Constructing Interface Engineering and Tailoring Nanoflower-like FeP/CoP Heterostructure Enhance Oxygen Evolution Reaction

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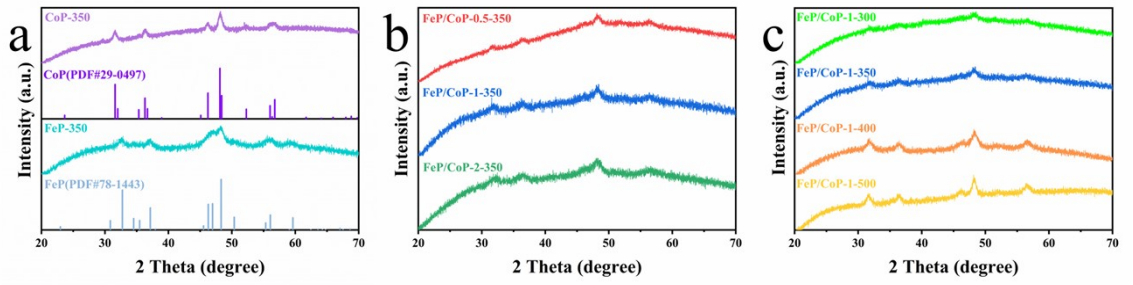


Figure S1. XRD patterns of (a) CoP-350 and FeP-350; (b) samples with different input ratios; (c) samples with different phosphating temperatures.

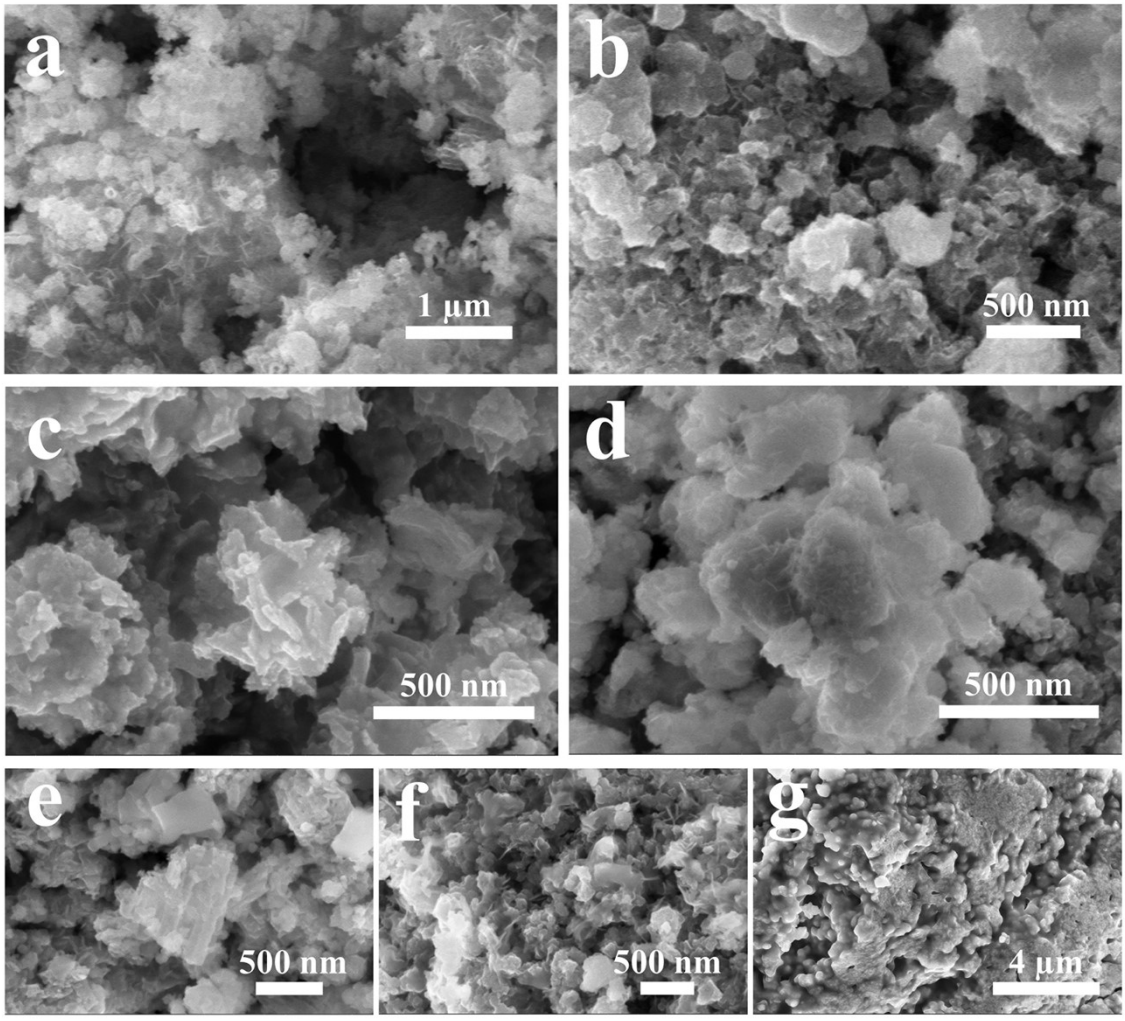


Figure S2. SEM images of (a) FeP/CoP-0.5-350; (b) FeP/CoP-2-350; (c) CoP-350; (d) FeP-350; (e) FeP/CoP-1-300; (f) FeP/CoP-1-400 and (g) FeP/CoP-1-500.

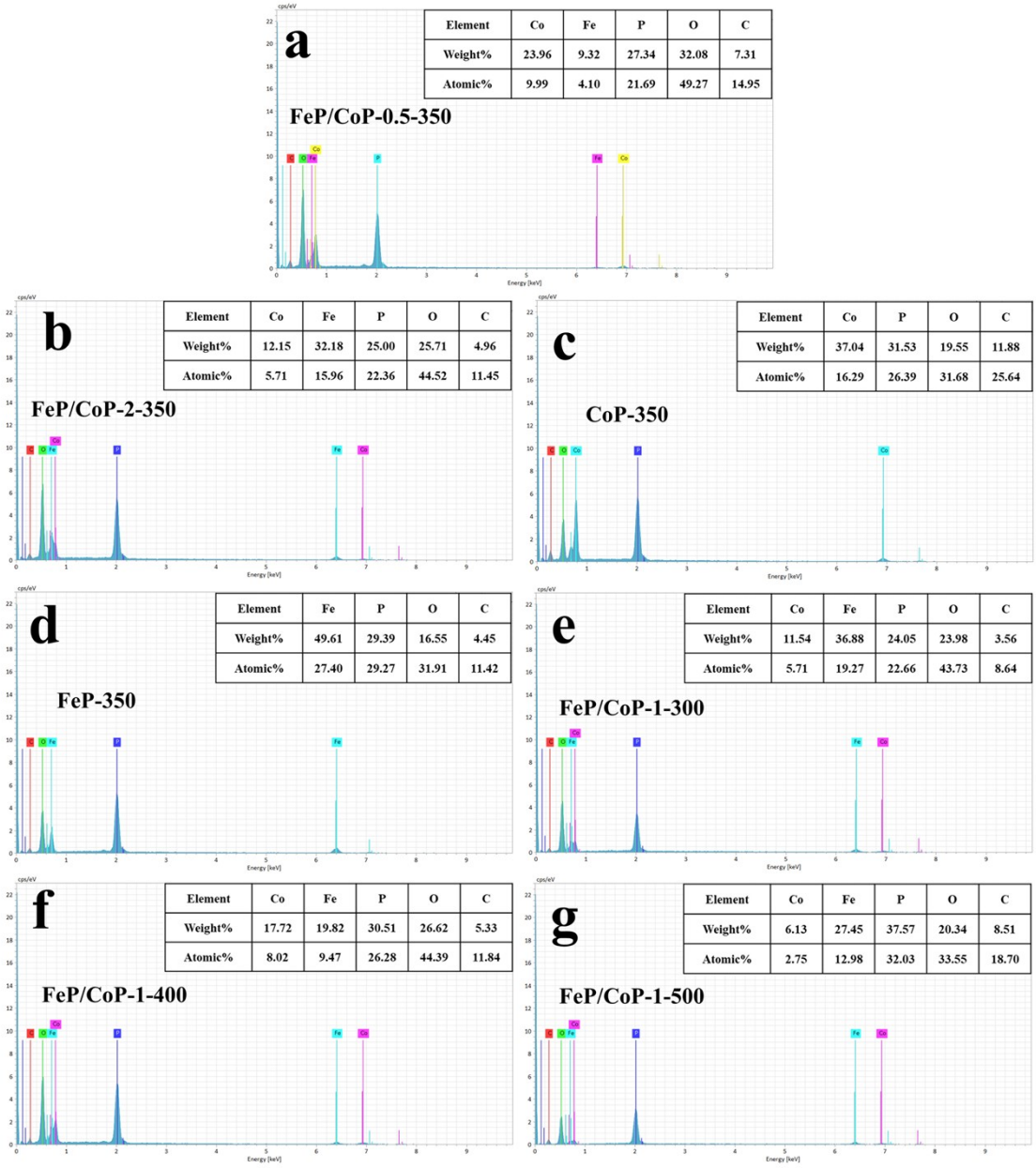


Figure S3. EDS spectrums of (a) FeP/CoP-0.5-350; (b) FeP/CoP-2-350; (c) CoP-350; (d) FeP-350; (e) FeP/CoP-1-300; (e) FeP/CoP-1-400 and (e) FeP/CoP-1-500.

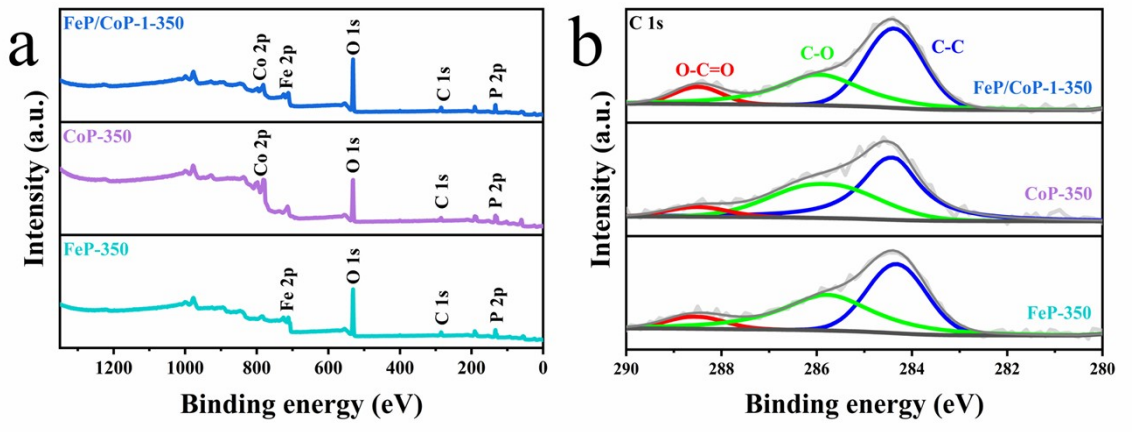


Figure S4. (a) Survey XPS spectra (b) C 1s high-resolution XPS spectra of FeP/CoP-1-350, CoP-350 and FeP-350.

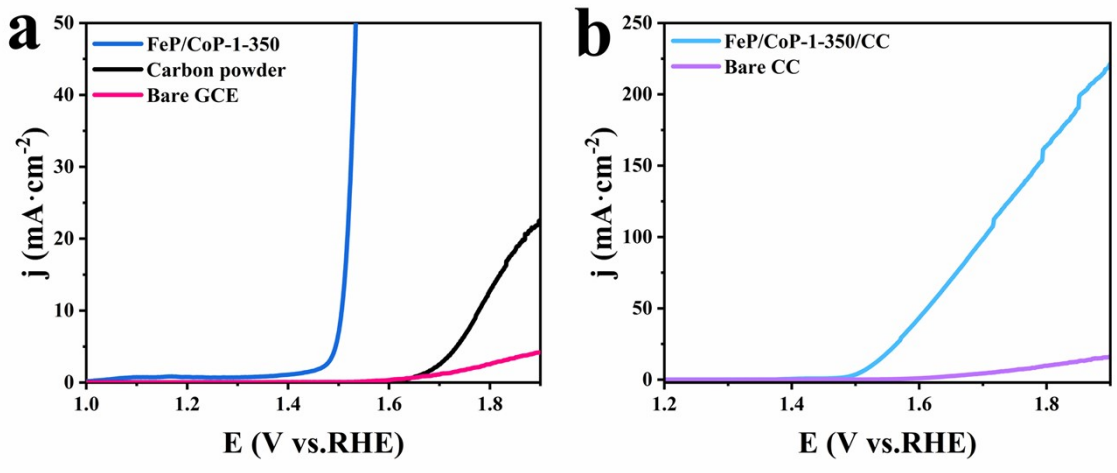


Figure S5. LSV curve of (a) FeP/CoP-1-350, Carbon powder and Bare GCE; (b) FeP/CoP-1-350/CC and Bare CC.

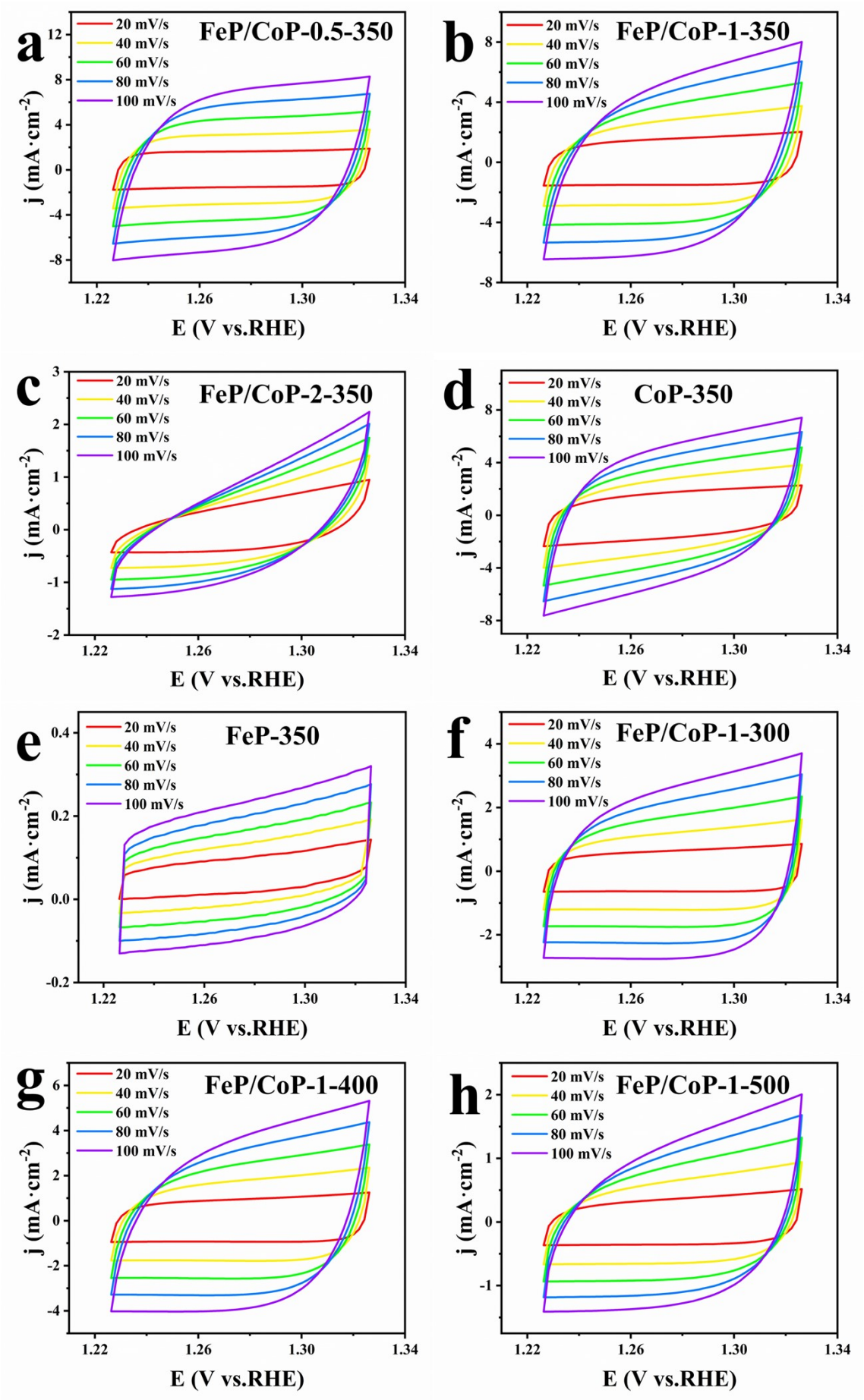


Figure S6. CVs measurement with various scan rates for all samples with various input ratios and phosphating temperatures in 1 M KOH.

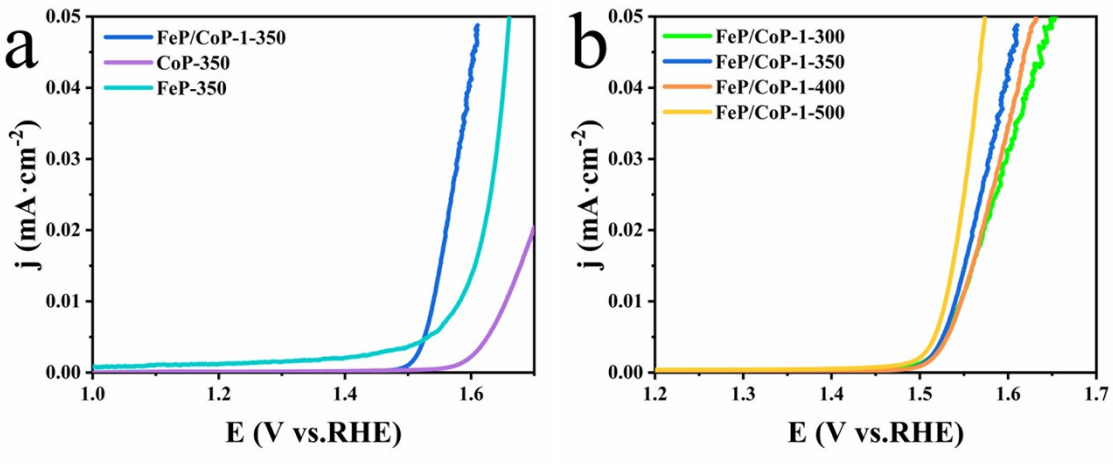
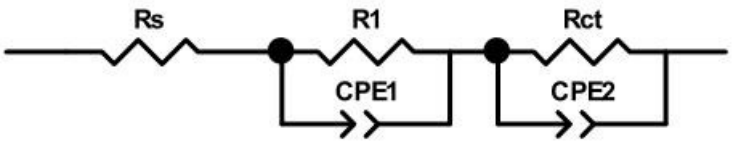


Figure S7. LSV curves normalized by ECSA.

Table S1. The values of charge transfer resistance (R_{ct}) and resistance (R_s) for different samples.

	R_s (Ω)	R_{ct} (Ω)
FeP/CoP-0.5-350	5.206	10.080
FeP/CoP-1-350	4.924	8.857
FeP/CoP-2-350	5.047	12.220
CoP-350	4.949	15.980
FeP-350	5.388	25.080
FeP/CoP-1-300	5.011	9.500
FeP/CoP-1-400	4.813	9.647
FeP/CoP-1-500	4.855	11.77



In the simplified equivalent electrical circuit, R_s is the overall series resistance, CPE_1 and R_1 are the constant phase element and resistance representing electron transport at CoFe-P catalyst/glassy carbon interface and between CoFe-P catalyst, respectively. CPE_2 is the constant phase element of the CoFe-P catalyst/electrolyte interface, and R_{ct} is the charge transfer resistance at CoFe-P catalyst/electrolyte interface related to the OER electrocatalysis process.

Table S2. The values of ECSA for different samples.

	ECSA (cm^2)
FeP/CoP-0.5-350	1709
FeP/CoP-1-350	1292.25
FeP/CoP-2-350	144
CoP-350	1084.5
FeP-350	38.25
FeP/CoP-1-300	642
FeP/CoP-1-400	896.75
FeP/CoP-1-500	286.25

Table S3. The comparison of OER performance between this work and other reported transition metal phosphide catalysts.

Electrocatalysts	Overpotential (mV)	Tafel slop ($mV \cdot dec^{-1}$)	Reference
FeP/CoP-1-350	276	37.71	This Work
NiCoFeP hollow nanoprism	294	50.5	S1
Cu-CoP nanosheets	411	101.4	S2
P@pCoPc/Co_3O_4 nanosheets	320	57.4	S3
CoP/NCNHP	310	70	S4
NiCoFeP films	300	124	S5
CoFeP	350	59	S6
$Ce_{0.5}$-CoP	365	96	S7
CoP/rGO	340	66	S8
CoP NFs	323	49.6	S9
Hollow Mo-CoP nanoboxes	305	56	S10
CoP-TiOx	337	72.1	S11
$Ni_{0.6}Co_{1.4}P$	300	80	S12

References

S1 B. He, C. Xu, Y. Tang, Y. Qian, H. Liu, Q. Hao and Z. Su, *J. Mater. Chem. A*, 2019, **7**, 24964-24972.

S2 L. Yan, B. Zhang, J. Zhu, Y. Li, P. Tsiakaras and P. Kang Shen, *Appl Catal B: Environ*, 2020, **265**, 118555.

S3 Y. Kim, D. Kim, J. Lee, L. Y. S. Lee and D. K. P. Ng, *Adv. Funct. Mater.*, 2021, **31**, 2103290.

S4 Y. Pan, K. Sun, S. Liu, X. Cao, K. Wu, W. C. Cheong, Z. Chen, Y. Wang, Y. Li, Y. Liu, D. Wang, Q. Peng, C. Chen and Y. Li, *J Am Chem Soc*, 2018, **140**, 2610-2618.

S5 S. Kan, M. Xu, W. Feng, Y. Wu, C. Du, X. Gao, Y. A. Wu and H. Liu, *ChemElectroChem*, 2021, **8**, 539-546.

S6 Y. Du, H. Qu, Y. Liu, Y. Han, L. Wang and B. Dong, *Appl. Surf. Sci.*, 2019, **465**, 816-823.

S7 J. Li, S. Zou, X. Liu, Y. Lu and D. Dong, *ACS Sustain Chem Eng*, 2020, **8**, 10009-10016.

S8 G. Zhang, B. Wang, J. Bi, D. Fang and S. Yang, *J. Mater. Chem. A*, 2019, **7**, 5769-5778.

S9 L. Ji, J. Wang, X. Teng, T. J. Meyer and Z. Chen, *ACS Catal*, 2019, **10**, 412-419.

S10 C. Guan, W. Xiao, H. Wu, X. Liu, W. Zang, H. Zhang, J. Ding, Y. P. Feng, S. J. Pennycook and J. Wang, *Nano Energy*, 2018, **48**, 73-80.

S11 Z. Liang, W. Zhou, S. Gao, R. Zhao, H. Zhang, Y. Tang, J. Cheng, T. Qiu, B. Zhu, C. Qu, W. Guo, Q. Wang and R. Zou, *Small*, 2020, **16**, 1905075.

S12 B. Qiu, L. Cai, Y. Wang, Z. Lin, Y. Zuo, M. Wang and Y. Chai, *Adv. Funct. Mater.*, 2018, **28**, 1706008.