Supplementary Information

A Novel Method to Enhance the Conductance of Transitional Metal Oxide Electrodes

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Experimental Methods

**Synthesis of the ultralong Cu nanowires and CuO nanotubes**: The method to synthesize ultralong copper nanowires was reported in our previous work. Typically, 8 g n-hexadecylamine (HDA) was melted at 180 °C, and 0.5 g hexadecyltrimethylammonium bromide (CTAB) was dissolved into it. Then, 0.2 g copper acetylacetonate was added and stirred until homogeneous blue solution formed. After that, the solution was transferred to a Teflon autoclave, and a 0.5 cm² silicon wafer sputtered with platinum was put in. Then the autoclave was put in a 180 °C oven and held for 10 h. After reaction, the autoclave cooled down to room temperature in air, and the
products were rinsed with toluene thoroughly. Finally, thread-like reddish product
was obtained and kept in toluene. After annealed at 300 °C in air for 30 min, CuO
nanotubes were obtained. X-ray diffraction measurements were taken on a Panalytical
X′Pert Pro X-ray powder diffractometer using Cu-Ka radiation (\( \lambda =1.54\text{Å} \)). SEM
experiments were conducted on a Jeol JSM-6700 FE-SEM instrument. TEM
experiments were conducted on a Philips CM120 instrument operated at 120 kV.

_Electrode fabrication and electrochemical measurement:_ To prepare working
electrodes, CuO nanotubes or a mixture of CuO nanotubes and MWNTs at a weight
ratio of 7:1 was pasted on a titanium sheet, and dried at 100 °C under vacuum for 12 h.
The electrodes were put on a hot plate of 250 °C and treated with atmospheric
pressure H\(_2\) plasma generated by Atomflow\textsuperscript{TM} 400L from Surfx\textsuperscript{®} Technologies LLC.
To make 2032 type coin cells, glass fiber (GF/D) from Whatman was used as the
separator. The electrolyte consisted of a solution of 1 M LiPF\(_6\) in ethylene carbonate
(EC)/dimethyl carbonate (DMC) (1:1 v/v). Lithium foil was used as counter
electrodes. The cells were assembled in a glove-box under an argon atmosphere. The
charge and discharge measurements were carried out by LAND CT2000 (Wuhan
Jinnuo Electronics, Ltd., Wuhan, China) in the voltage range of 0.005-3V (vs. Li\(^+\)/Li)
under different current densities. The specific capacitance was calculated based on the
total mass of anode materials. CV measurements and the electrochemical impedance
spectroscopy (EIS) recorded on a Solartron 1860/1287 Electrochemical Interface.
Figure S1 Cyclic voltammograms of the electrodes made of CuO nanotubes and CuO nanotube/CNT composites at a potential scan rate of 0.5 mV/s.

Figure S2 Elemental analysis of a single CuO nanotube before and after H₂ plasma treatment by STEM (a) a CuO nanotube, the inset is the transmitting electron image of a part of a CuO nanotube, and the elemental analysis was conducted by scanning across the nanotube; (b) a CuO nanotube after H₂ plasma treatment for 5 min; (c) a CuO nanotube covered with CNTs; (d) a CuO nanotube covered with CNTs after H₂ plasma treatment for 5 min. The valley in the center area is caused by the tube structure of CuO.
Figure S3 Impedance measurement of the electrode made of CuO nanotube, CuO nanotube-CNT composite, and their electrode treated with H₂ plasma for 2 min.

Figure S4 SEM image of CuO nanotube-CNT composite electrode treated with H₂ plasma for 5 min.