Electronic Supplementary Material (ESI) for Materials Advances.
This journal is © The Royal Society of Chemistry 2022

Phosphorus-Modified Pt@Cu Surfaces for Efficient Electrocatalysts of Hydrogen Evolution

Yeshu Tan[1], Longxiang Liu[1], Liquan Zhang[1], Siyu Zhao[2], Dan J.L. Brett[2], Paul R. Shearing[2], Ying Bai[3], Ivan P. Parkin[1]* and Guanjie He[1.2]*

[1]*Christopher Ingold Laboratory, Department of Chemistry, University College London, 20 Gordon Street, London WC1H 0AJ, United Kingdom. Email: g.he@ucl.ac.uk; i.p.parkin@ucl.ac.uk*

[2]*Electrochemical Innovation Laboratory, Department of Chemical Engineering, University College London, London WC1E 7JE, United Kingdom.*

[3]*School of Physics & Electronics, Henan University, Kaifeng 475004, P.R. China*

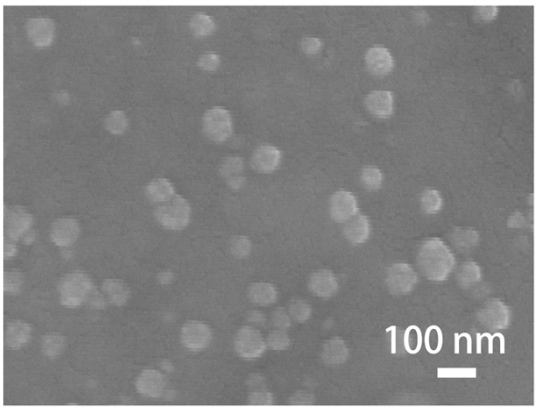

Fig. S1 SEM image of Pt@Cu.

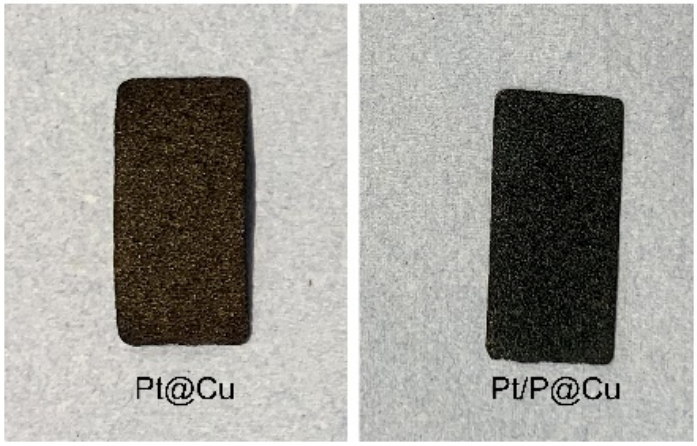

Fig. S2 Photographic images of Pt@Cu and Pt/P@Cu.

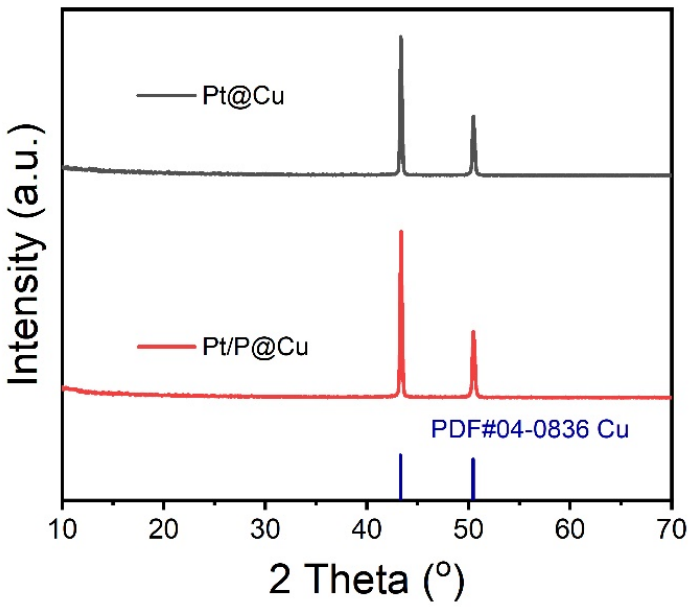

Fig. S3 XRD patterns of Pt@Cu and Pt/P@Cu.

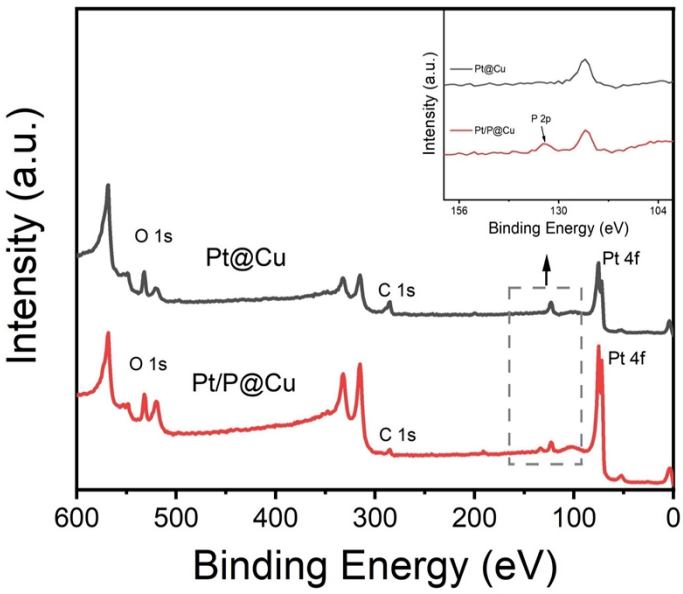

Fig. S4 XPS survey spectra of Pt@Cu and Pt/P@Cu.

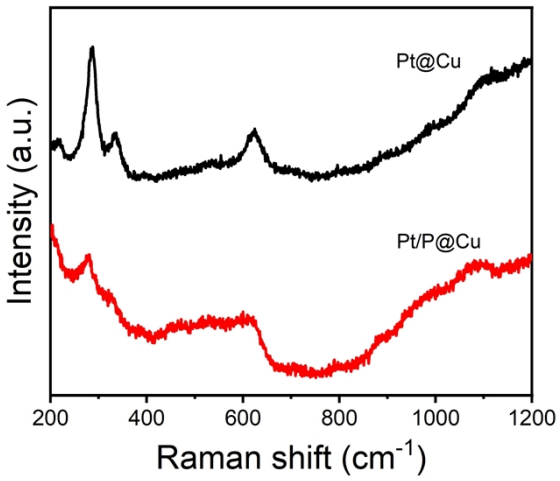

Fig. S5 Raman spectra of Pt@Cu and Pt/P@Cu.

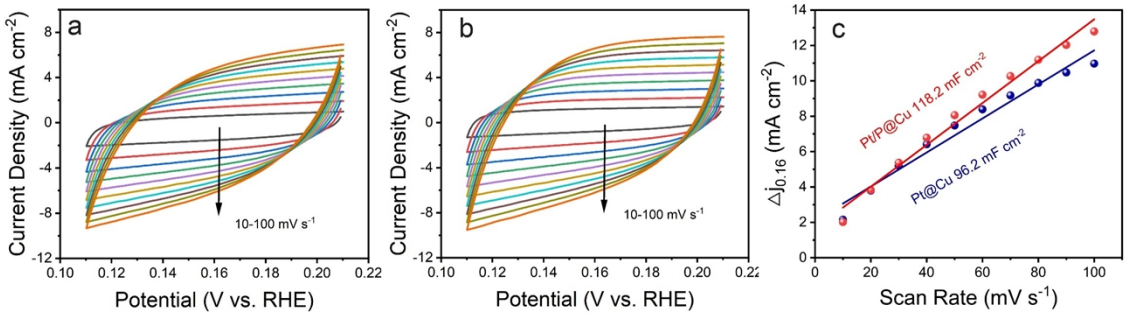

Fig. S6 CV curves of (a) Pt@Cu and (b) Pt/P@Cu with scan rates from 10 mV s^{-1} to 100 mV s^{-1}. (c) Double-layer capacitance of Pt@Cu and Pt/P@Cu.

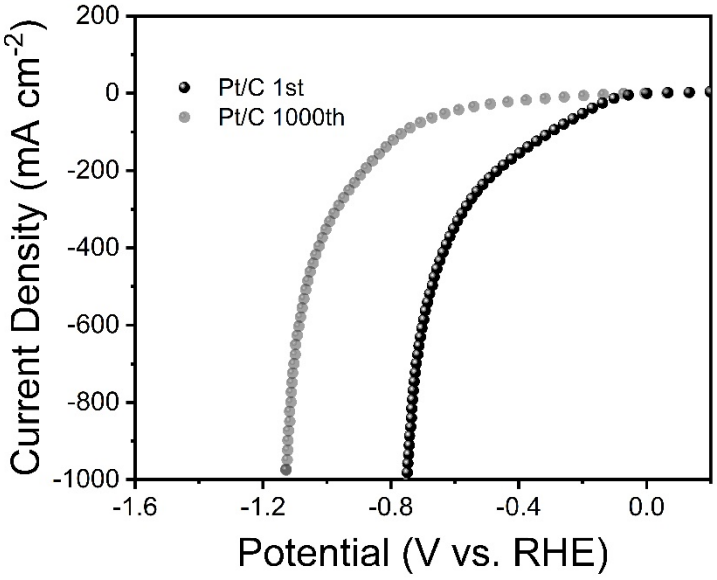

Fig. S7 1000 cycles of LSV tests of Pt/C under a scan rate of 100 mV s^{-1} with iR correction.

Supplementary Table 1. Comparison of overpotentials at a current density of -10 mA cm^{-2} and Tafel slopes of Pt/P@Cu with recently reported Pt-based catalysts in a neutral medium.

Catalysts	Electrolyte	Overpotential at –10 mA cm^{-2} (mV)	Tafel Slope (mV dec^{-1})	Reference
Pt/P@Cu	1 M PBS	24.3	50.2	This work
Pt-$Fe_5Ni_4S_8$	1 M PBS	98	58	[1]
PtRh DNAs	1 M PBS	23	87	[2]
Pt–TiO_{2-x} NS	1 M PBS	88	67.6	[3]
Pt_{SA}/α-MoC_{1-x}@C	1 M PBS	36	30	[4]
Pt/np-$Co_{0.85}Se$	1 M PBS	55	35	[5]
Pt/N-Mo_2C	1 M PBS	49	86.7	[6]
Pt_3Fe/BNC	1 M PBS	72	30.7	[7]
Pt–Pd@NPA	1 M PBS	34.8	32.2	[8]
Pt/VC	1 M PBS	68	65	[9]

Reference

1. C. Zhang, Y. Cui, Y. Yang, L. Lu, S. Yu, Z. Meng, Y. Wu, Y. Li, Y. Wang, H. Tian and W. Zheng, *Adv. Funct. Mater.*, 2021, **31**, 2105372.
2. Z. Han, R.-L. Zhang, J.-J. Duan, A.-J. Wang, Q.-L. Zhang, H. Huang and J.-J. Feng, *Int. J. Hydrogen Energ.*, 2020, **45**, 6110-6119.
3. K. M. Naik, E. Higuchi and H. Inoue, *Nanoscale*, 2020, **12**, 11055-11062.
4. W. Wang, Y. Wu, Y. Lin, J. Yao, X. Wu, C. Wu, X. Zuo, Q. Yang, B. Ge, L. Yang, G. Li, S. Chou, W. Li and Y. Jiang, *Adv. Funct. Mater.*, 2022, **32**, 2108464.
5. K. Jiang, B. Liu, M. Luo, S. Ning, M. Peng, Y. Zhao, Y.-R. Lu, T.-S. Chan, F. M. F. de Groot and Y. Tan, *Nat. Commun.*, 2019, **10**, 1743.
6. Y. Qiu, Z. Wen, C. Jiang, X. Wu, R. Si, J. Bao, Q. Zhang, L. Gu, J. Tang and X. Guo, *Small*, 2019, **15**, 1900014.
7. Y. Qiao, J. Cui, F. Qian, X. Xue, X. Zhang, H. Zhang, W. Liu, X. Li and Q. Chen, *ACS Appl. Nano Mater.*, 2022, **5**, 318-325.
8. C. Yang, H. Lei, W. Z. Zhou, J. R. Zeng, Q. B. Zhang, Y. X. Hua and C. Y. Xu, *J. Mater. Chem. A*, 2018, **6**, 14281-14290.
9. N. Wang, X. Bo and M. Zhou, *ACS Appl. Mater. Interfaces*, 2022, **14**, 23332-23341.