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Ultra-uniform CuO/Cu in nitrogen-doped carbon nanofibers as a stable anode for Li-ion batteries

Hang Zhang,[1] Guanhua Zhang,[2] Zhiqin Li,[2] Ke Qu,[3] Lei Wang,[2] Wei Zeng,[1] Qingfeng Zhang[2] & Huigao Duan[2,*]

1 College of Chemistry and Chemical Engineering, State Key Laboratory for Chemo/Biosensing and Chemometrics, Hunan University, Changsha 410082, P. R. China

2 School of Physics and Electronics, Key Laboratory for Micro-Nano Optoelectronic Devices of Ministry of Education, Hunan University, Changsha 410082, P. R. China

3 School of Physical Science and Technology, Lanzhou University, Lanzhou 730000, P. R. China

* Corresponding author: E-mail: duanhg@hnu.edu.cn

Content

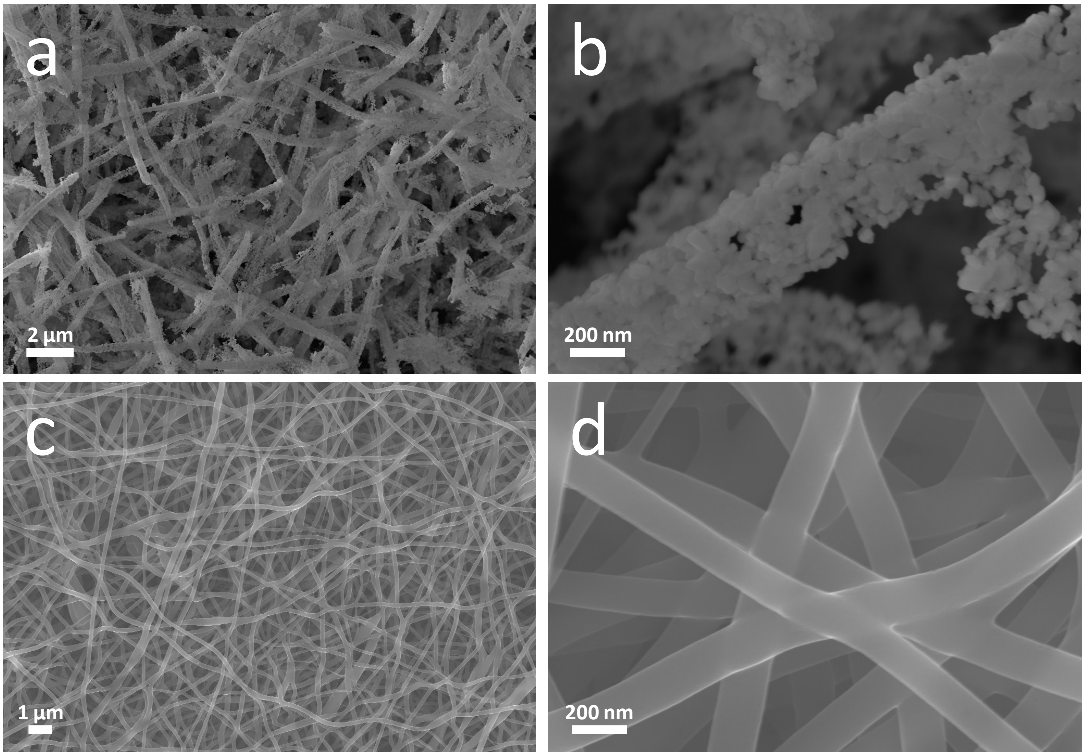

Fig. S1. a) SEM image and b) high magnification SEM image of CuO NFs. c) SEM image and d) high magnification SEM image of C NFs.

Theoretical calculation of Cu in CuO/Cu/C NFs

As Cu element comes from copper acetate monohydrate, carbon is derived from pyrolysis of PAN with high carbon yields (about 70%[1]). The percentage content of Cu element is calculated as follows:

$$m_{Cu} = n_{Cu(CH_3COO)_2 \cdot H_2O} \times M_{Cu} = \frac{m_{Cu(CH_3COO)_2 \cdot H_2O}}{M_{Cu(CH_3COO)_2 \cdot H_2O}} \times M_{Cu} \tag{1}$$

$$= \frac{0.28\ g}{199.65\ g \cdot mol^{-1}} \times 63.55\ g \cdot mol^{-1} = 0.089\ g$$

$$m_C = m_{PAN} \times 70\% \tag{2}$$

$$= 0.8\ g \times 70\% = 0.560\ g$$

$$W_{Cu}\% = \frac{m_{Cu}}{m_{Cu} + m_C} \times 100\% \tag{3}$$

$$= \frac{0.089\ g}{0.089\ g + 0.560\ g} \times 100\% \approx 13.7\%$$

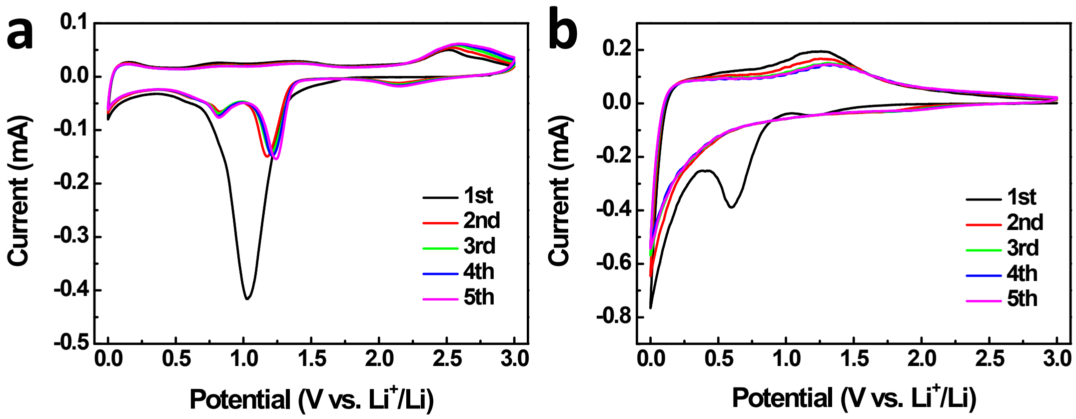

Fig. S2. CV curves of a) CuO NFs and b) N-doped C NFs at a scanning rate of 0.1 mV s^{-1} between 0.005 and 3 V.

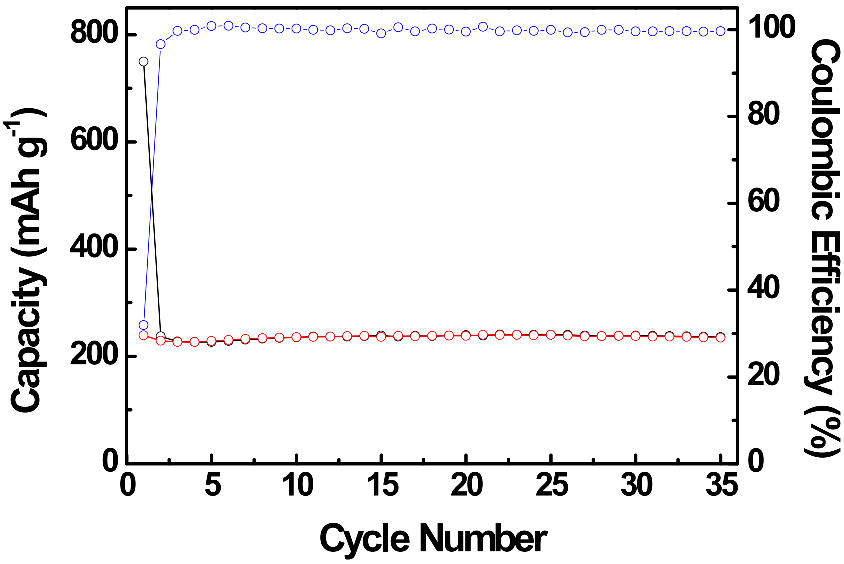

Fig. S3. Cycling performance of CuO NFs at a current density of 0.5 A g^{-1}.

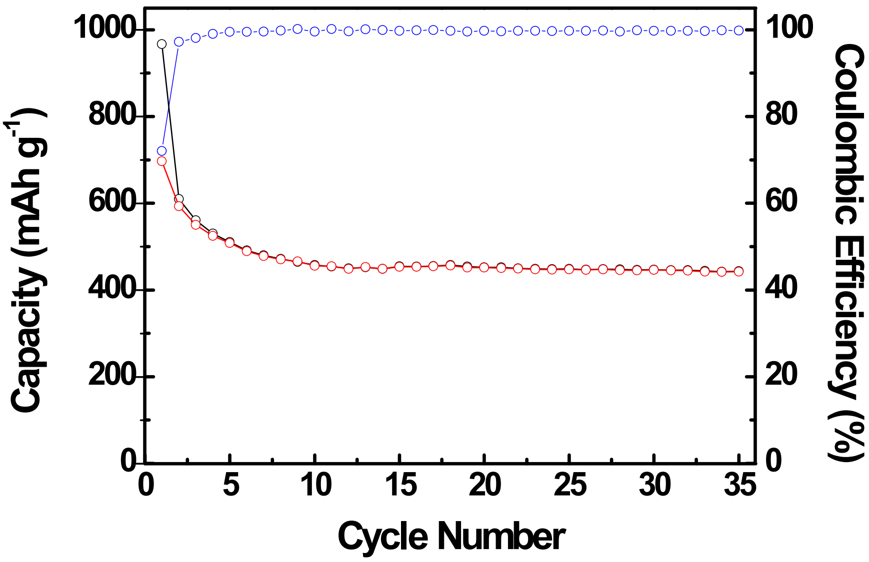

Fig. S4. Cycling performance of N-doped C NFs at a current density of 0.5 A g^{-1}.

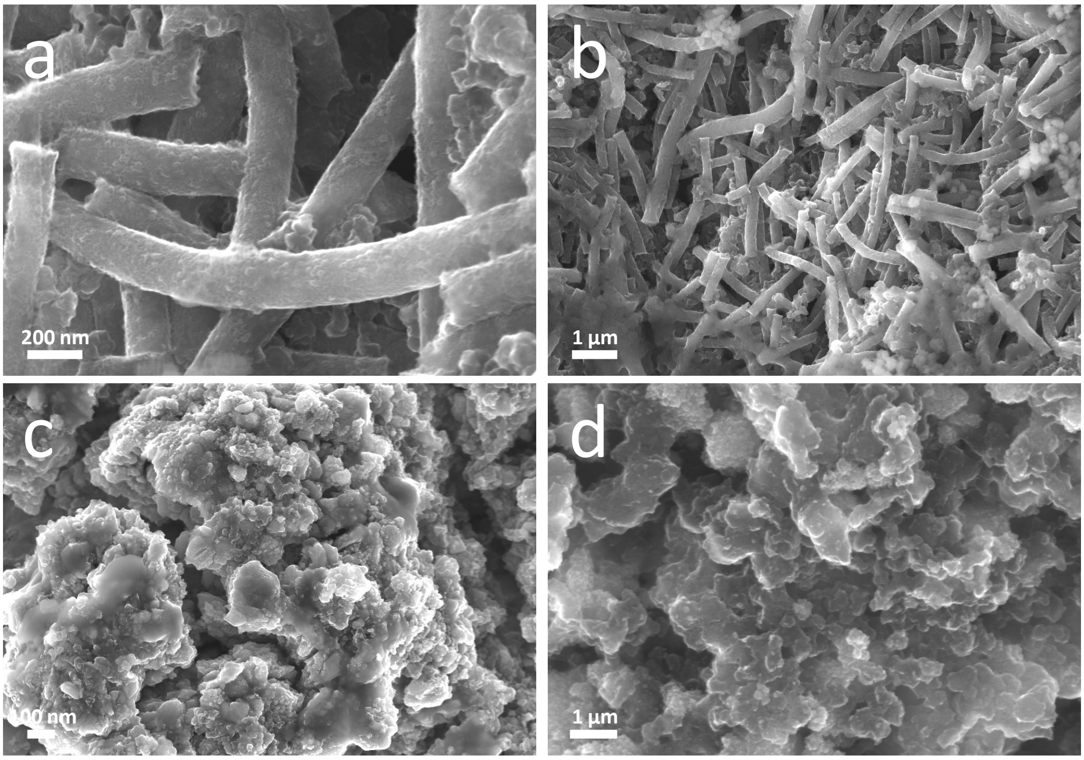

Fig. S5. SEM images of electrode materials after 80th rate testing. a) and b) CuO/Cu/C NFs; c) and d) pure CuO NFs.

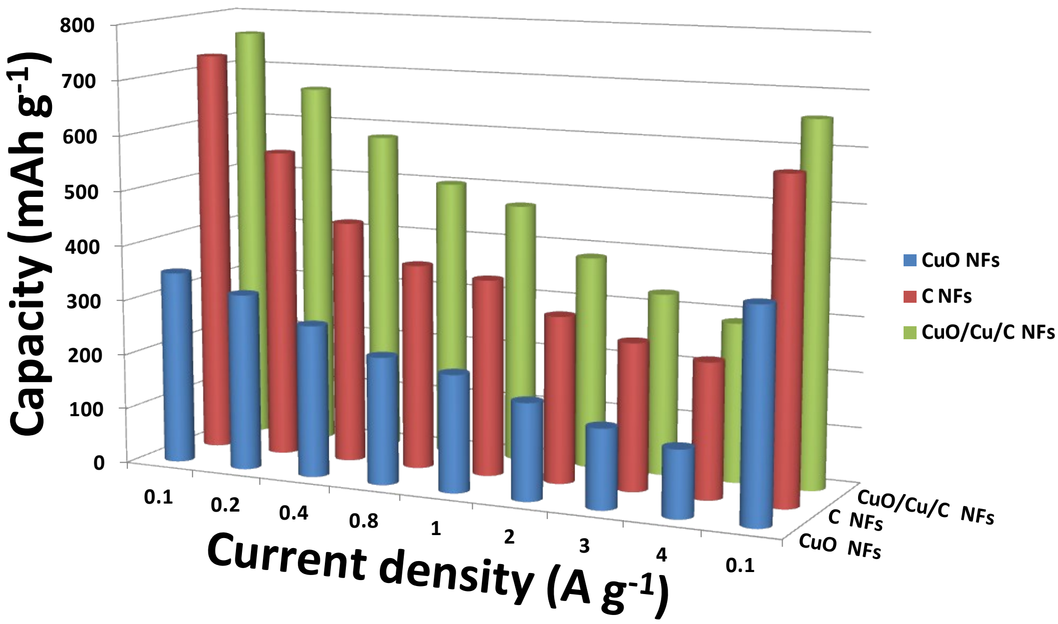

Fig. S6. Rate performance of CuO/Cu/C, C, CuO NFs tested for comparison.

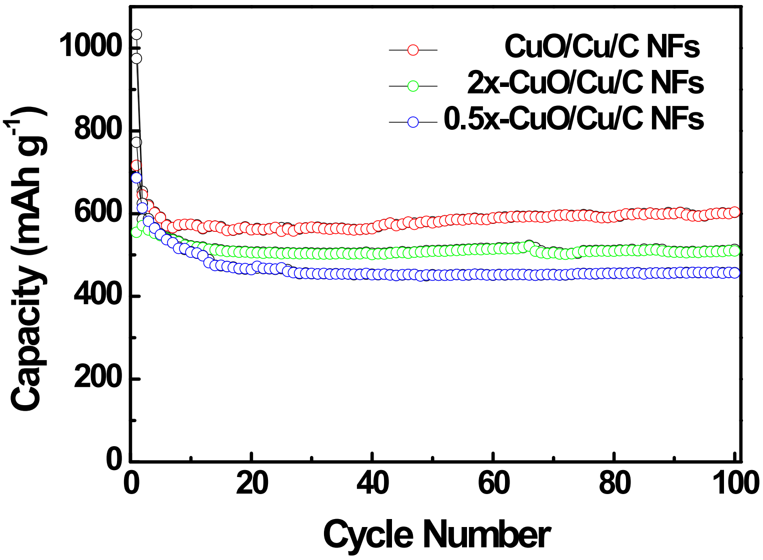

Fig. S7. Cycling performance of the CuO/Cu/C NFs, 2x-CuO/Cu/C NFs and 0.5x-CuO/Cu/C NFs electrodes at a current density of 0.5 A g^{-1}.

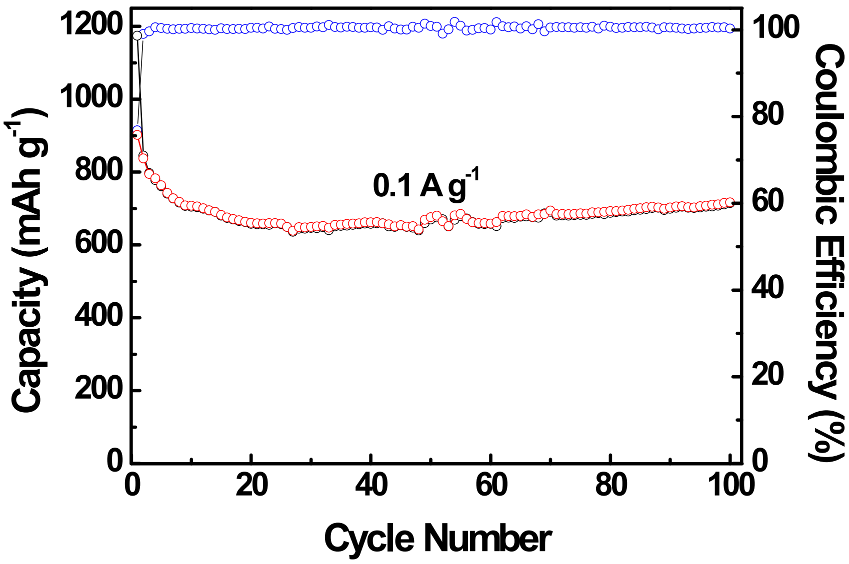

Fig. S8. Cycling performance and Coulombic efficiency of CuO/Cu/C NFs at a constant current density of 0.1 A g^{-1}.

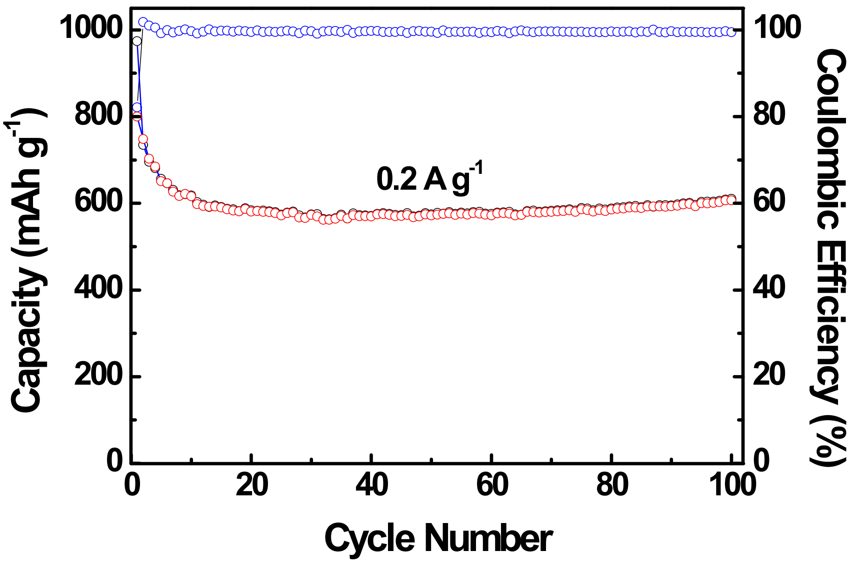

Fig. S9. Cycling performance and Coulombic efficiency of CuO/Cu/C NFs at a constant current density of 0.2 A g^{-1}.

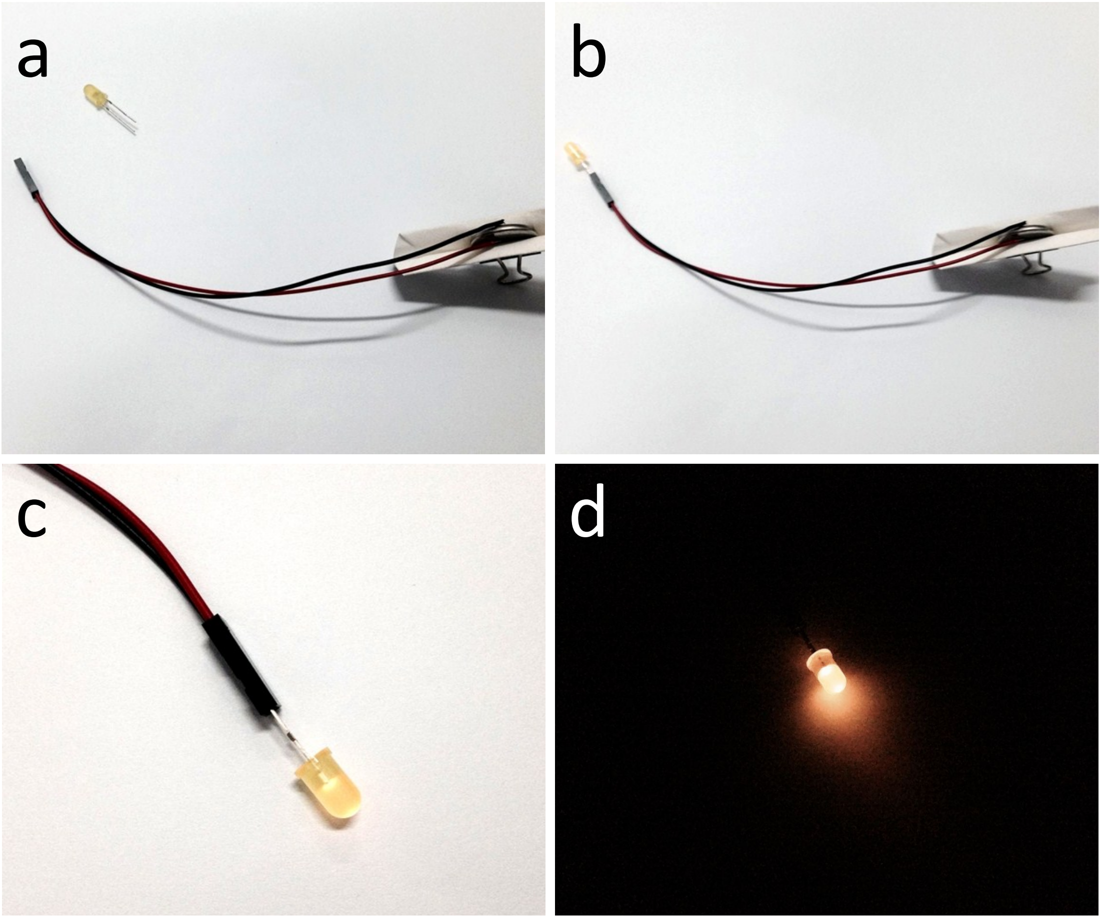

Fig. S10. Photographs of a LED lighted by one coin cell prepared from CuO/Cu/C NFs electrode. a) Off-state; b) on-state; c) durable light in daylight; d) bright yellow light in darkness.

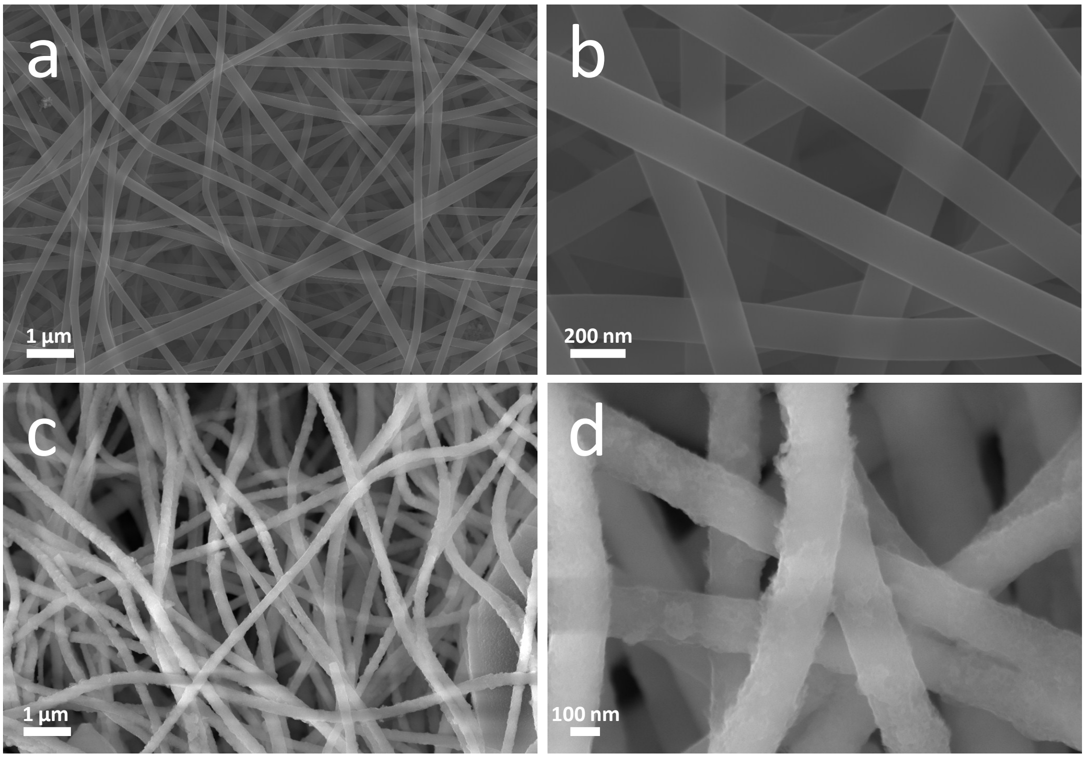

Fig. S11. a) SEM image and b) high magnification SEM image of flexible CuO/Cu/C NFs electrode before 100 cycles; c) SEM image and d) high magnification SEM image of flexible CuO/Cu/C NFs electrode after 100 cycles.

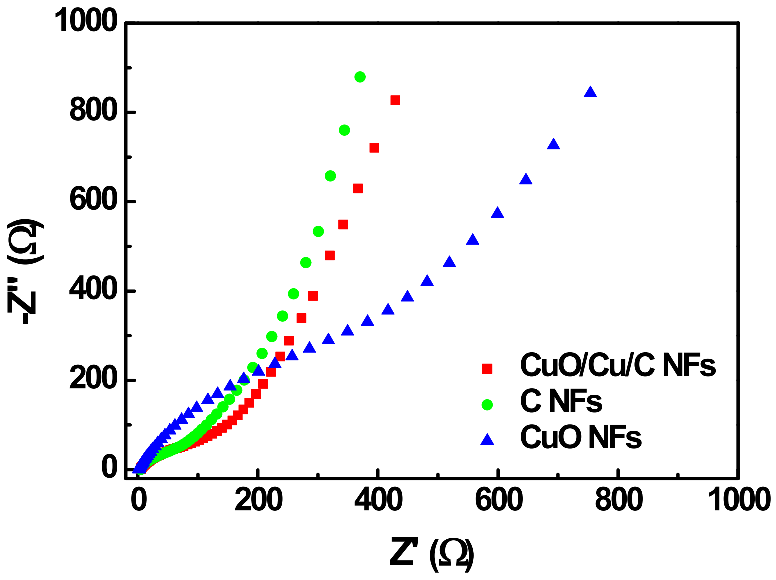

Fig. S12. Nyquist plots for CuO/Cu/C NFs, bare C NFs and pure CuO NFs.

Table S1. Comparison of the electrochemical properties of CuO/Cu/C NFs with recently reported carbon-based nanostructures and CuO/C composites anode materials for LIBs.

Sample	Current density	Cycles	Capacity	Ref.
Nanographene-constructed hollow carbon spheres	0.2 C/0.074 A g^{-1}	30	600 mAh g^{-1}	2
Vertically aligned carbon Nanotubes/graphene paper	0.03 A g^{-1}	40	290 mAh g^{-1}	3
Graphene nanosheets-carbon nanotubes composite	0.2 C/0.074 A g^{-1}	30	518 mAh g^{-1}	4
Nitrogen-doped carbon nanotubes	0.1 A g^{-1}	100	397 mAh g^{-1}	5
Graphene-multiwalled carbon nanotubes hybrid nanostructure	0.09 A g^{-1}	100	768 mAh g^{-1}	6
Graphene-carbon nanotube hybrid materials	0.5 C/0.372 A g^{-1} 1 C/0.744 A g^{-1}	100 100	429 mAh g^{-1} 330 mAh g^{-1}	7
Folded structured graphene paper	0.1 A g^{-1}	100	568 mAh g^{-1}	8
Nitrogen-doped graphene	0.1 A g^{-1}	80	460 mAh g^{-1}	9
Two-dimensional mesoporous graphene	0.2 A g^{-1} 0.5 A g^{-1} 1 A g^{-1}	10 10 10	540 mAh g^{-1} 430 mAh g^{-1} 370 mAh g^{-1}	10
Vertically aligned Graphitic carbon nanosheets	0.5 A g^{-1}	680	648 mAh g^{-1}	11
Nitrogen-doped double-shelled hollow carbon spheres	1.5 C/0.558 A g^{-1}	500	512 mAh g^{-1}	12
Hierarchical porous carbon microspheres	0.05 A g^{-1}	70	480 mAh g^{-1}	13
Core-shell structured porous carbon-graphene composites	0.1 A g^{-1} 0.1 A g^{-1}	100 100	680 mAh g^{-1} 620 mAh g^{-1}	14

N-doped herringbone carbon nanofibers	0.5 C/0.186 A g^{-1}	110	＞300 mAh g^{-1}	15
Hard carbon/graphene	0.4 A g^{-1}	500	205 mAh g^{-1}	16
CuO/C microspheres	0.1 A g^{-1}	50	440 mAh g^{-1}	17
CuO/CNT nanocomposites	0.1 C/0.067 A g^{-1}	100	650 mAh g^{-1}	18
Core-shell CuO/polypyrrole nanocomposites	0.2 A g^{-1}	80	613 mAh g^{-1}	19
CuO nanosheets/r-GO paper	0.067 A g^{-1}	50	736.8 mAh g^{-1}	20
CuO/GNS nanocomposite	0.1 A g^{-1}	60	650 mAh g^{-1}	21
CuO/graphene nanocomposite	0.2 C/0.122 A g^{-1}	30	500 mAh g^{-1}	22
Porous CuO/C submicron spheres	0.2 C/0.134 A g^{-1}	100	681 mAh g^{-1}	23
N-GO/CuO nanocomposite	0.372 A g^{-1}	100	472 mAh g^{-1}	24
CuO nanorods/graphene nanocomposites	0.1 C/0.067 A g^{-1}	50	692.5 mAh g^{-1}	25
CuO-Cu_2O/graphene composite	0.2 A g^{-1}	60	487 mAh g^{-1}	26
Nanoleaf-on-sheet CuO/graphene composites	0.1 A g^{-1}	50	600 mAh g^{-1}	27
CuO-graphene hybrids	0.2 A g^{-1}	120	532 mAh g^{-1}	28
Nanoporous CuO/Cu composite	0.5 A g^{-1}	200	600 mAh g^{-1}	29
Hierarchical branching Cu@Cu_2O@CuO NWs	0.1 A g^{-1}	50	345 mAh g^{-1}	30
Ultra-uniform CuO/Cu/C composites	0.1 A g^{-1} 0.2 A g^{-1} 0.5 A g^{-1} 1 A g^{-1}	100 100 500 400	714.5 mAh g^{-1} 610.4 mAh g^{-1} 572.0 mAh g^{-1} 441.9 mAh g^{-1}	Our work
CuO/Cu/C NFs paper	0.1 A g^{-1}	100	569.4 mAh g^{-1}	

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