Supplement materials

Engineering High-Valence Metal-Enriched Cobalt Oxyhydroxide Catalysts for Enhanced OER in Near pH-Neutral Condition

Ruijing Dong[a,b], Jiajian Gao[b], Truong-Giang Vo[b], Shibo Xi[b], Choon Wee Kee[b], Xun Cao[b], Wei Chu[a*], Yan Liu[b*]

[a] School of Chemical Engineering, Sichuan University, No. 24 South Section 1, Yihuan Road, Chengdu, 610065, China.

[b] Institute of Sustainability for Chemicals, Energy and Environment (ISCE^2), Agency for Science, Technology, and Research (A*STAR), 1 Pesek Road, Jurong Island, Singapore 627833, Republic of Singapore

[*]Corresponding authors:

chuwei1965@scu.edu.cn (W Chu);

liu_yan@isce2.a-star.edu.sg (Y Liu).

Supplementary Figures

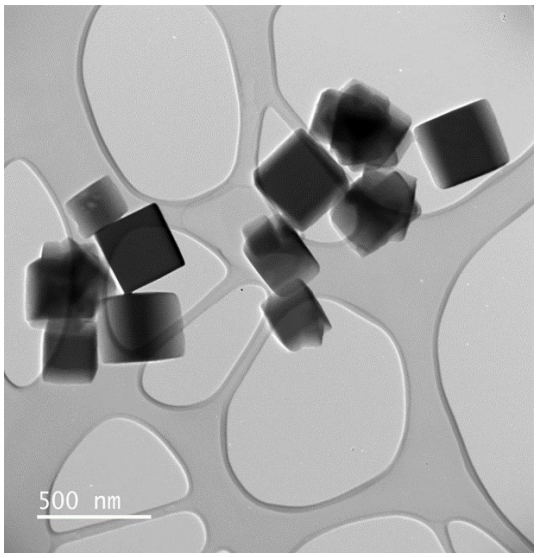

Fig. S1TEM image of ZIF-67

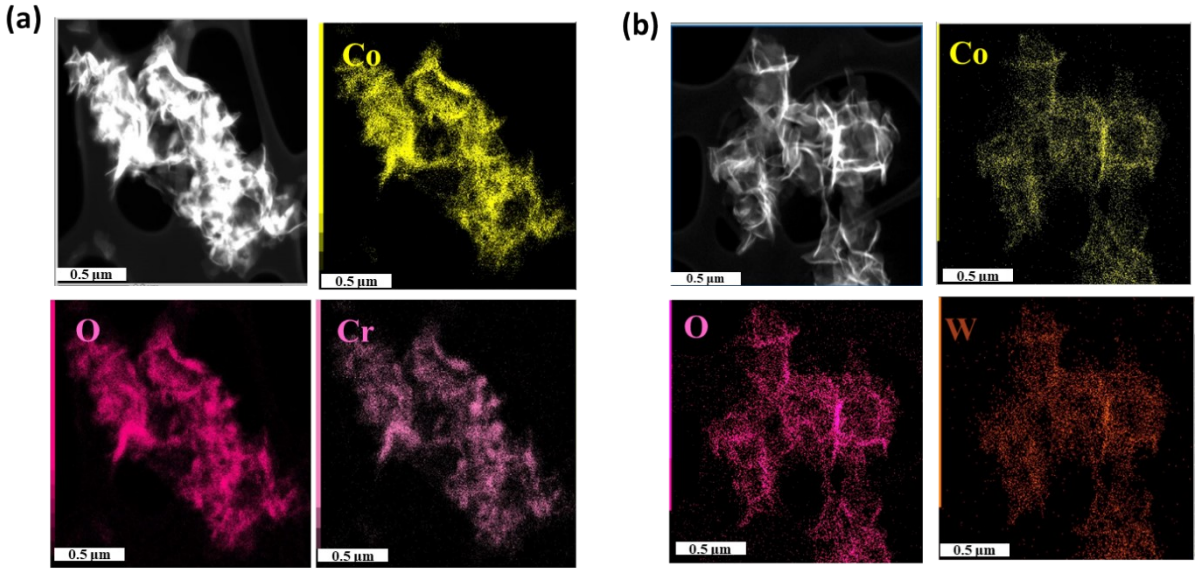

Fig. S2 TEM mapping images of Cr-$Co(OH)_2$ (a) and W-$Co(OH)_2$ (b)

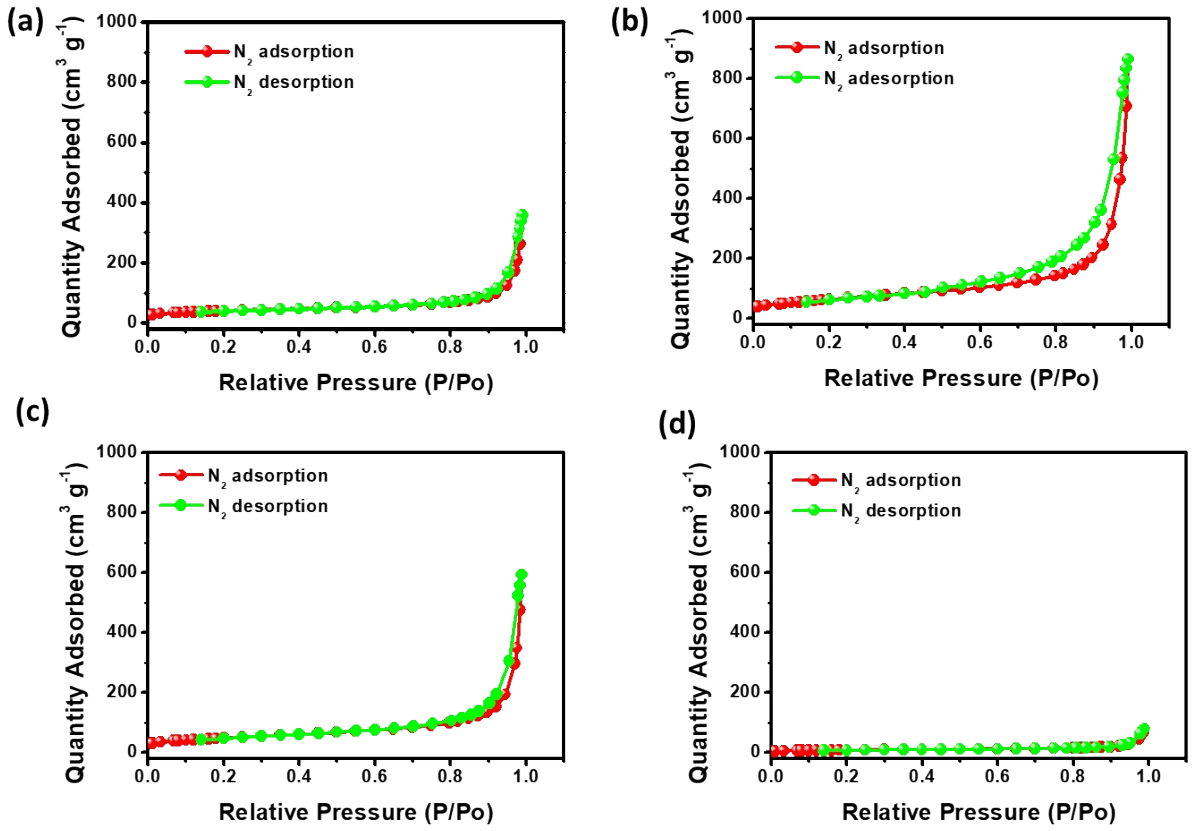

Fig. S3 N_2 adsorption-desorption isotherms of Mo-$Co(OH)_2$ (a), Cr-$Co(OH)_2$ (b), W-$Co(OH)_2$ (c) and $Co(OH)_2$ (d)

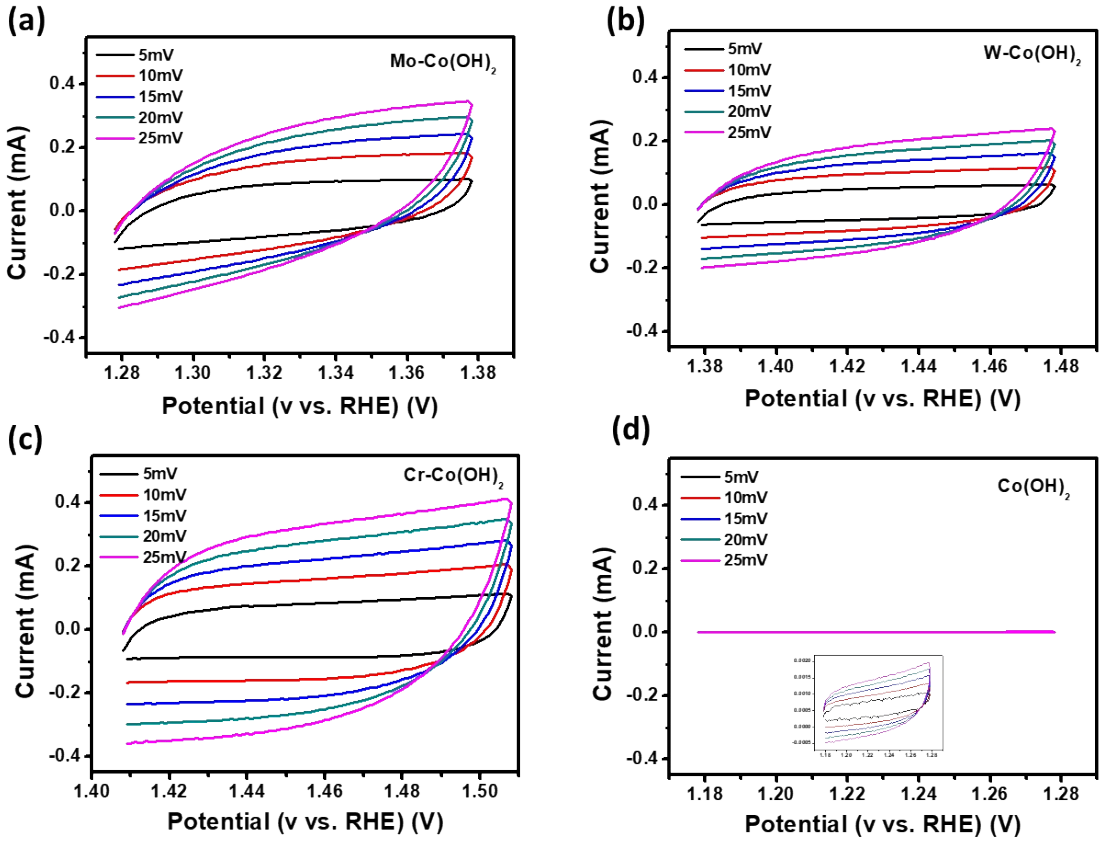

Fig. S4 Double electronic layer of Mo-$Co(OH)_2$ (a), W-$Co(OH)_2$ (b), Cr-$Co(OH)_2$ (c) and $Co(OH)_2$ (d)

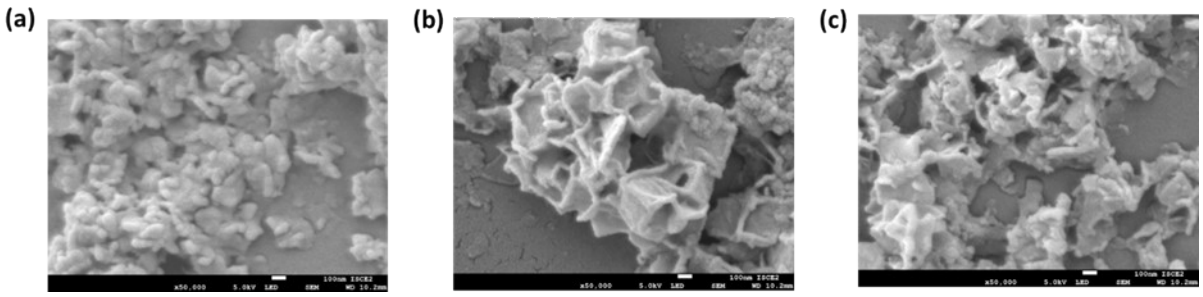

Fig. S5 SEM image of Mo-$Co(OH)_2$ (a), Cr-$Co(OH)_2$ (b) and W-$Co(OH)_2$ (c).

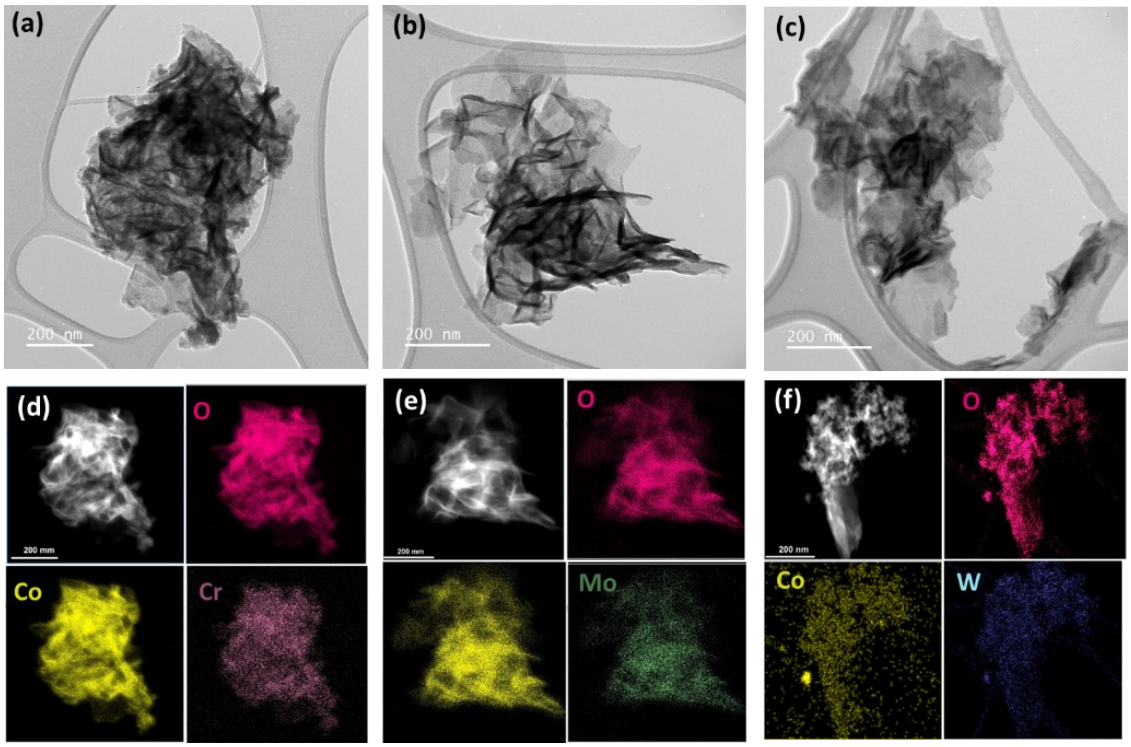

Fig. S6 TEM image and mapping of Cr-$Co(OH)_2$ (a,d), Mo-$Co(OH)_2$ (b,e) and W-$Co(OH)_2$ (c,f) after stability test.

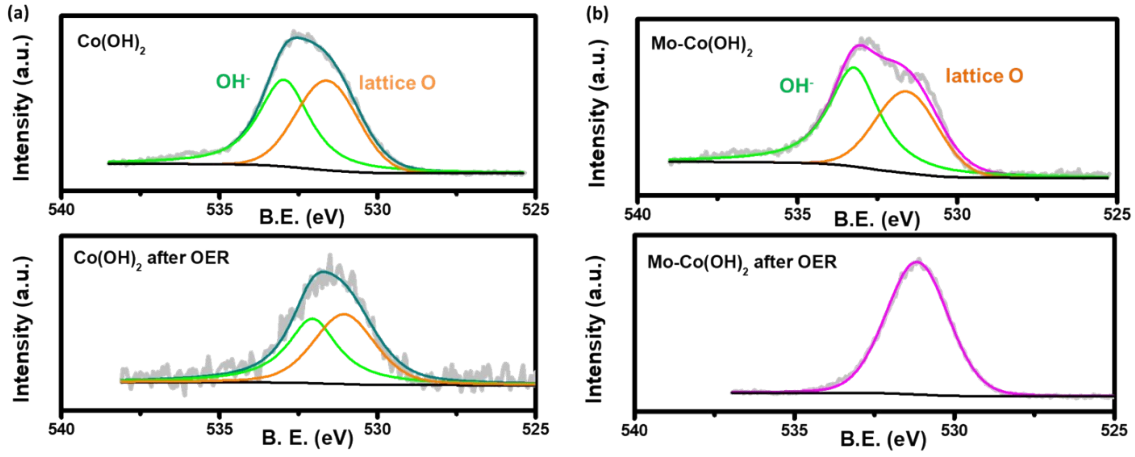

Fig. S7 XPS absorption spectra of O1s for $Co(OH)_2$ (a) and Mo-$Co(OH)_2$ (b)

As shown in Fig.S7, compared with unmodified $Co(OH)_2$, Mo promotes the transformation of OH to OOH as lattice oxygen during the OER process.

Supplementary Tables

Table S1. ECSA of different catalysts

catalyst	ECSA (c
Mo-$Co(OH)_2$	157.5(
Cr-$Co(OH)_2$	280.0(
W-$Co(OH)_2$	147.5(
$Co(OH)_2$	0.75

Table S2. Fourier Transforms k2-weight of Co K-edge curve fitting

Sample	path	CN	σ^2	ΔE_0	R	R-factor
Co foil	Co-Co	12 (fixed)	0.006(0.004)	-2.6	2.492 (0.007)	0.006
$Co(OH)_2$-std	Co-O	6 (fixed)	0.009(0.001)	-1.63	2.088 (0.008)	0.005
	Co-Co	6 (fixed)	0.009(0.001)		3.192 (0.009)	
Mo-$Co(OH)_2$	Co-O	5.1 (0.6)	0.013(0.002)	-1.47	2.055 (0.01)	0.004
	Co-Co/ Co-Mo		0.01(0.001)		3.126 (0.008)	

Table S3. Comparison of catalytic performance in this work with what has reported in literature.

catalyst	**Electrolyte**	**On glassy carbon Overpotential (mV) at 10 mA cm^{-2}**	**On Carbon paper Overpotential (mV) at 10 mA cm^{-2}**	**Ref.**
Mo-$Co(OH)_2$	0.5 M $KHCO_3$	550	390	This work
Cr-$Co(OH)_2$	-	570	412	This work
W-$Co(OH)_2$	-	640	468	This work
a-Co_2P	0.1 M PBS	~320	-	1
PO-CoFe-OH	0.1 M $KHCO_3$		365	2
Co-Pi	0.1 M KPi	-	550	3

Reference:

1. K. Xu, H. Cheng, L. Liu, H. Lv, X. Wu, C. Wu and Y. Xie, *Nano Lett*, 2017, **17**, 578-583.

2. D. Zhong, T. Li, D. Wang, L. Li, J. Wang, G. Hao, G. Liu, Q. Zhao and J. Li, *Nano Research*, 2021, **15**, 162-169.

3. M. W. Kanan and D. G. Nocera, *Science*, 2008, **321**, 1072-1075.