Supporting Information

Hierarchical CuO nanorod arrays in situ generated on three-dimensional copper foam via cyclic voltammetry oxidization for high-performance supercapacitors

Ying Liu†, Xueying Cao†, Degang Jiang, Dedong Jia, Jingquan Liu*

College of Material Science and Engineering, Institute for Graphene Applied Technology Innovation, Collaborative Innovation Centre for Marine Biomass Fibers, Materials and Textiles of Shandong Province, Qingdao University, Qingdao 266071, Shandong, China.

† Ying Liu and Xueying Cao contributed equally to this work.

*Corresponding author. Tel: +86 532 83780128. E-mail: jliu@qdu.edu.cn (Jingquan Liu)

Part I: Calculations

The formula to calculate the mass of CuO is as below:

M (CuO) = [*m* (Cu@CuO) - *m* (Cu)]×80/16

Where *m* (Cu@CuO) is the total mass of Cu@CuO composites, *m* (Cu) is the mass of pure Cu.

Part II: Supplementary Figures

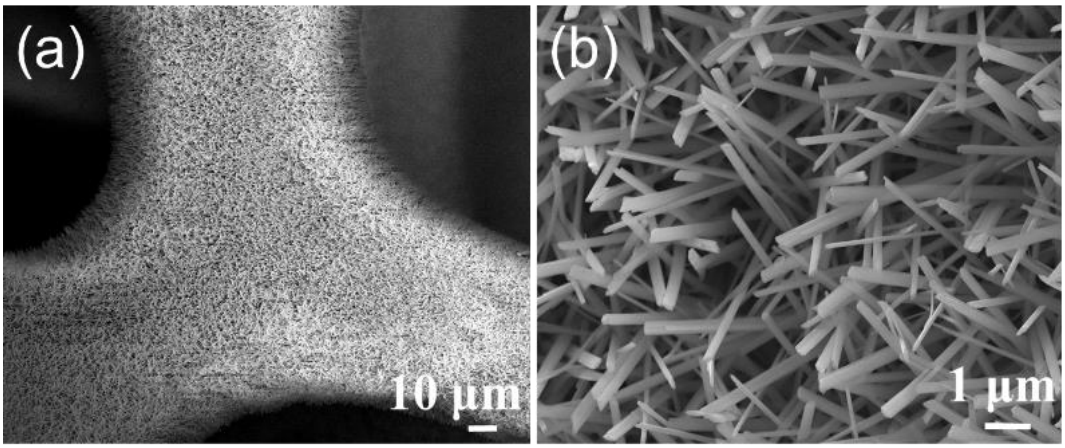

Fig. S1 (a,b) SEM images of the $Cu(OH)_2$ nanorod arrays

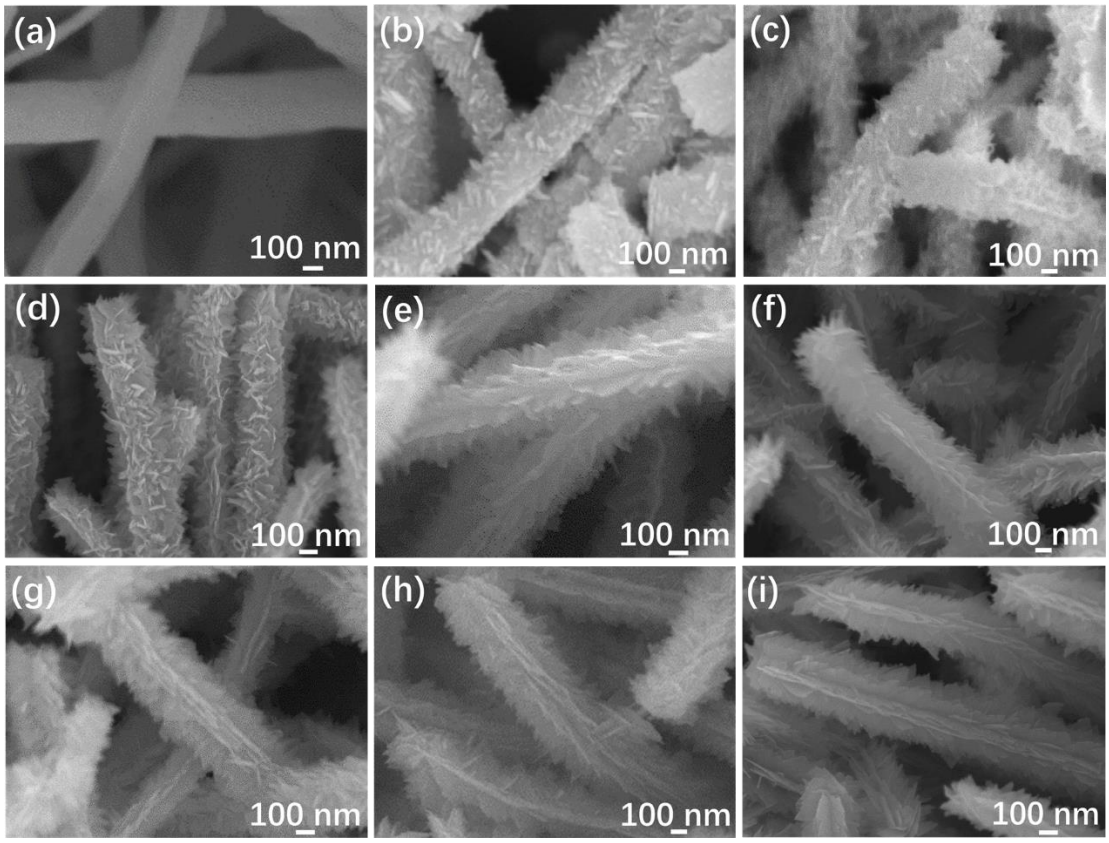

Fig. S2 SEM images of CuO nanorods obtained from different CV cycle numbers. (a) 0 cycle. (b) 500 cycles. (c) 1000 cycles. (d) 1500 cycles. (e) 2000 cycles. (f) 3000 cycles. (g) 4000 cycles. (h) 5000 cycles. (i) 6000 cycles.

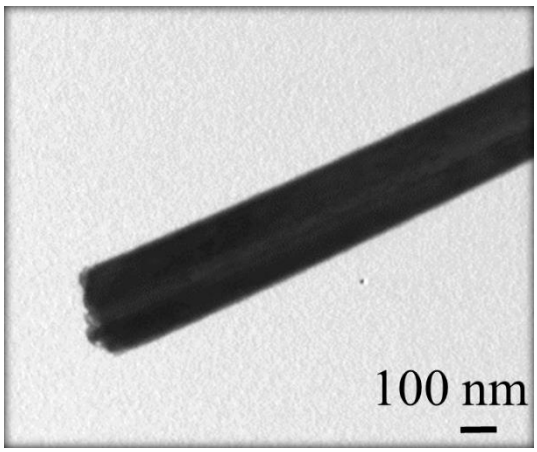

Fig. S3 TEM image of $Cu(OH)_2$ nanorod arrays.

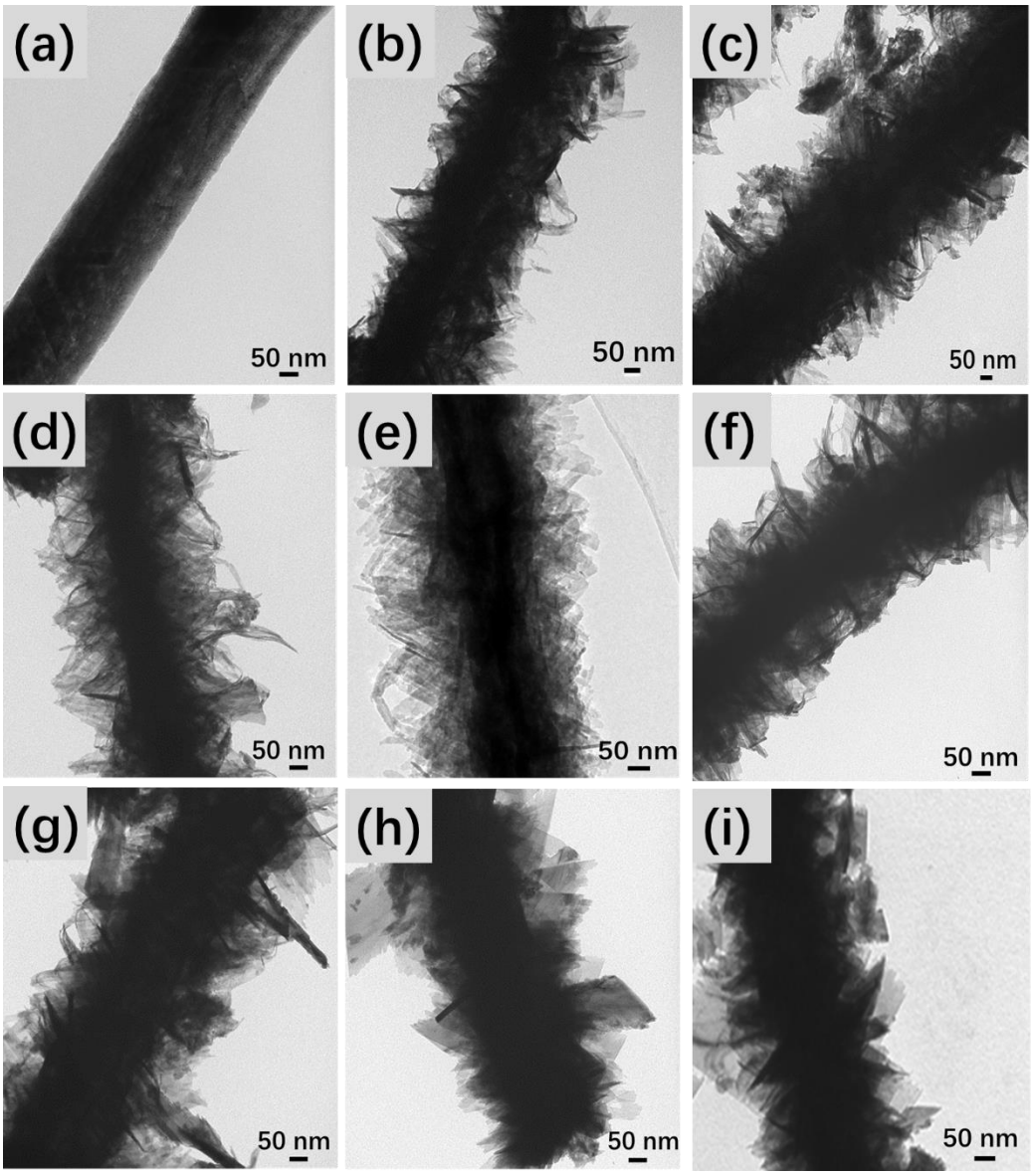

Fig. S4 TEM images of CuO nanorods obtained from different CV cycle numbers. (a) 0 cycle. (b) 500 cycles. (c) 1000 cycles. (d) 1500 cycles. (e) 2000 cycles. (f) 3000 cycles. (g) 4000 cycles. (h) 5000 cycles. (i) 6000 cycles.

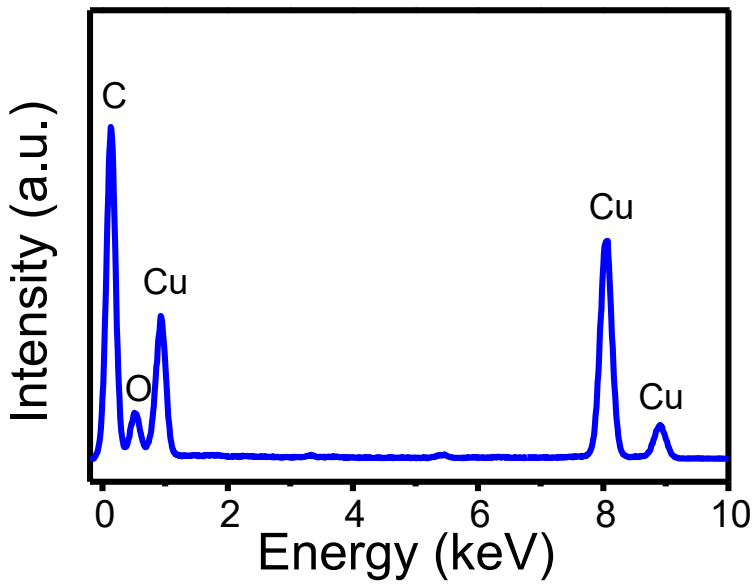

Fig. S5 EDX spectra of CVO Cu@CuO

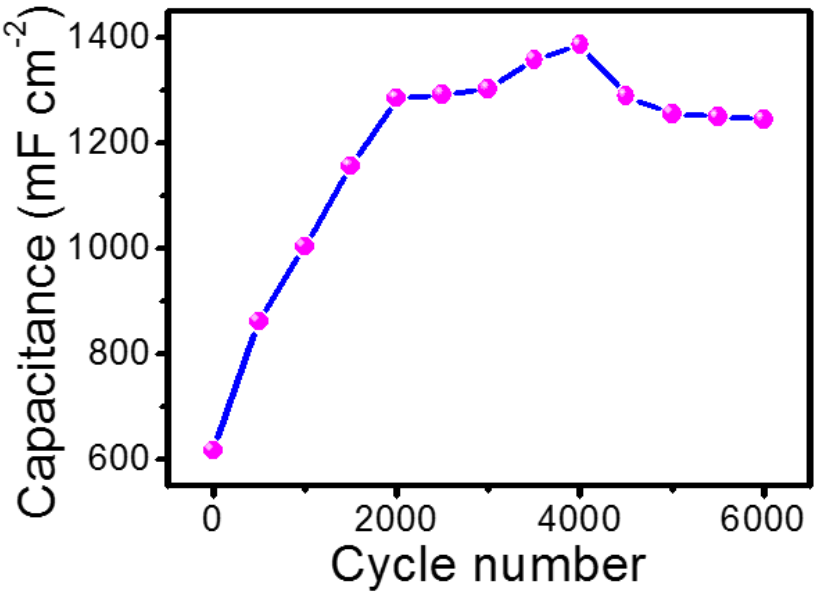

Fig. S6 The curve of capacitance of CuO nanorod arrays with the increasing CV cycle numbers.

Table 1. The weight of CuO and the gravimetric capacitance of the Cu@CuO electrode in the cycle course.

Cycle number	***m* (mg)**	***I* (A g^{-1})**	C_m **(F g^{-1})**
0	2.80	7.14	220.35
500	2.79	7.17	279.65
1000	2.78	7.19	331.89
1500	2.80	7.14	383.76
2000	2.80	7.14	428.40
2500	2.79	7.17	433.94
3000	2.80	7.14	436.10
3500	2.79	7.17	457.78
4000	2.82	7.09	462.44
4500	2.81	7.12	429.64
5000	2.80	7.14	419.37
5500	2.80	7.14	416.99
6000	2.79	7.17	416.97

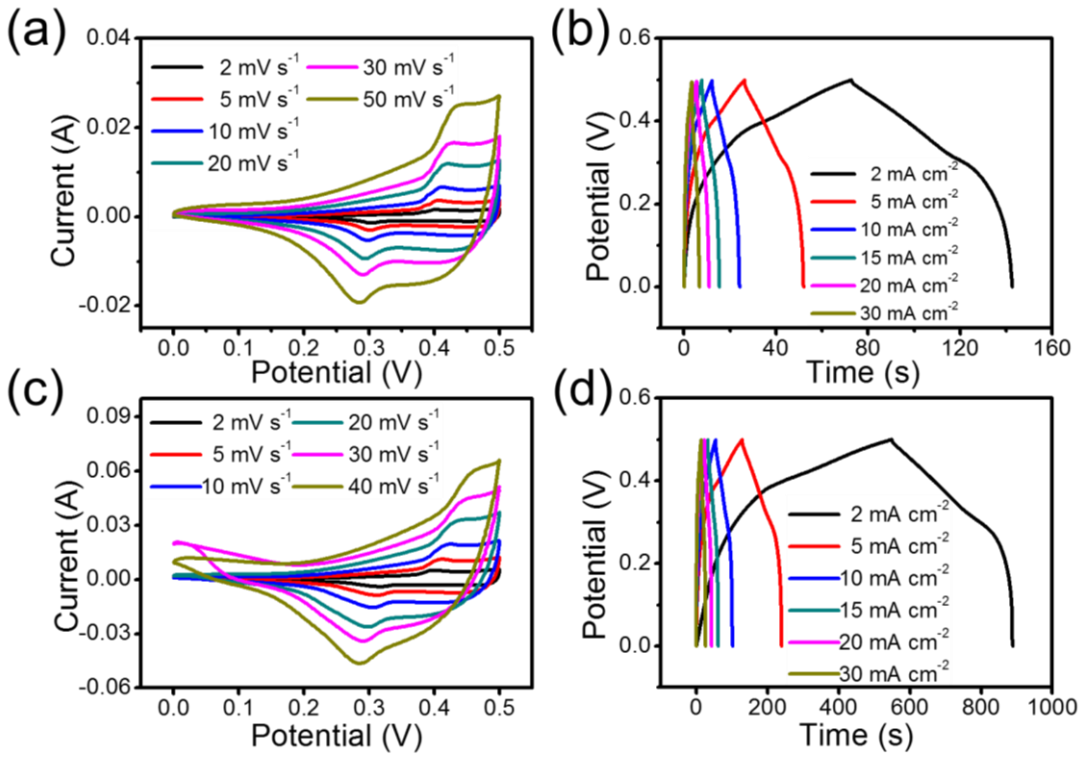

Fig. S7 Electrochemical characterization of the Cu@$Cu(OH)_2$ and Cu@CuO nanorod arrays electrode in 6 M KOH aqueous solution. (a) CV curves of the electrode at various scan rates from 2 to 50 mV s^{-1}. (b) Galvanostatic charge-discharge curves of the electrode at various current densities from 2 to 30 mA cm^{-2}. (c) CV curves of the electrode at various scan rates from 2 to 50 mV s^{-1}. (d) Galvanostatic charge-discharge curves of the electrode at various current densities from 2 to 30 mA cm^{-2}.

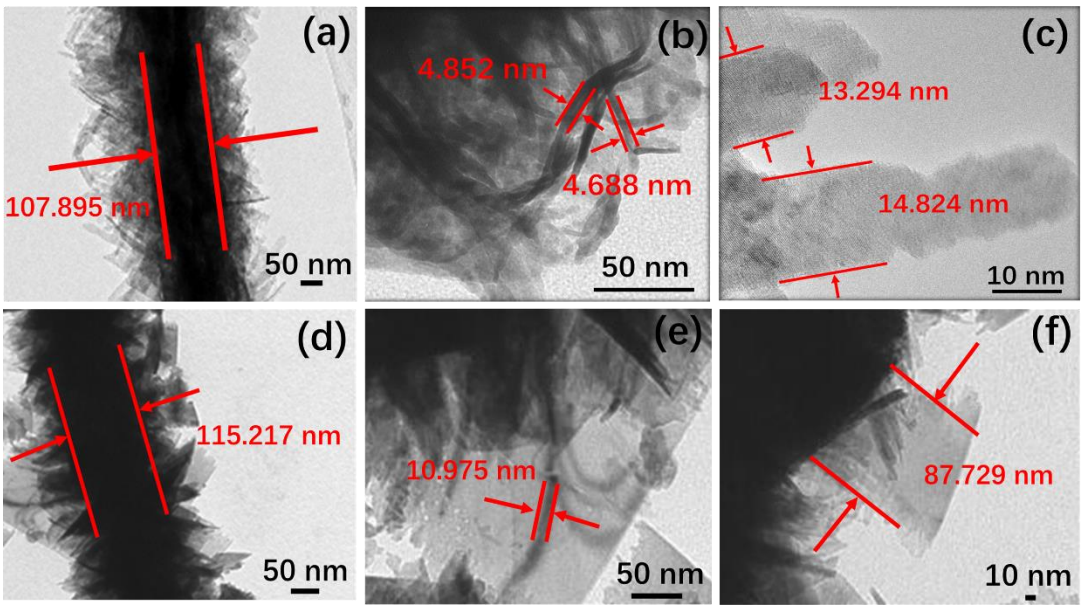

Fig. S8 TEM images of CuO nanorods and nanosheets. (a-c) Before cycle test, (d-f) after the test for 4000 cycles.

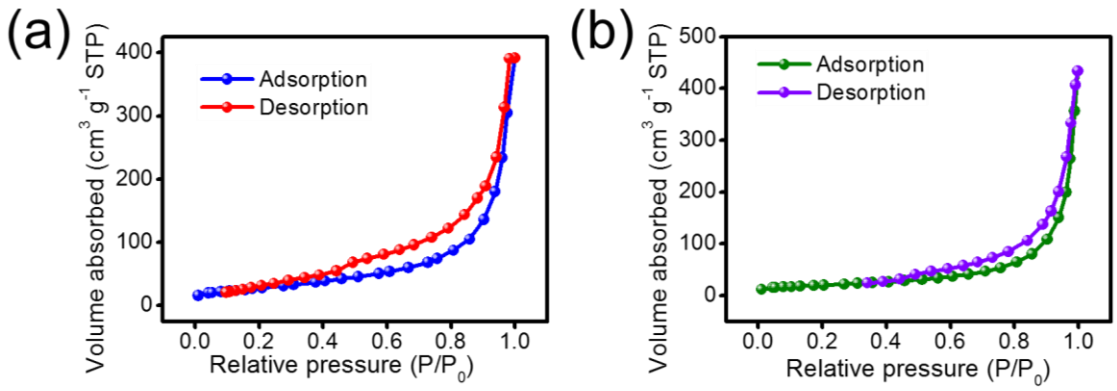

Fig. S9 N_2 adsorption-desorption isotherms of the CVO Cu@CuO nanorod arrays. (a) Before cycle test, (b) after the test for 4000 cycles.

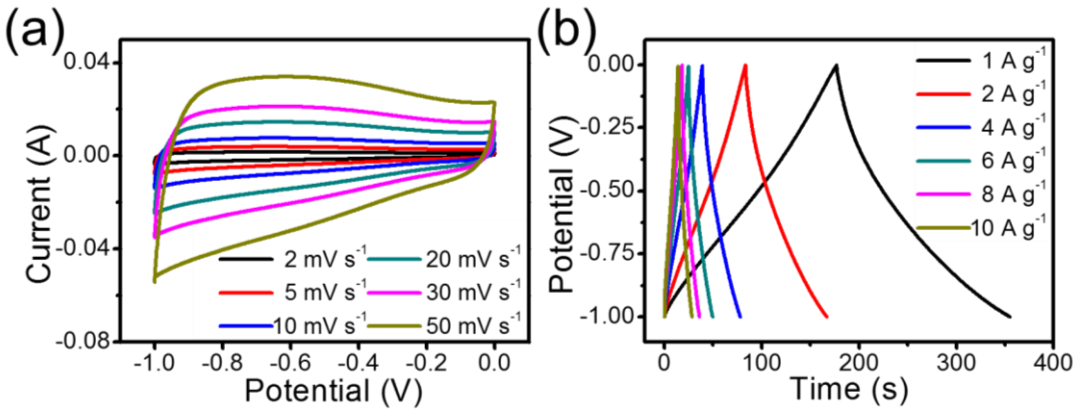

Fig. S10 Electrochemical characterization of the active carbon electrode in the 6 M KOH aqueous solution. (a) CV curves of the electrode at various scan rates from 2 to 50 mV s^{-1}. (b) Galvanostatic charge-discharge curves of the electrode at various current densities from 1 to 10 A g^{-1}.

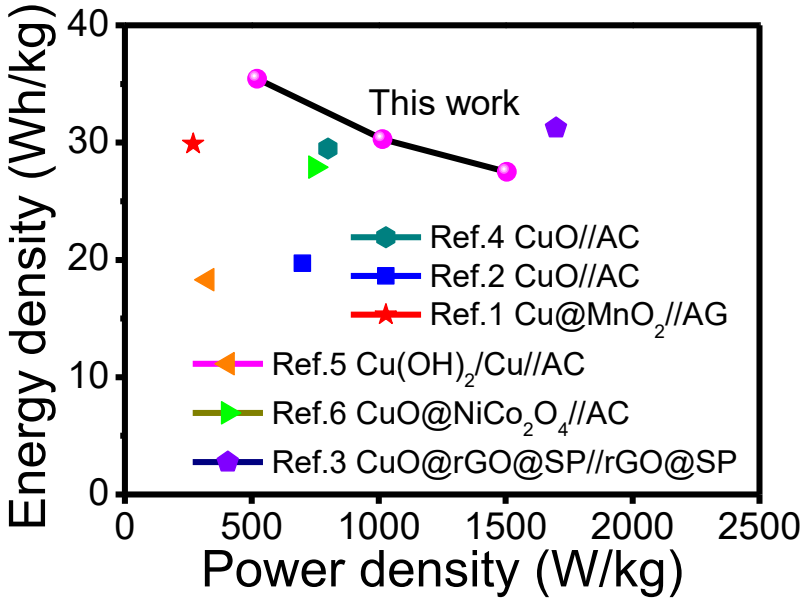

Fig. S11 Ragone plot of the as-prepared ASC device compared with those previously reported.

References

1 H. Chen, M. Zhou, T. Wang, F. Li, Y.X. Zhang, *J. Mater. Chem. A*, 2016, **4**, 10786-10793.

2 S.E. Moosavifard, M.F. El-Kady, M.S. Rahmanifar, R.B. Kaner, M.F. Mousavi, *ACS Appl. Mater. Interfaces*, 2015, **7**, 4851-4860.

3 D.P. Dubal, N.R. Chodankar, G.S. Gund, R. Holze, C.D. Lokhande, P. Gomez-Romero, *Energy Technol.*, 2015, **3**, 168-176.

4 B. Vidyadharan, I.I. Misnon, J. Ismail, M.M. Yusoff, R. Jose, *J. Alloy. Compd.*, 2015, **633**, 22-30.

5 P. Xu, K. Ye, M. Du, J. Liu, K. Cheng, J. Yin, G. Wang, D. Cao, *RSC Adv.*, 2015, **5**, 36656-36664.

6 C. Wu, J. Cai, Y. Zhu, K. Zhang, *RSC Adv.*, 2016, **6**, 63905-63914.