

## Electronic supplementary information

### Designed synthesis of multi-defective $\text{Ti}_{0.9}\text{Cu}_{0.1}\text{N}@\text{Pt}$ as a robust catalyst for oxygen reduction reaction

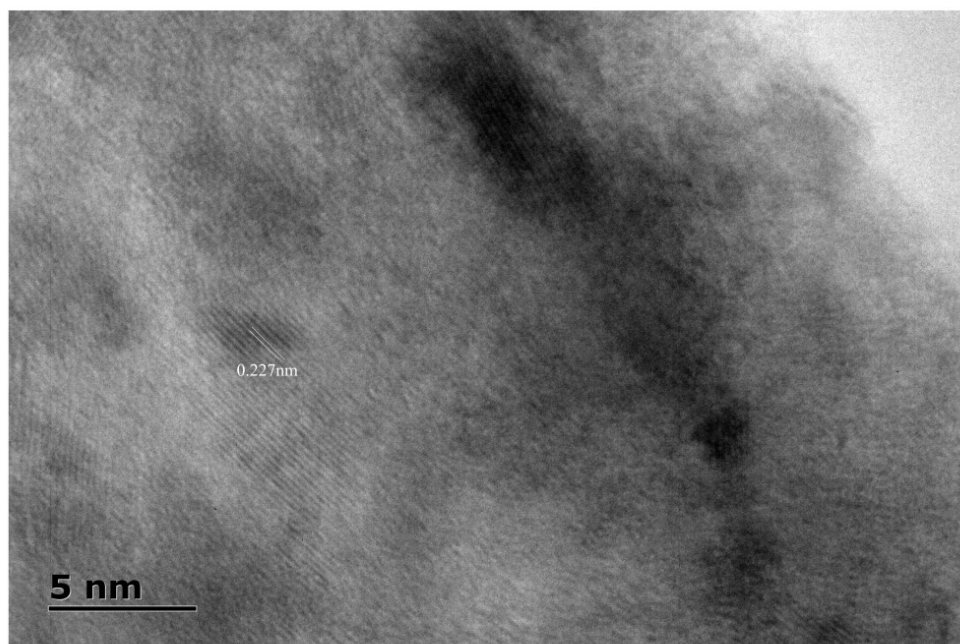
Sipeng Chen,<sup>ab</sup> Jiquan Lu,<sup>ab</sup> Yuying Li,<sup>ab</sup> Yuying Zheng,<sup>ab\*</sup> and Ting Zhu<sup>c\*</sup>

<sup>a</sup> Guangdong Provincial Laboratory of Chemistry and Fine Chemical Engineering  
Jieyang Center, Jieyang 515200, China

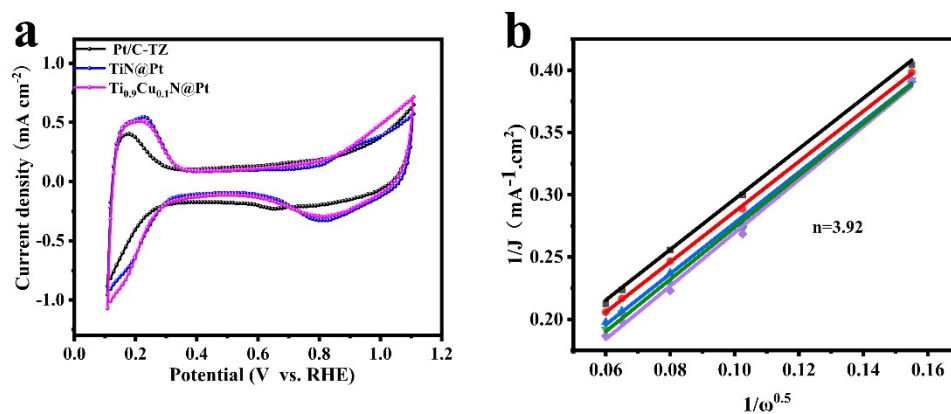
<sup>b</sup> School of Chemical Engineering and Light Industry, Guangdong Provincial Key  
Laboratory of Plant Resources Biorefinery, Guangdong University of Technology,  
Guangzhou 510006, China

<sup>c</sup> School of Physics and Electronic Information, Yunnan Normal University, Kunming  
650500, China.

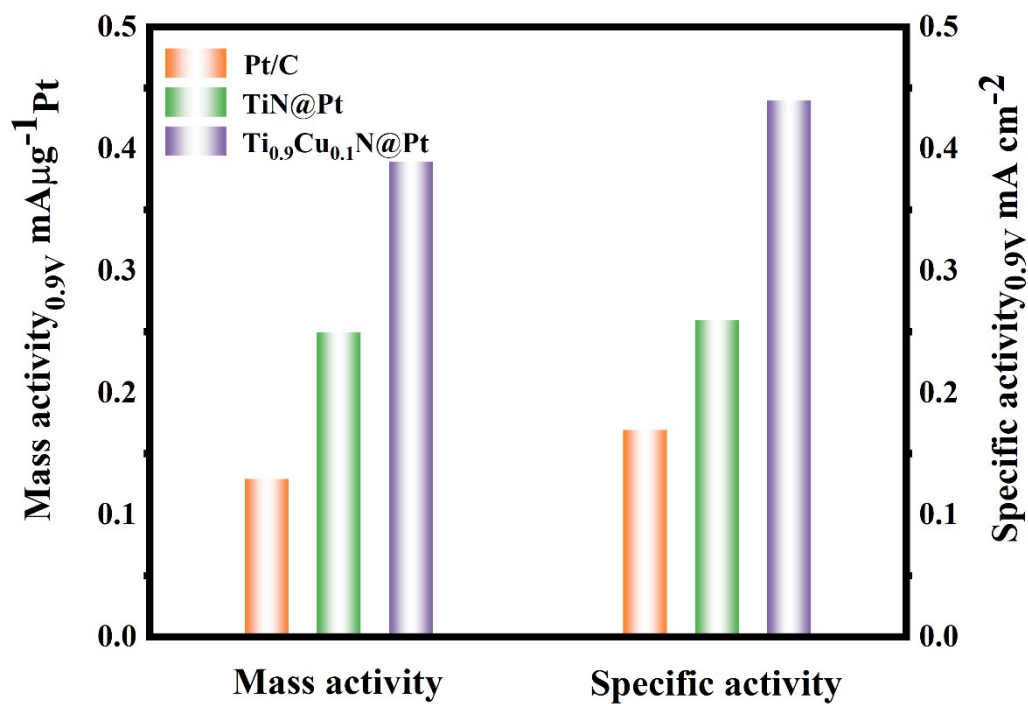
\*Emails: yyz74@gdut.edu.cn (Y.Y. Zheng); zhut0002@ynnu.edu.cn (T. Zhu)



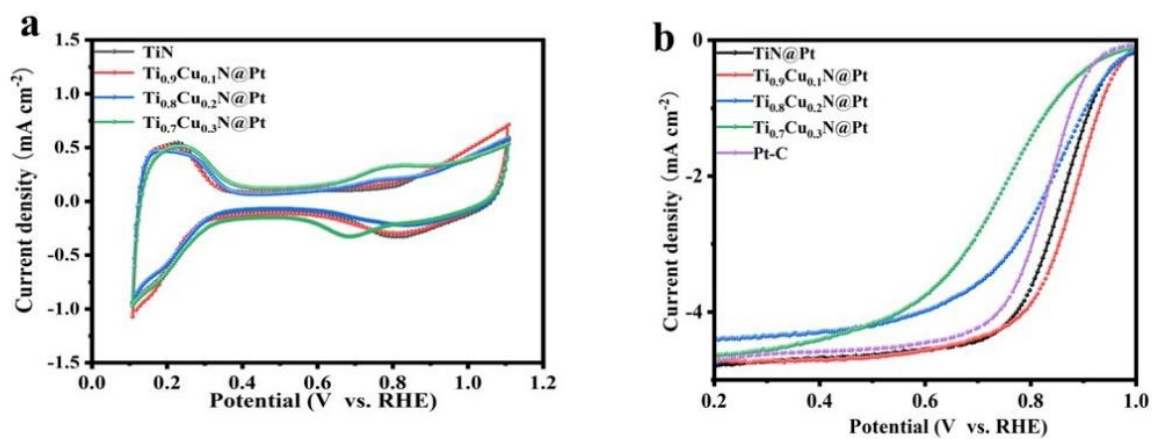
**Fig. S1.** HR-TEM image of the TiN@Pt control sample.



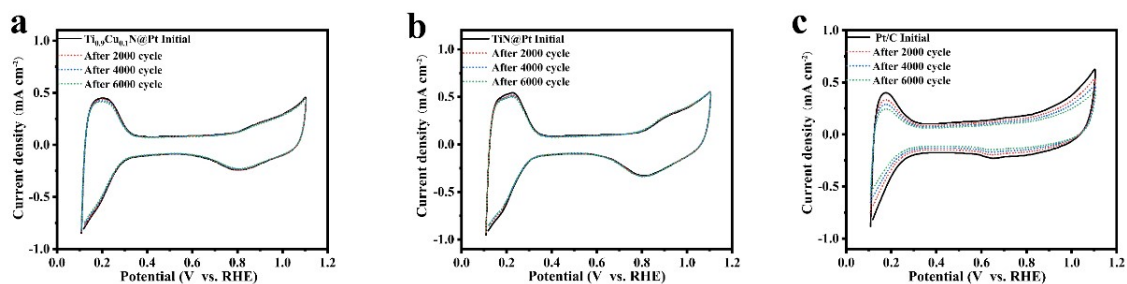
**Fig. S2.** (a) CV curves of TiN@Pt,  $\text{Ti}_{0.9}\text{Cu}_{0.1}\text{N@Pt}$ , Pt/C, and (b) Koutecky–Levich plots.



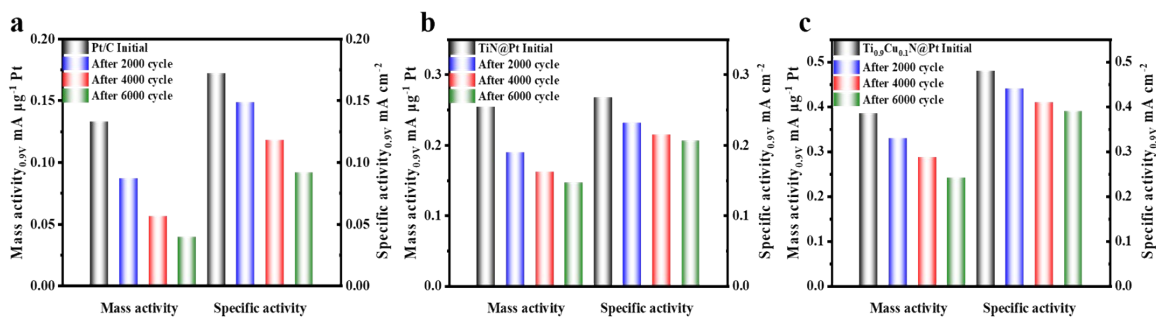
**Fig. S3.** The mass activities and specific activities of all the samples.



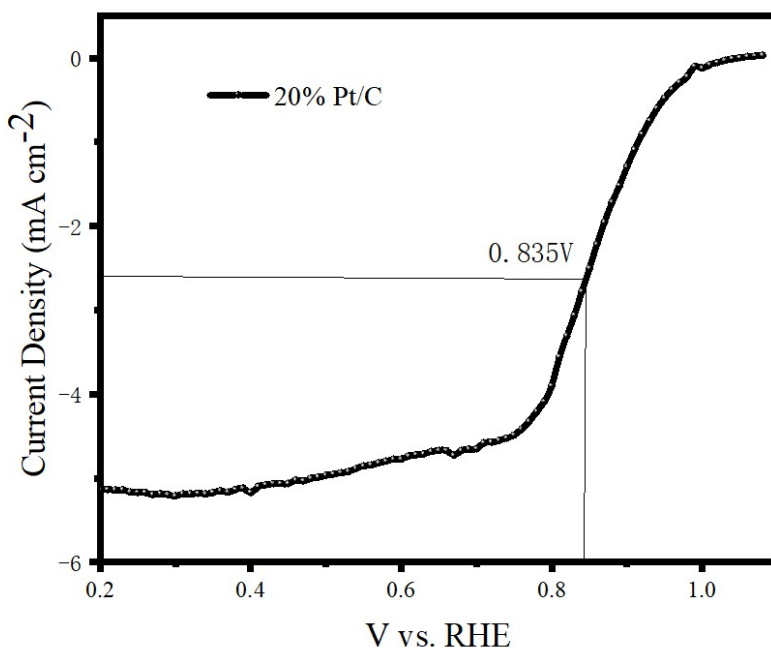
**Fig. S4.** (a) CVs of Ti<sub>x</sub>Cu<sub>y</sub>N@Pt, and (b) LSVs of Ti<sub>x</sub>Cu<sub>y</sub>N@Pt in a solution saturated with O<sub>2</sub> measured with RDE at 1600 rpm and a scan rate of 10 mV s<sup>-1</sup>.



**Fig. S5.** CVs of (a) TiN@Pt, (b)  $\text{Ti}_{0.9}\text{Cu}_{0.1}\text{N@Pt}$ , and (c) Pt/C before and after 6000 cycles.



**Fig. S6.** Comparisons of MA and SA performance of Pt/C, TiN@Pt, and  $\text{Ti}_{0.9}\text{Cu}_{0.1}\text{N@Pt}$  at 0.9 V (verse RHE) before and after ADT.



**Fig. S7.** The LSV curve of the 20% Pt/C control sample obtained a scan rate of  $10 \text{ mV s}^{-1}$  at 1600 rpm in  $0.1 \text{ M KClO}_4$  solution.

**Table S1.** The of  $E_{1/2}$  values of the 20%Pt/C samples reported in previous work.

Material	$E_{1/2}$	References
20%Pt/C	0.82	A facile synthesis for nitrogen-doped carbon catalyst with high activity of oxygen reduction reaction in acidic media. International Journal of Energy Research, 2021, 45(13)
20%Pt/C	0.84	Platinum Particles Electrochemically Deposited on Multiwalled Carbon Nanotubes for Oxygen Reduction Reaction in Acid Media. Journal of The Electrochemical Society, 2017, 164(9): F1014.
20%Pt/C	0.835	Atomically Dispersed Co <sub>2</sub> -N <sub>6</sub> and Fe-N <sub>4</sub> Costructures Boost Oxygen Reduction Reaction in Both Alkaline and Acidic Media, Advanced Materials, 2021, 33, 49, 2104718