Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information

CoFe layered double hydroxides with adjustable composition and structure for enhanced oxygen evolution reaction

Wan Rong,[ab] Rui Dang,[b] Yunfei Chen,[b] Kang Huang,[a] Jiuyang Xia,[a] Bowei Zhang,*[a] Jianfei Liu,[b] Meixin Li,[c] Qigao Cao *[b] and Junsheng Wu *[a]

[1]Institute of Advanced Materials and Technology, University of Science and Technology Beijing, Beijing 100083, P.R. China.

[2]Northwest Institute For Nonferrous Metal Research, 96 Weiyang Road, Xi'an, Weiyang district, 710016, P.R. China.

[3]The Faculty of Printing, Packaging Engineering and Digital Media Technology, Xi'an University of Technology, Xi'an 710054, P.R. China.

Corresponding Author

[1]Institute of Advanced Materials and Technology, University of Science and Technology Beijing, Beijing 100083, P.R.China.

*Email: bwzhang@ustb.edu.cn (Bowei Zhang)

*Email: wujs76@163.com (Junsheng Wu)

[2]Northwest Institute For Nonferrous Metal Research, 96 Weiyang Road, Weiyang district, 710016, P.R. China.

*Email: caoqigao@c-nin.com (Qigao Cao)

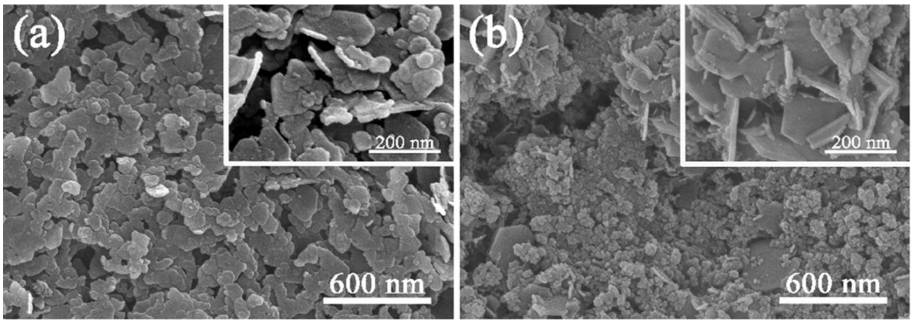

Fig. S1 SEM images of different samples: (a) Co_2Fe_1 LDH and (b) Co_1Fe_2 LDH

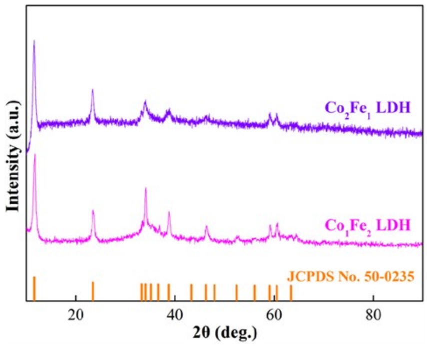

Fig. S2 XRD patterns of the Co_2Fe_1 LDH and Co_1Fe_2 LDH

Table S1. Mass fraction of Co and Fe in different LDHs defined by ICP-OES.

Sample	Co (wt. %)	Fe (wt. %)	Other elements (wt. %)
Co_2Fe_1 LDH	25.3	11.9	62.8
Co_1Fe_1 LDH	19.2	18.5	62.3
Co_1Fe_2 LDH	13.5	25.7	60.8
Co LDH	35.3	/	64.7
Fe LDH	/	41.2	58.8

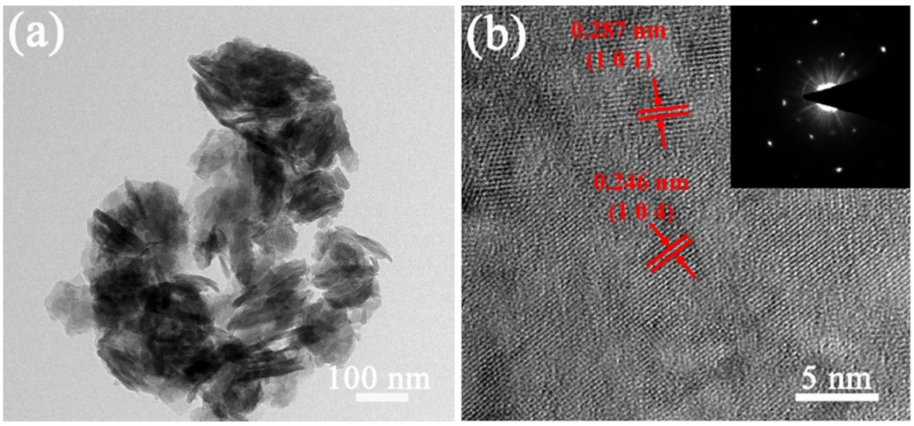

Fig. S3 (a) TEM and (b) HRTEM images of Co_2Fe_1 LDH, Inset to (b): Corresponding SAED pattern

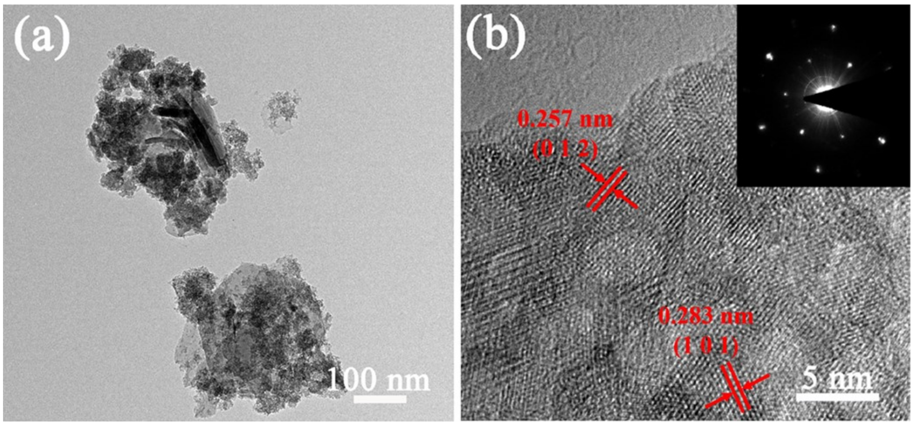

Fig. S4 (a) TEM and (b) HR-TEM images of Co_1Fe_2 LDH, Inset to (b): Corresponding SAED pattern

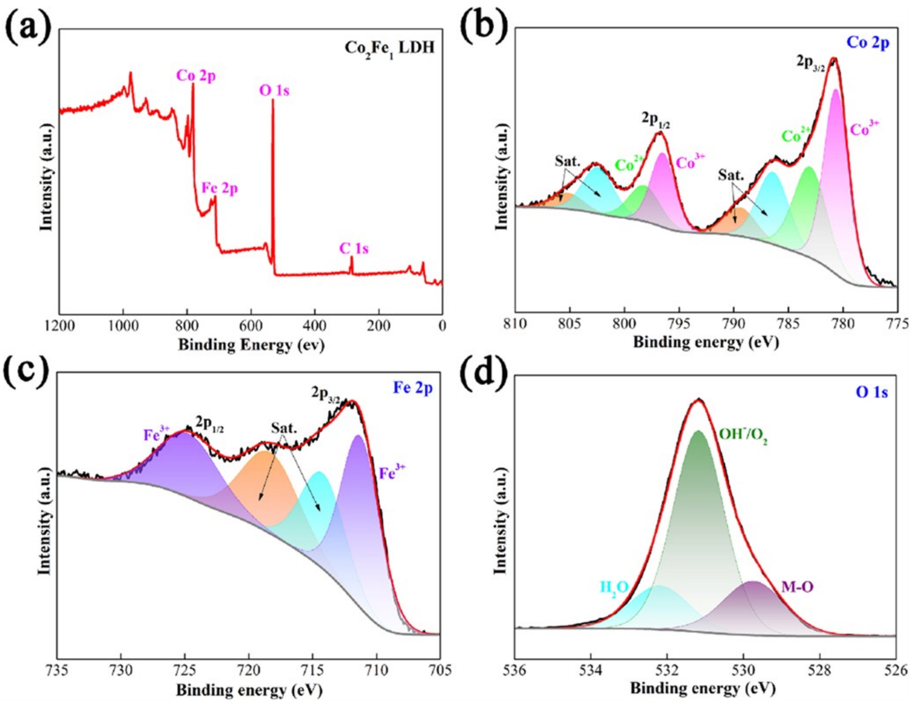

Fig. S5 Electronic structure analysis of the Co_2Fe_1 LDH: (a) XPS survey spectra, (b) Co 2p XPS spectra, (c) Fe 2p XPS spectra and (d) O1 s XPS spectra

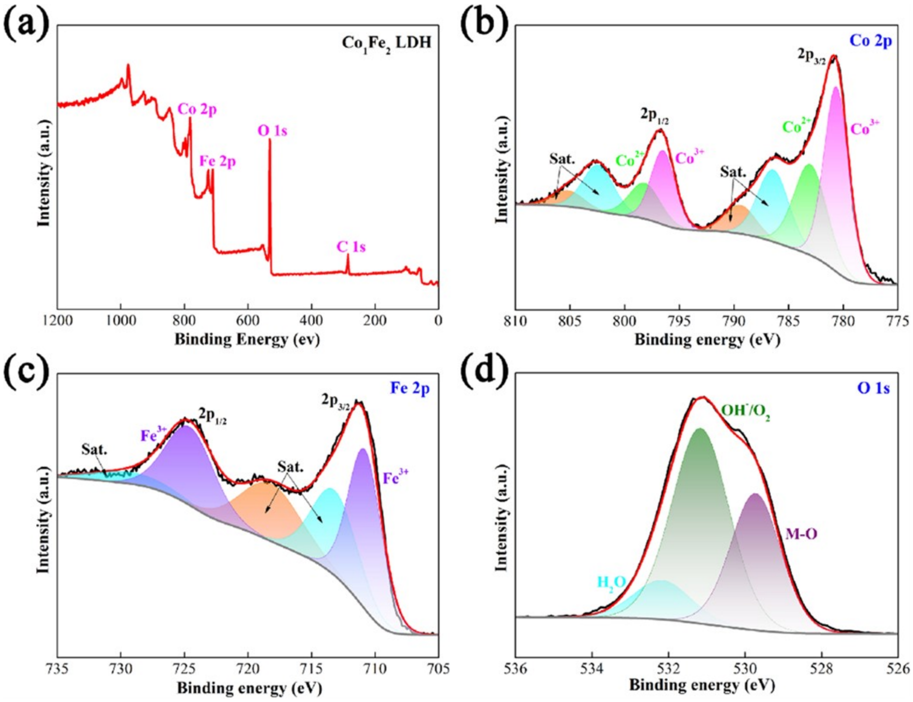

Fig. S6 Electronic structure analysis of the Co_1Fe_2 LDH: (a) XPS survey spectra, (b) Co 2p XPS spectra, (c) Fe 2p XPS spectra and (d) O1 s XPS spectra

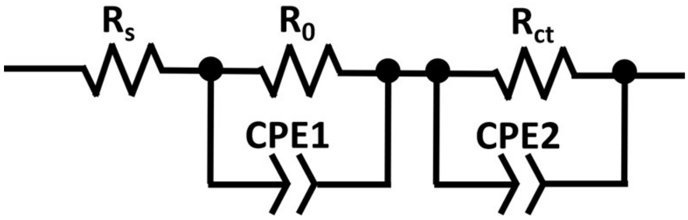

Fig. S7 Equivalent electrical circuit of electrochemical impedance spectroscopy. An equivalent electrical circuit used to model the OER process.

Table S2. The values of R_{ct} of the Co_2Fe_1 LDH, Co_1Fe_1 LDH, Co_1Fe_2 LDH, Co LDH and Fe LDH from EIS spectra.

Samples	Co_2Fe_1 LDH	Co_1Fe_1 LDH	Co_1Fe_2 LDH	Co LDH	Fe LDH	IrO_2
R_{ct} (Ω)	1.53	1.14	1.46	3.25	2.68	3.9

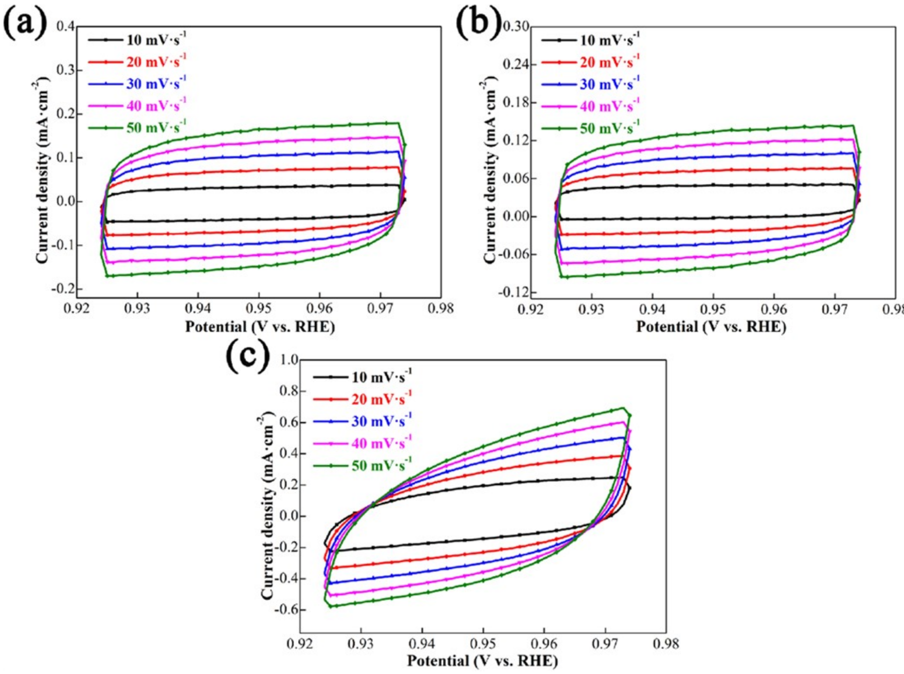

Fig. S8 The scan rate-dependent CV curves of (a) Co LDH, (b) Fe LDH and (c) Co_1Fe_1 LDH

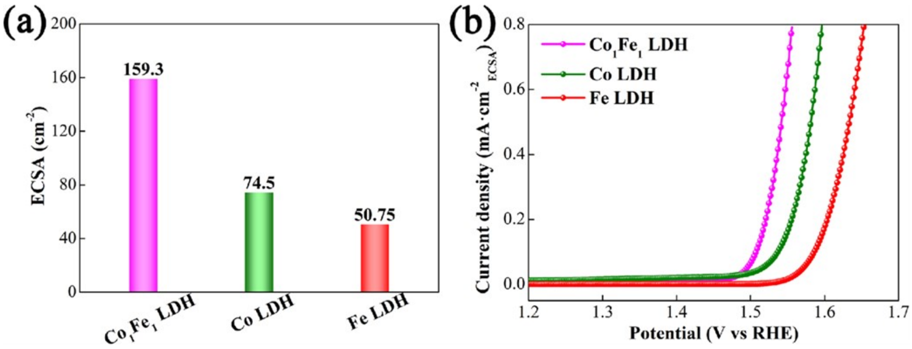

Fig. S9 (a) ECSA and (b) ECSA-normalized OER activity of the Co_1Fe_1 LDH, Co LDH and Fe LDH

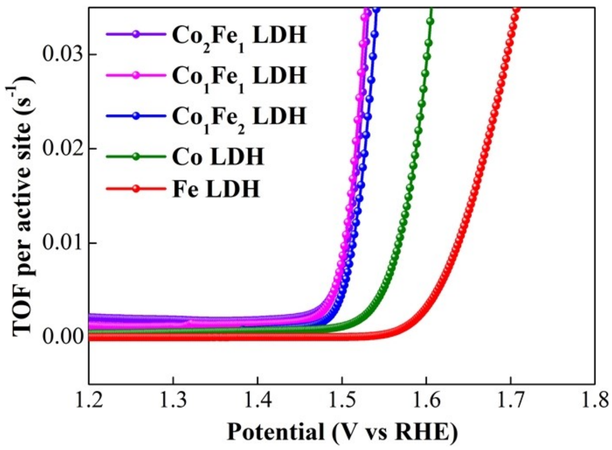

Fig. S10 TOF curves of the Co_2Fe_1 LDH, Co_1Fe_1 LDH, Co_1Fe_2 LDH, Co LDH and Fe LDH

Table S3. The values of TOFs of the Co_2Fe_1 LDH, Co_1Fe_1 LDH, Co_1Fe_2 LDH, Co LDH and Fe LDH for OER.

Samples	Co_2Fe_1 LDH	Co_1Fe_1 LDH	Co_1Fe_2 LDH	Co LDH	Fe LDH
TOFs for OER @1.53 V vs. RHE (S^{-1})	0.03295	0.03839	0.02246	0.00253	0.000096

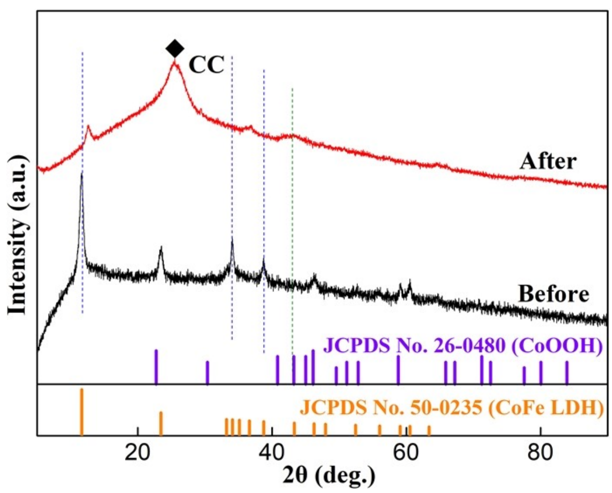

Fig. S11 XRD patterns of Co_1Fe_1 LDH before and after OER stability test

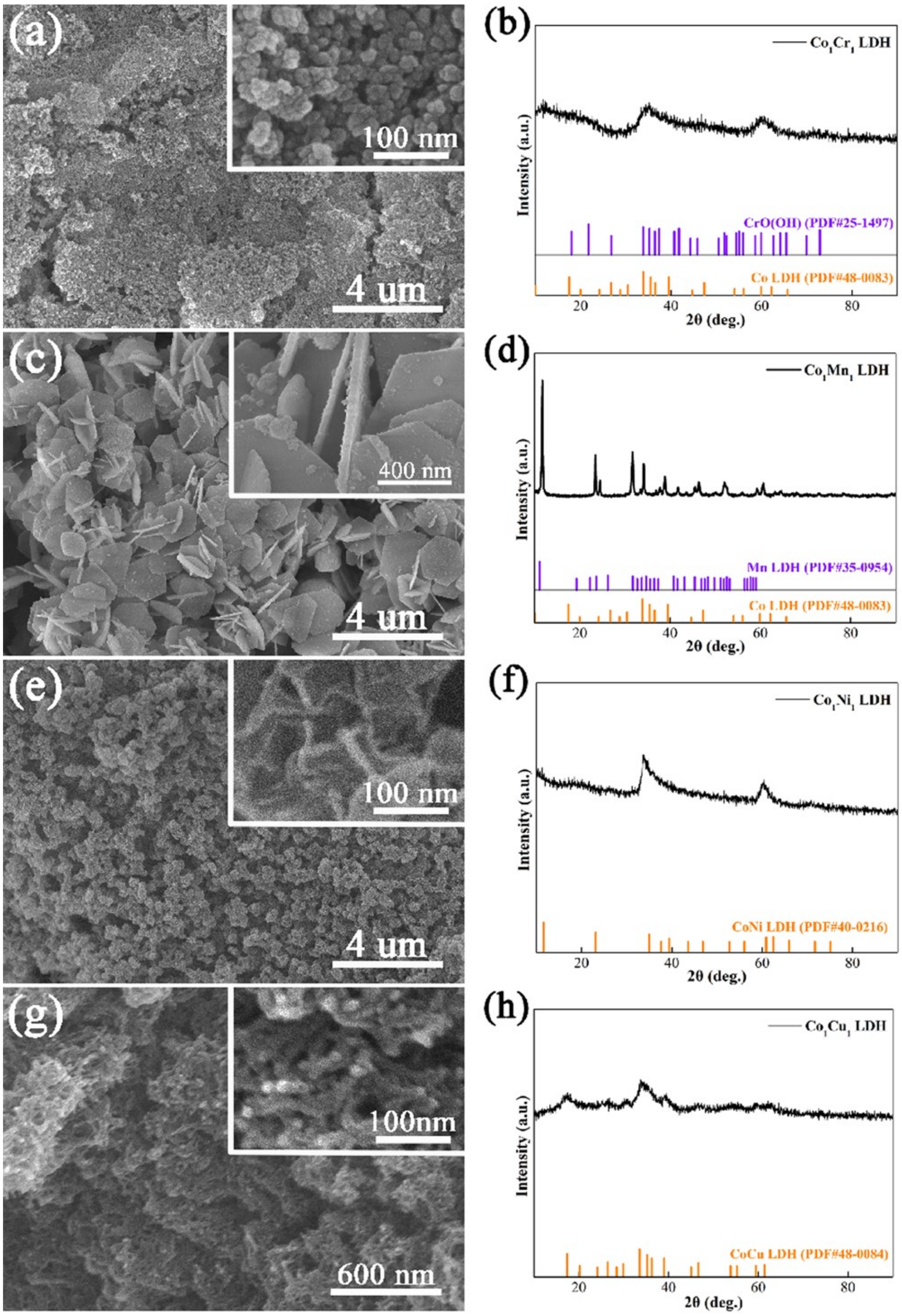

Fig. S12 SEM images of different samples: (a) Co_1Cr_1 LDH, (c) Co_1Mn_1 LDH, (e) Co_1Ni_1 LDH and (g) Co_1Cu_1 LDH; (b,d,f,h) the corresponding PXRD patterns of them

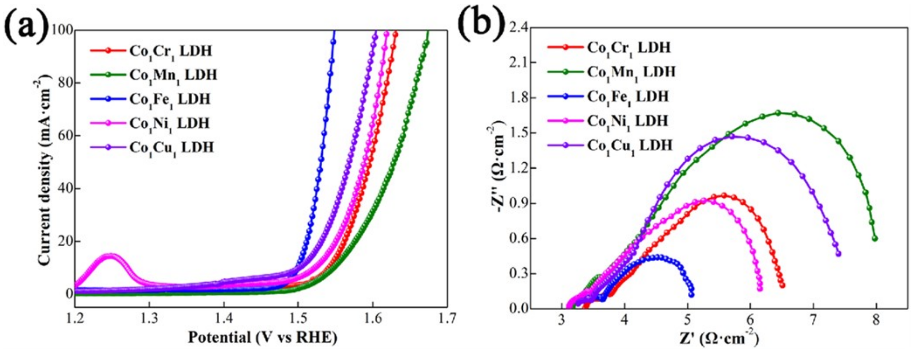

Fig. S13 The LSV and EIS curves of different Co_1M_1 LDHs

Table S4. Comparison of the OER activity between Co_1Fe_1 LDH with other electrocatalysts in 1.0 M KOH

Catalysts	Catalyst loading (mg cm^{-2})	η_{10} (mV)	Tafel slope (mV dec^{-1})	Reference
Co_1Fe_1 LDH	**1.00**	**270**	**42.7**	**This Work**
Co-LDH FNSAs	0.18	300	110	Co-precipitation [S1]
CoFe LDH	0.71	310	72.7	Hydrothermal [S2]
$Co_1Fe_{0.2}$ NPs	0.28	246	37.0	Co-precipitation [S3]
$Co_{0.55}Fe_{0.45}$BPO-OER	0.70	270	26.0	Hydrothermal [S4]
CoFe-LDHs	1.00	310	59.0	Co-precipitation [S5]
Co_2FeO_4	0.20	293	67.0	Hydrothermal [S6]
CoFe-MOF-OH	0.21	351	48.0	Hydrothermal [S7]
Co_4Fe_6-MOF	1.00	241	30.1	Co-precipitation [S8]
CoFe LDH	0.10	404	-	Solvothermal [S9]
$Co_5Fe_5O(OH)$	0.20	276	52.0	Hydrothermal [S10]
Fe-Co3O4@C/FTO	1.10	396	68.6	MOF-derived pyrolysis [S11]
$FeSe_2$	0.01	330	48.1	Solvothermal [S12]
NF-PVP/$CoFe_{1.3}$	2.00	234	46.4	electro-spinning [S13]
CoFe LDH	--	280	58.2	Co-precipitation [S14]

References

[S1] T Wang, X Liu, Y Li, F Li, Z Deng and Y Chen, ***Nano Res***, 2020, **13**, 79-80.

[S2] M Li, Y Gu, Y Chang, X Gu, J Tian, X Wu and L Feng, ***Chem. Eng. J.***, 2021, 130686.

[S3] X Bai, Z Duan, B Nan, L Wang, T Tang and J Guan, ***Chin. J. Catal.***, 2022, **43**, 2240–2248.

[S4] L Reith, J Hausmann, S Mebs, I Mondal, H Dau, M Driess and P Menezes, ***Adv. Energy Mater.***, 2023, 2203886-2203896.

[S5] P Li, M Wang, X Duan1, L Zheng, X Cheng, Y Zhang, Y Kuang, Y Li, Q Ma, Z Feng, W Liu and X Sun, ***Nat. Commun.***, 2019, **10**, 1711-1721.

[S6] A Hanan, M Lakhan, D Shu, A Hussain, M Ahmed, I Soomro, V Kumar and D Cao, ***Int. J. Hydrogen Energy.***, 2023, **2**, 49-63.

[S7] Z Zou, T Wang, X Zhao, W Jiang, H Pan, D Gao and Cailing Xu, ***ACS Catal.***, 2019, **9**, 7356−7364.

[S8] X Hou, Z Han, X Xu, D Sarker, J Zhou, M Wu, Z Liu, M Huang and H Jiang, ***Chem. Eng. J.***, 2021, **418**, 129330-129339.

[S9] F Dionigi, Z Zeng, I Sinev, T Merzdorf, S Deshpande, M Lopez, S Kunze, I Zegkinoglou, H Sarodnik, Di Fan, A Bergmann, J, Drnec, J Araujo, M Gliech, D Teschner, J Zhu, We Li, J Greeley, B Cuenya and P Strasser, ***Nat. Commun.***, 2020, **11**, 2522.

[S10] J Chen, H Li, S Chen, J Fei, C Liu, Z Yu, K Shin, Z Liu, L Song, G Henkelman, L Wei and Y Chen, ***Adv. Energy Mater.***, 2021, **11**, 2003412.

[S11] D Raja, P Cheng, C Cheng, S Chang, C Huang and S Lu, ***Appl. Catal. B-environ.**, 2022, **303**, 120899*.

[S12] R Gao, H Zhang and D Yan, ***Nano Energy***, 2017, **31**, 90.

[S13] Z Guo, W Ye, X Fang, J Wan, Y Ye, Y Dong, D Cao and D Yan, ***Inorg. Chem. Front.***, 2019, **6**, 687.

[S14] R Gao and D Yan, **Nano Res**, 2018, **11**, 1883.