Supplementary Information

Novel NiCoMn-PDC MOFs: A dual functional material for electrocatalytic water splitting and hybrid supercapacitor applications

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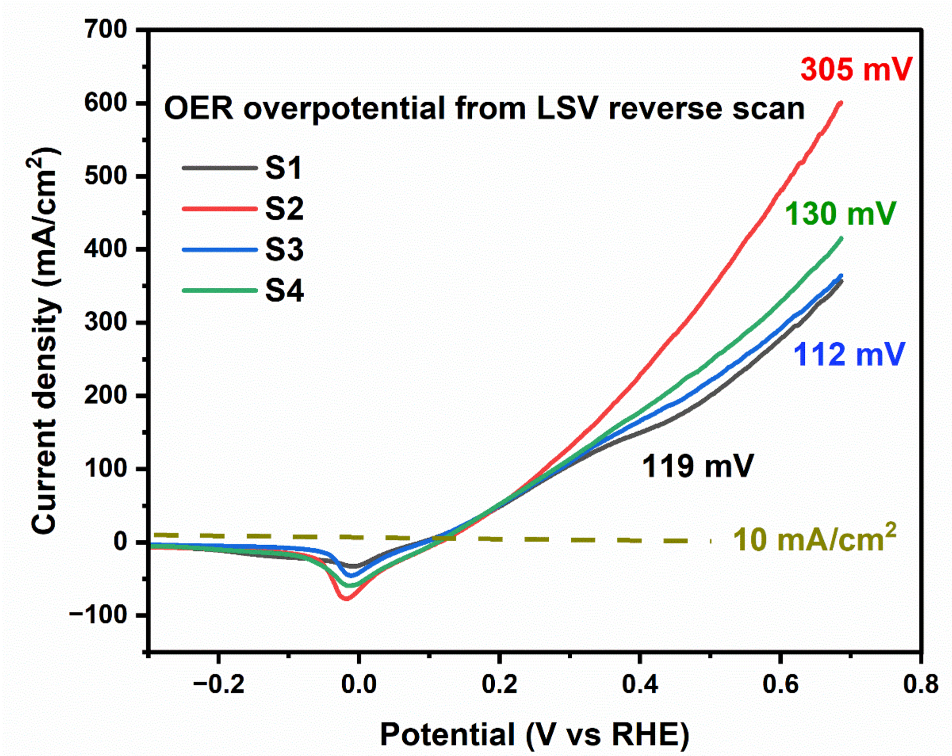

Fig. S1 OER overpotential is calculated from the reverse Linear sweep voltammetry (LSV) scan for samples S1–S4 under identical conditions. (Lu, 2024)

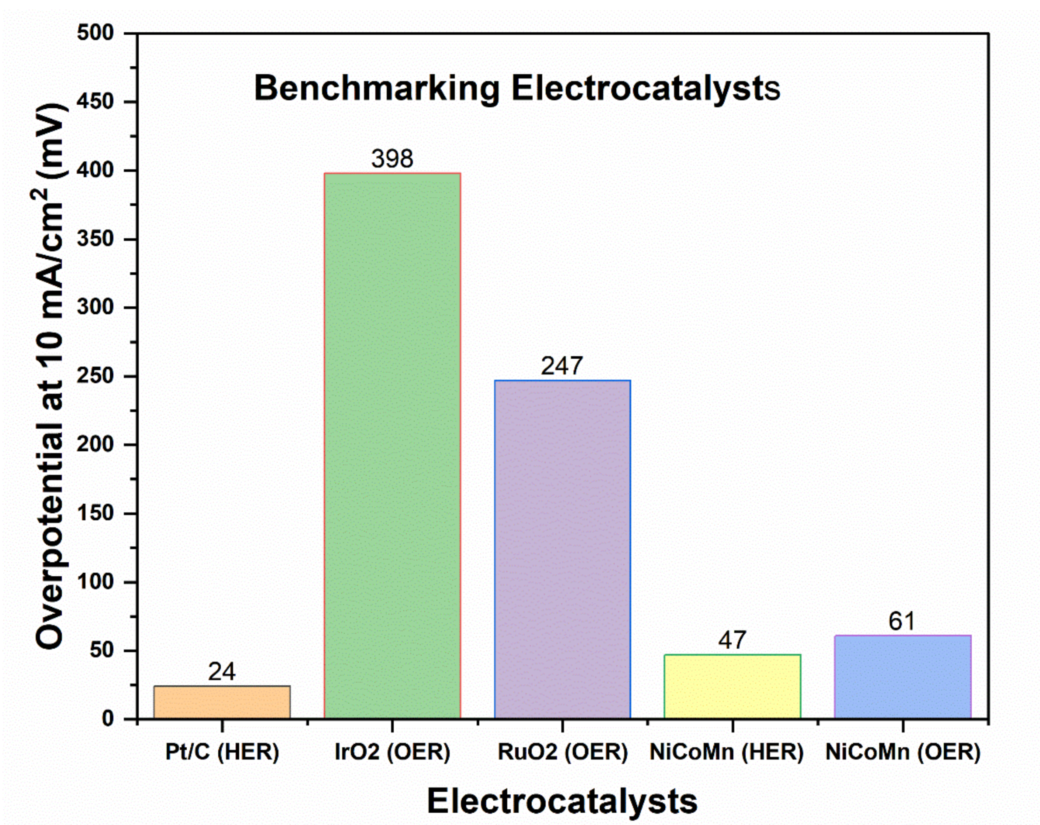

Fig. S2 Benchmarking HER and OER overpotentials of the NiCoMn catalyst against commercial (Pt/C), (IrO_2), and (RuO_2), highlighting its superior bifunctional activity.

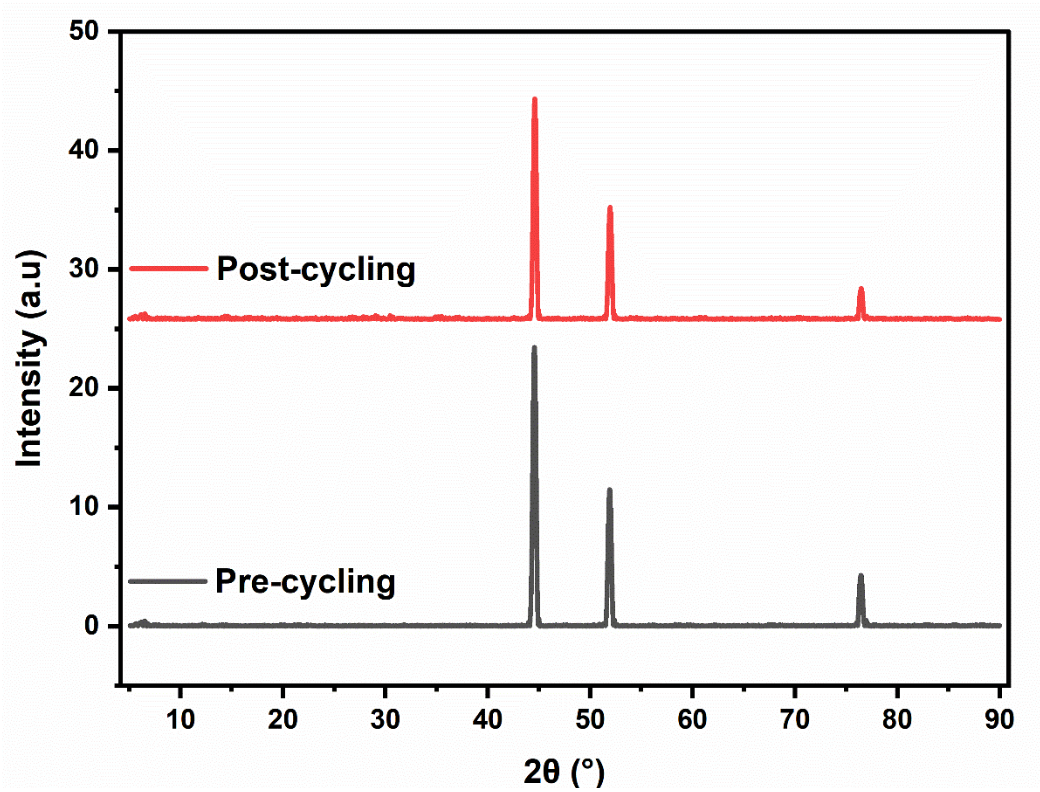

Fig. S3 XRD patterns of the electrode material before and after 5,000 cycles, confirming excellent structural stability without phase changes.

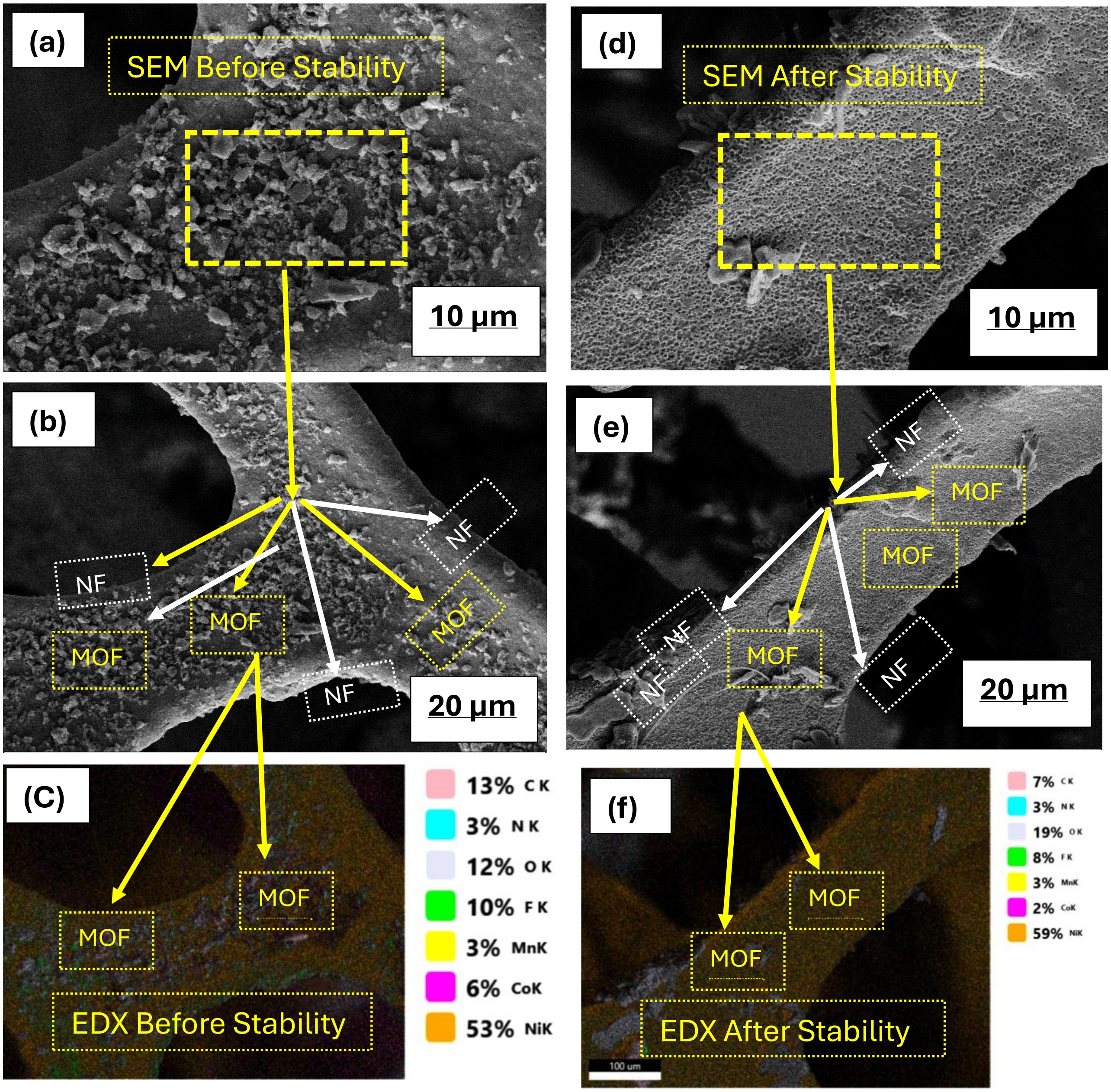

Fig. S4 SEM/EDX of NiCoMn-PDC MOF/NF. (a) SEM pre (10 μm); (b) magnified pre (20 μm); (c) EDX pre (100 μm); (d) SEM post (10 μm); (e) magnified post (20 μm); (f) EDX post (100 μm). Colors denote atomic %.

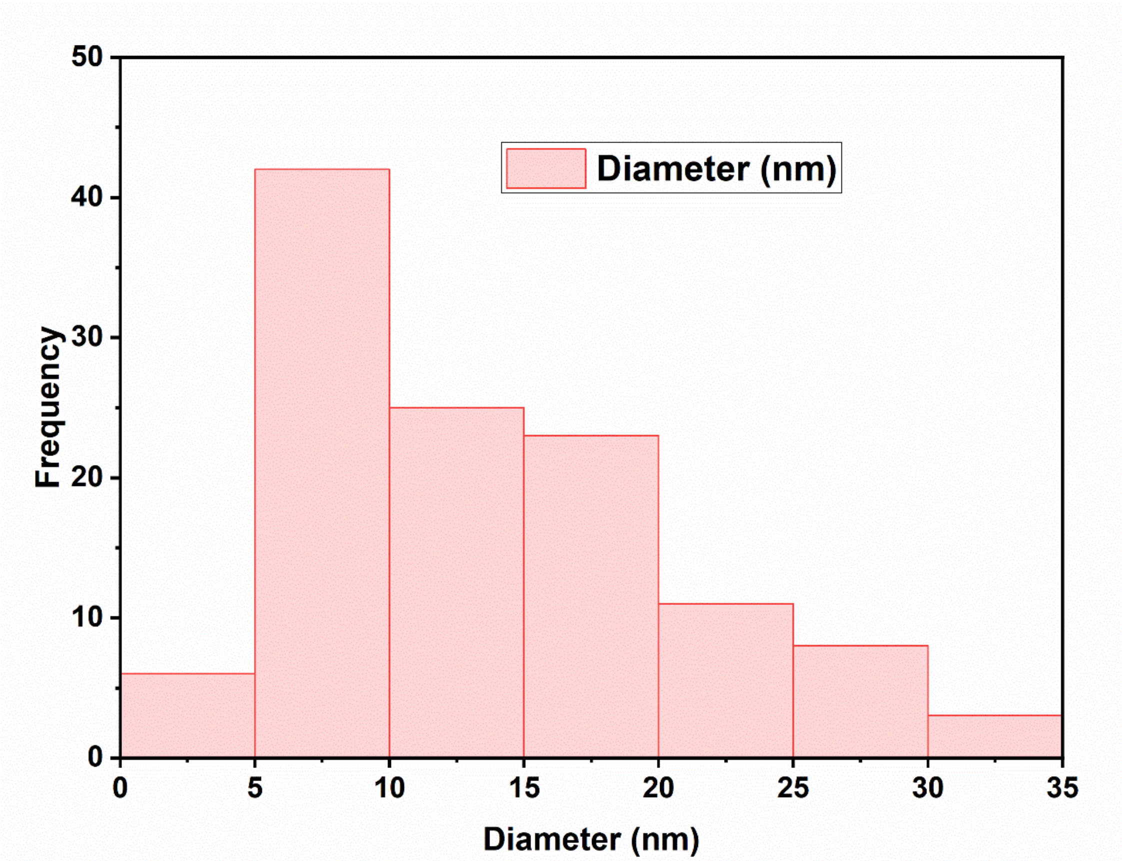

Fig. S5 Diameter distribution of S2 nanostrips from SEM analysis, confirming their ultrathin average diameter of ~7.9 nm.

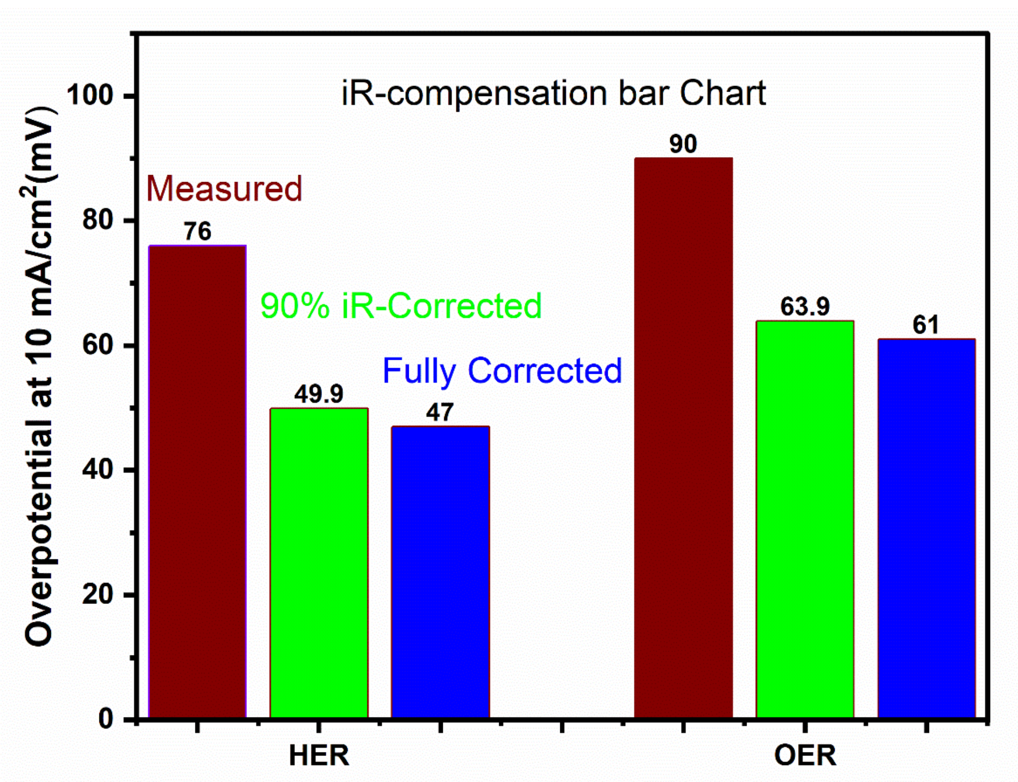

Fig. S6 iR-compensated HER and OER overpotentials of sample S2, confirming its intrinsic catalytic activity comparable to noble metal benchmarks.

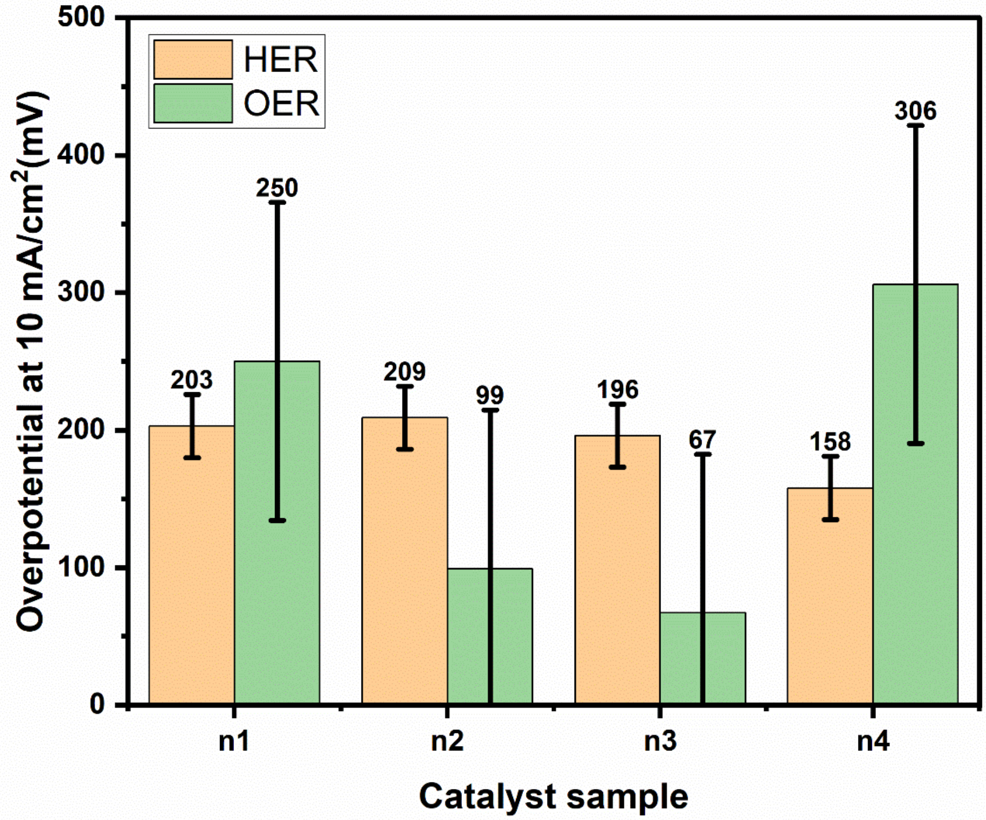

Fig. S7 Bar chart showing mean overpotentials ± SD (n = 4) for HER and OER based on optimized sample S2.

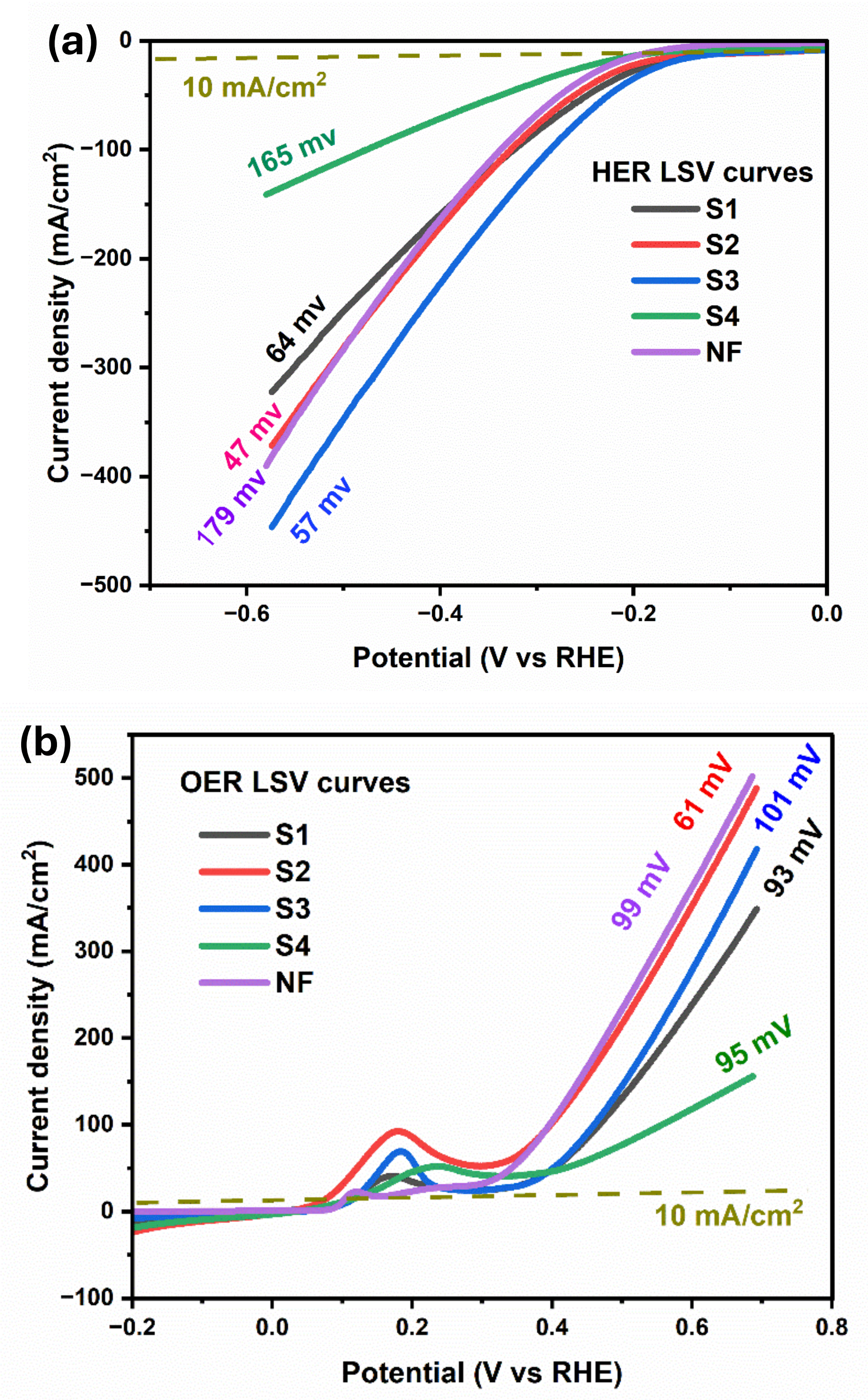

Fig. S8 Linear sweep voltammetry (LSV) curves for (a) HER and (b) OER of composition S1–S4 recorded under identical conditions for Ni foam (NF) control.

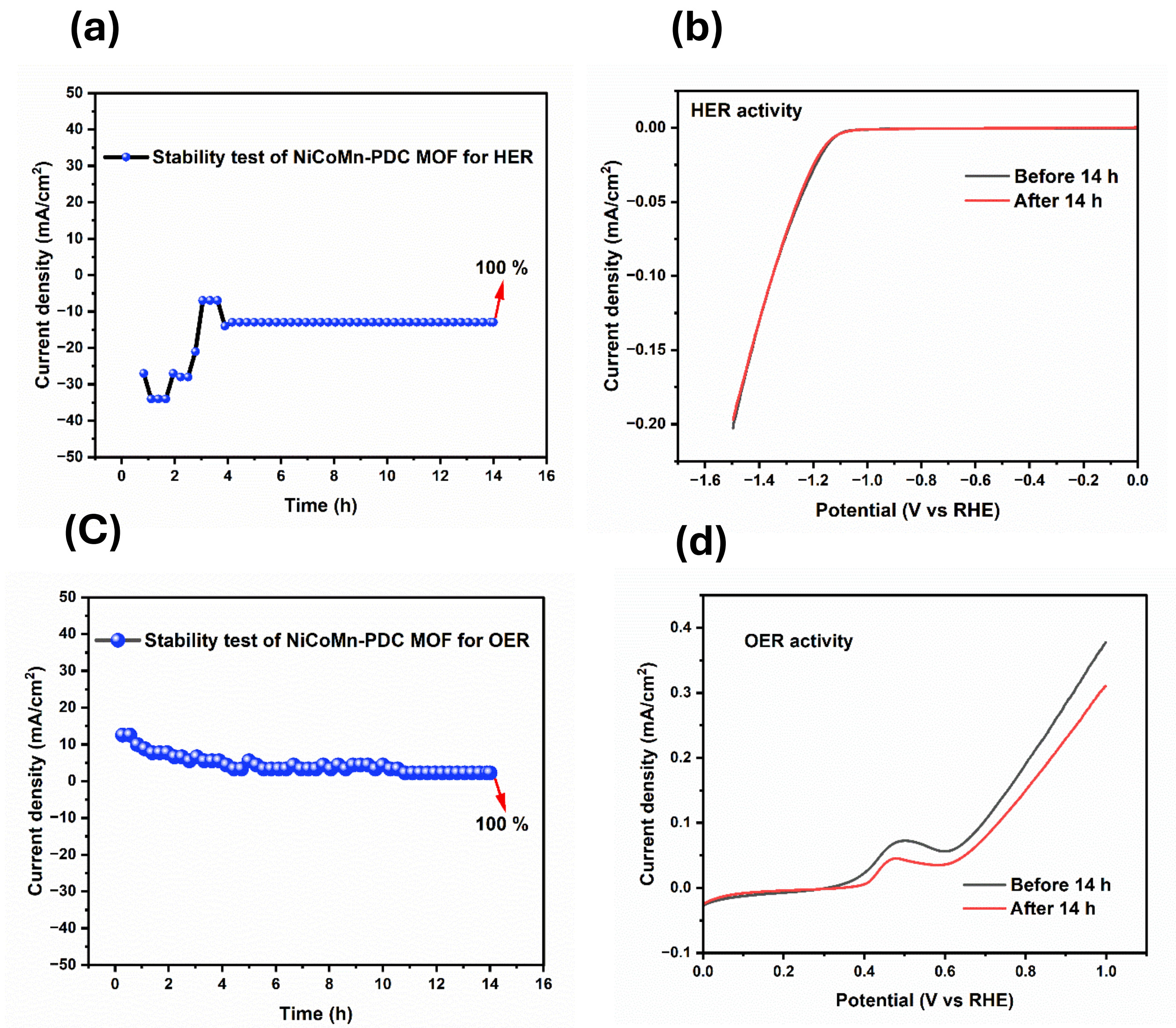

Fig. S9 Stability tests of NiCoMn-PDC MOF. (a) Chronoamperometry for HER over 14 h. (b) LSV curves for HER before and after 14 h stability test. (c) Chronoamperometry for OER over 14 h. (d) LSV curves for OER before and after 14 h stability test.

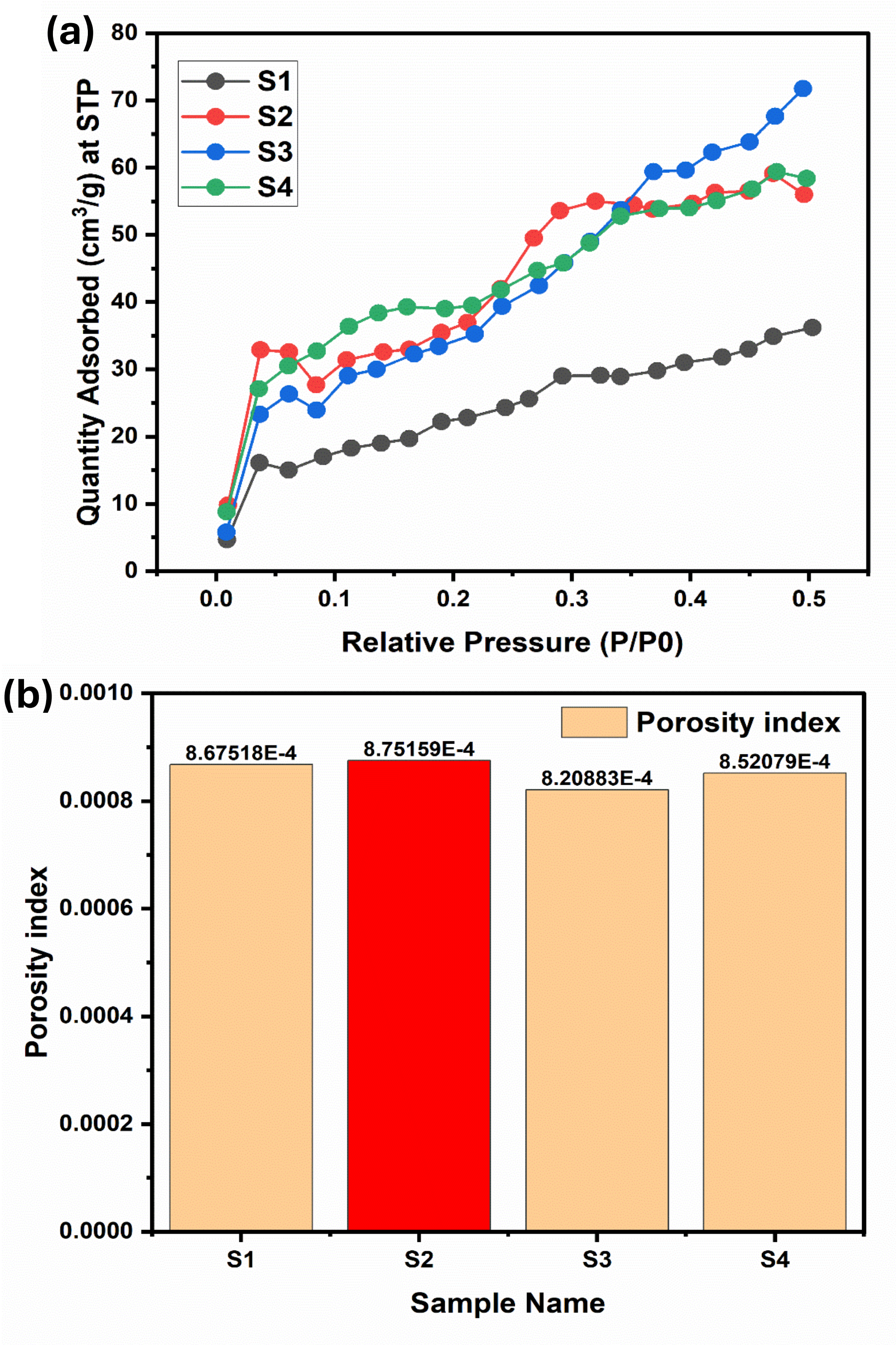

Fig. S10 (a) Nitrogen adsorption–desorption isotherms of catalysts S1–S4 recorded at 77 K, showing typical mesoporous behavior. (b) Porosity index of each catalyst, calculated as the ratio of total pore volume ($cm^3\ g^{-1}$) to BET surface area ($m^2\ g^{-1}$).

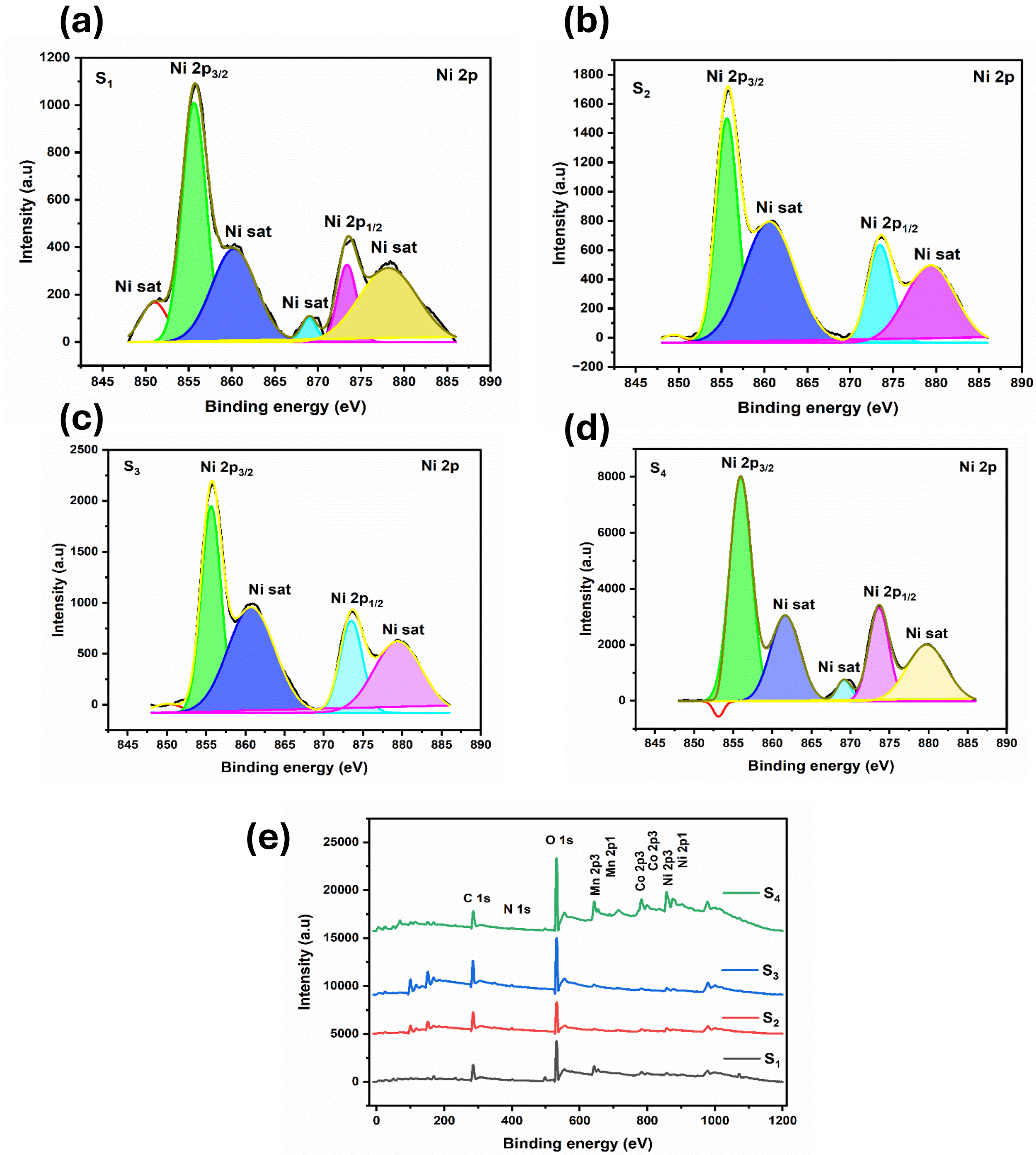

Fig. S11 Deconvoluted XPS spectra of Ni 2p for Ni–Co–Mn–PDC MOFs based on compositions (a) S1, (b) S2, (c) S3, and (d) S4, showing presence of Mn^{2+}/Mn^{3+} redox states. (e) Survey spectrum for composition S1 to S4.

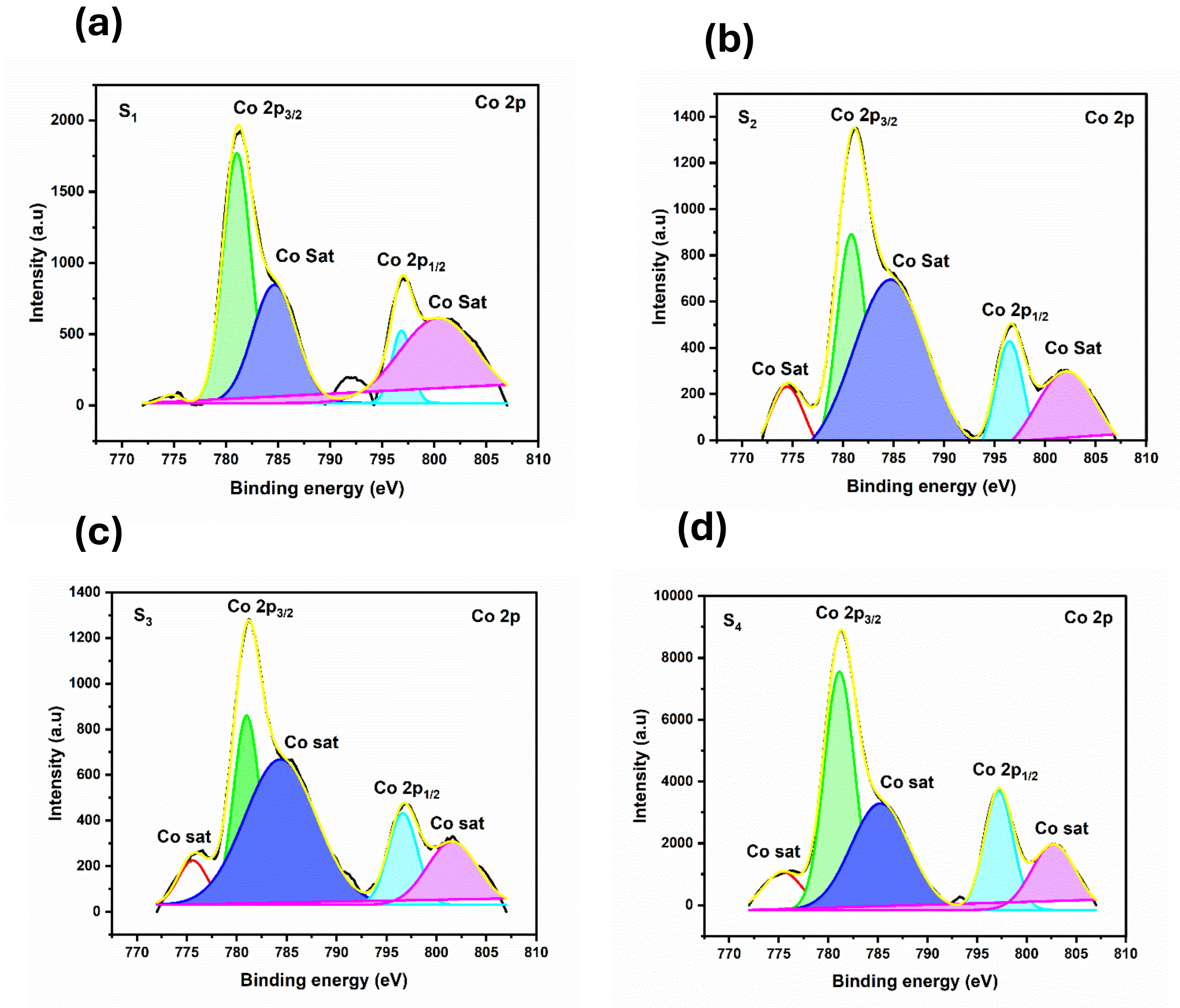

Fig. S12 Deconvoluted XPS spectra of Co 2p for Ni–Co–Mn–PDC MOFs based on compositions (a) S1, (b) S2, (c) S3, and (d) S4, showing presence of Mn^{2+}/Mn^{3+} redox states.

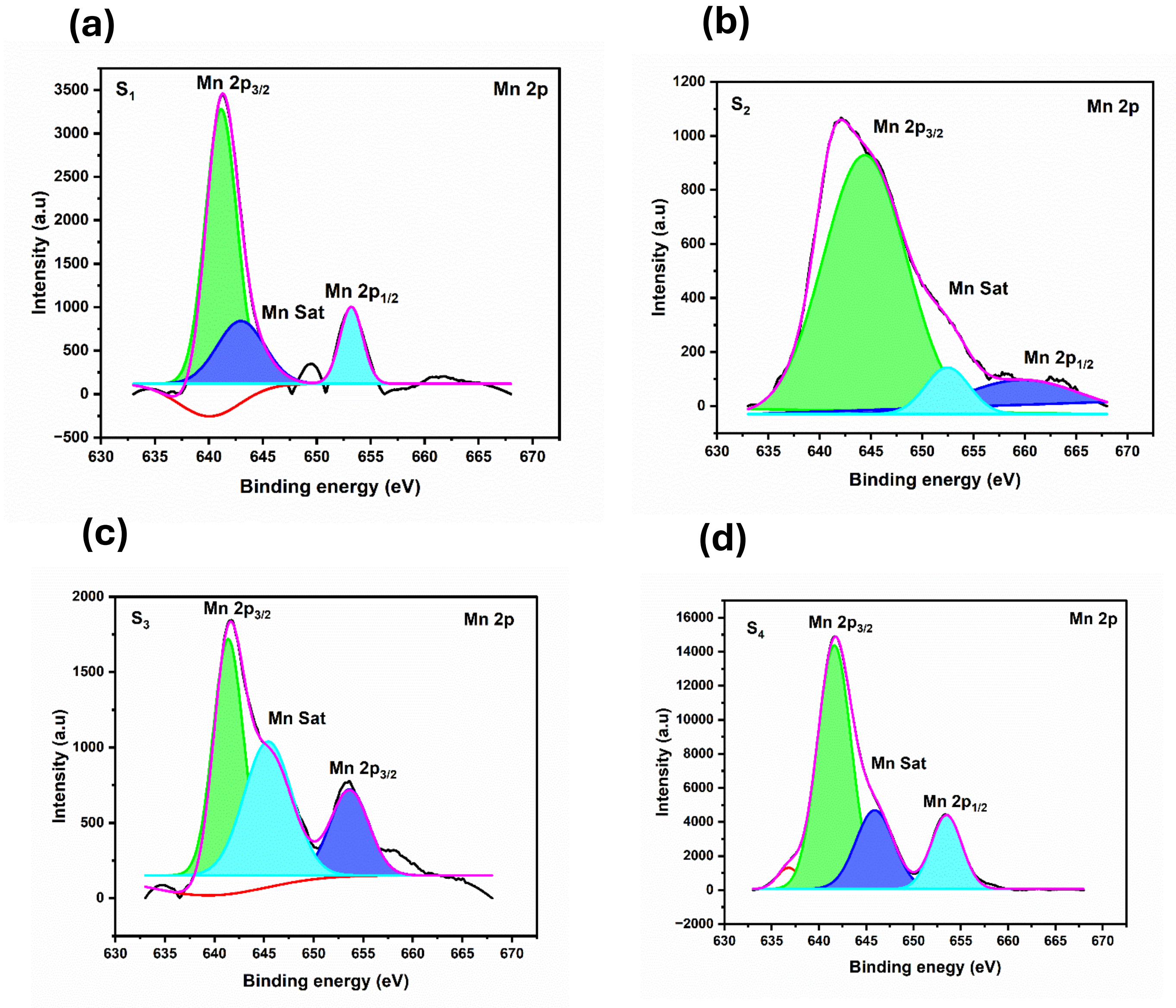

Fig. S13 Deconvoluted XPS spectra of Mn 2p for Ni–Co–Mn–PDC MOFs based on compositions (a) S1, (b) S2, (c) S3, and (d) S4, showing presence of Mn^{2+}/Mn^{3+} redox states.

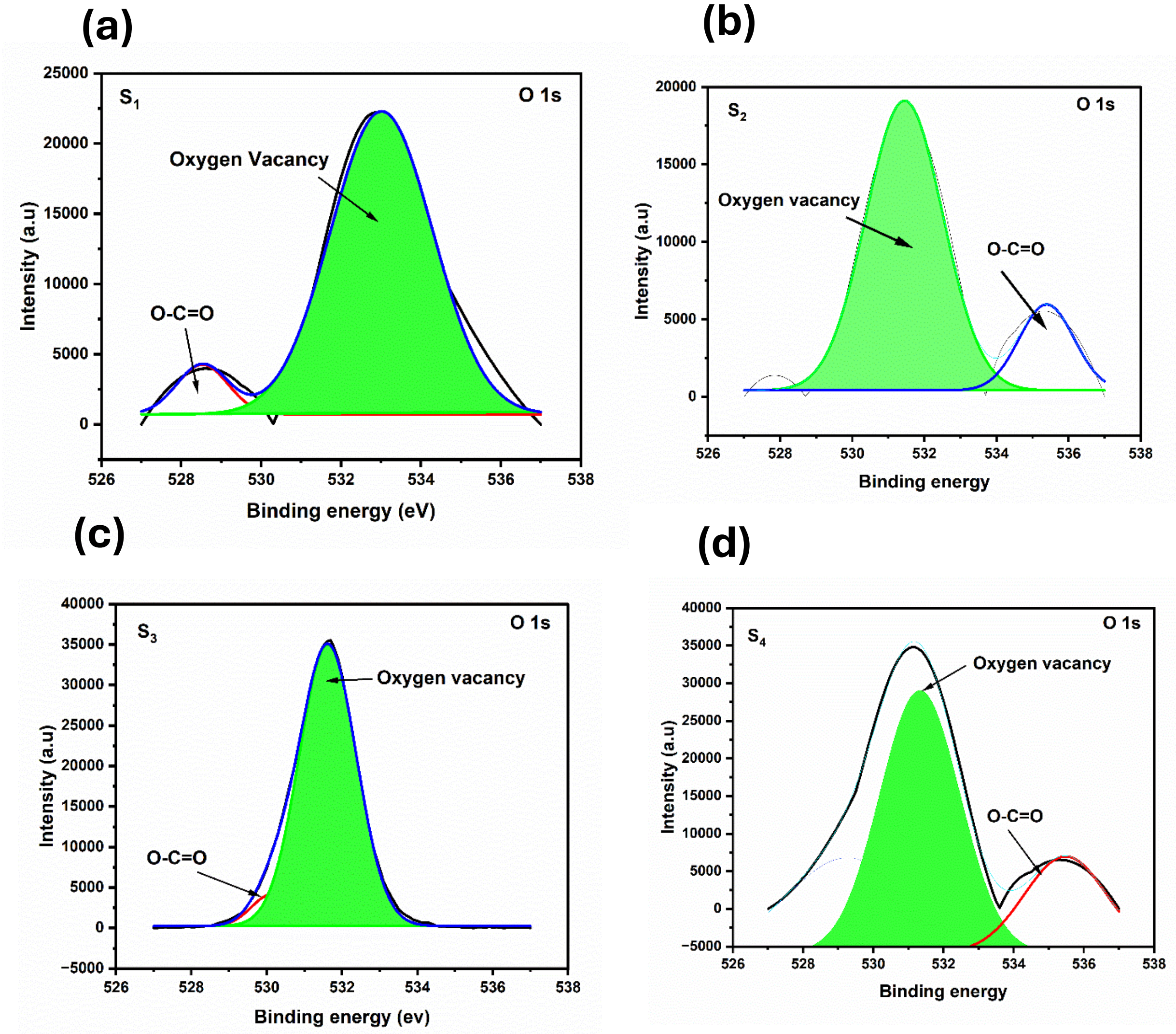

Fig. S14 Deconvoluted XPS spectra of Oxygen 1s for Ni–Co–Mn–PDC MOFs based on compositions (a) S1, (b) S2, (c) S3, and (d) S4, showing presence of Mn^{2+}/Mn^{3+} redox states.

References

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