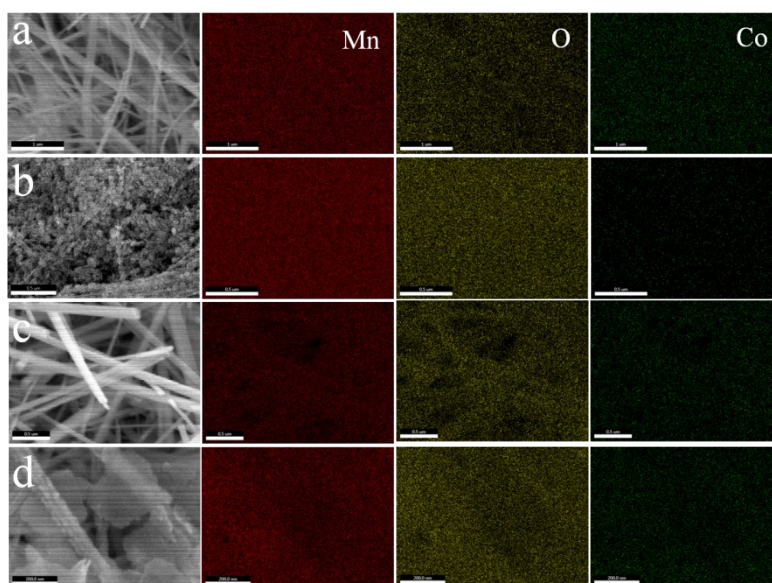


Figure S3. SEM element mapping of (a) MnO_2 , (b) $\text{MnO}_2@ \text{Mn}_3\text{O}_4$, (c) Co-doped- MnO_2 , (d) Co-doped- $\text{MnO}_2@ \text{MnCo}_2\text{O}_{4.5}$: SEM images showing the area of mapping and element mappings for Mn, O and Co elements.

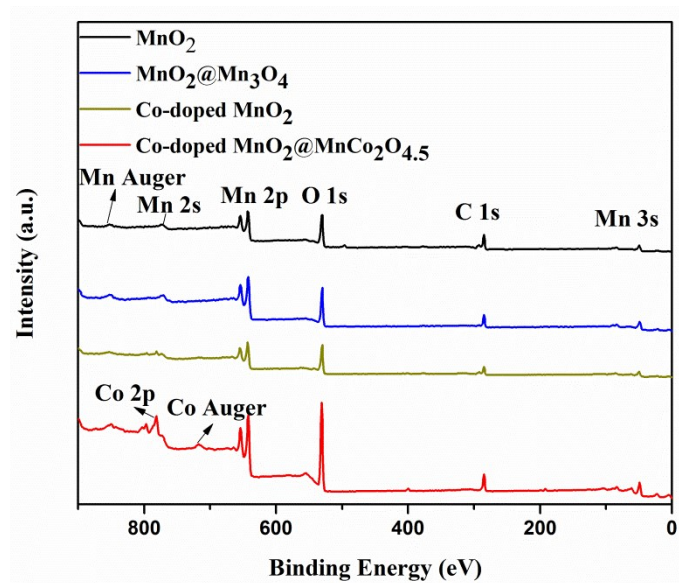


Figure S4. XPS survey spectrum of MnO_2 , $\text{MnO}_2@\text{Mn}_3\text{O}_4$, Co-doped- MnO_2 , Co-doped $\text{MnO}_2@\text{MnCo}_2\text{O}_{4.5}$.

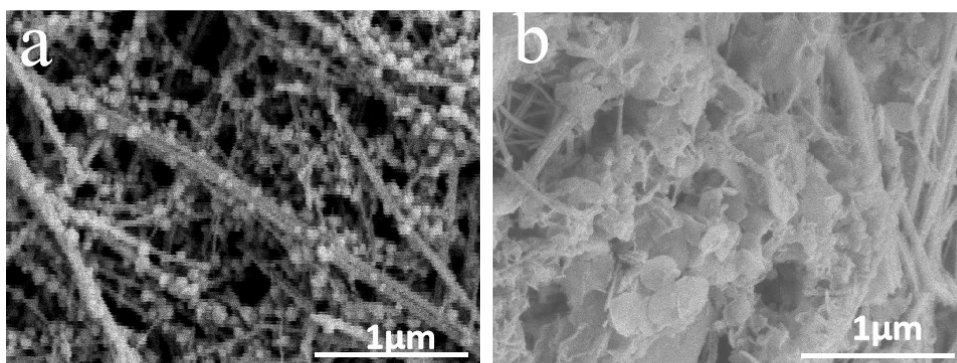


Figure S5. SEM images of the samples after durability test (a) $\text{MnO}_2@\text{Mn}_3\text{O}_4$, (b) Co-doped $\text{MnO}_2@\text{MnCo}_2\text{O}_{4.5}$.

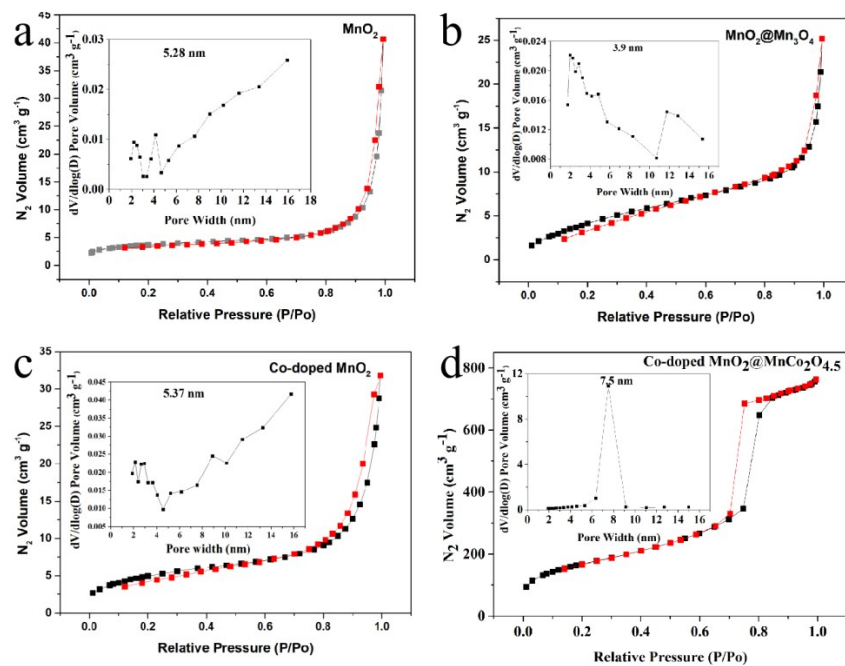


Figure S6. N_2 adsorption/desorption isotherm and the corresponding pore size distribution (inset image) of (a) MnO_2 , (b) $MnO_2@Mn_3O_4$, (c) Co-doped- MnO_2 , (d)

Co-doped- $MnO_2@MnCo_2O_{4.5}$.

Table S1. The BET information of MnO₂, (b) MnO₂@Mn₃O₄, (c) Co-doped-MnO₂, (d)

Co-doped-MnO₂@MnCo₂O_{4.5}

Samples	Pore size (nm)	V (cm ³ g ⁻¹)	S _{BET} (m ² g ⁻¹)
MnO ₂	5.28	0.011	12
MnO ₂ @Mn ₃ O ₄	3.9	0.03	15
Co-doped MnO ₂	5.37	0.049	17.70
Co-doped MnO ₂ @MnCo ₂ O _{4.5}	7.5	1.17	574

Table S2. The Mn:Co atom ratio of the Co-doped-MnO₂ and Co-doped-MnO₂@MnCo₂O_{4.5} from ICP-AES analysis.

Samples	Mn (at. %)	Co (at. %)	The Mn:Co atom ratio
Co-doped MnO ₂	29.8	5.5	5.4:1
Co-doped MnO ₂ @MnCo ₂ O _{4.5}	31.1	3.5	8.9:1