Facile Method to Synthesize Carbon Layer Embedded into Titanium Dioxide Nanotubes with Metal Oxide Decoration for Electrochemical Applications

Yan-Yan Song,[a] Ya-Hang Li,[a] Jing Guo,[a] Zhi-Da Gao,*[a] and Ying Li*[b]

[a] College of Science, Northeastern University, Wenhua Road 3-11, Shenyang, China, E-mail: gaozd@mail.neu.edu.cn

[b] Jiangsu Province Hi-Tech Key Laboratory for Bio-medical Research, School of Chemistry and Chemical Engineering, Southeast University, Nanjing 210096, China, E-mail: yingli@seu.edu.cn

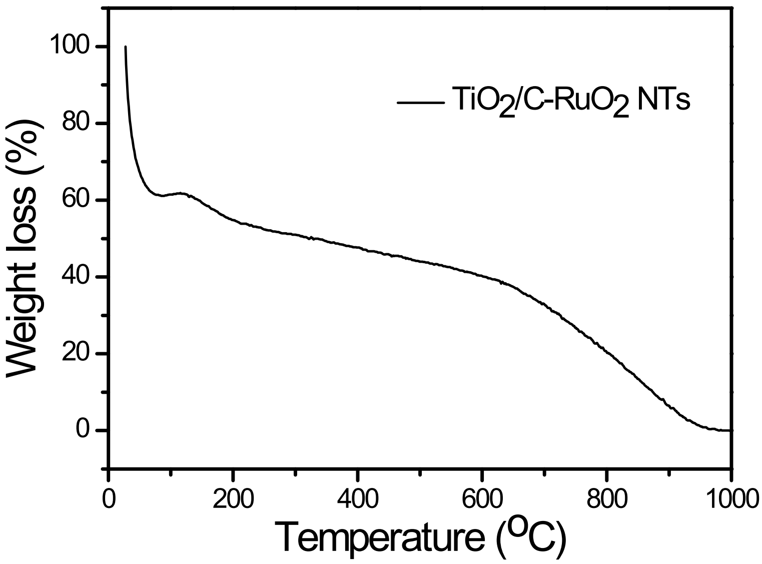


Fig. S1. Thermogram of TiO_2/C-RuO_2NTs taken under the flow of O_2during the temperature ramp.

The thermal stability ofTiO_2/C-RuO_2NTswas investigated by using the TGA technique. The first step of weight loss before 130 °C was attributed to theremoval of the adsorbed water. The second weight loss from 200 to 650 °C was attributed to thetransfer of TiO_2 crystalline from amorphous to anatase,the removal of crystalline water in hydrous ruthenium oxide and the subsequent burning of carbon layers.

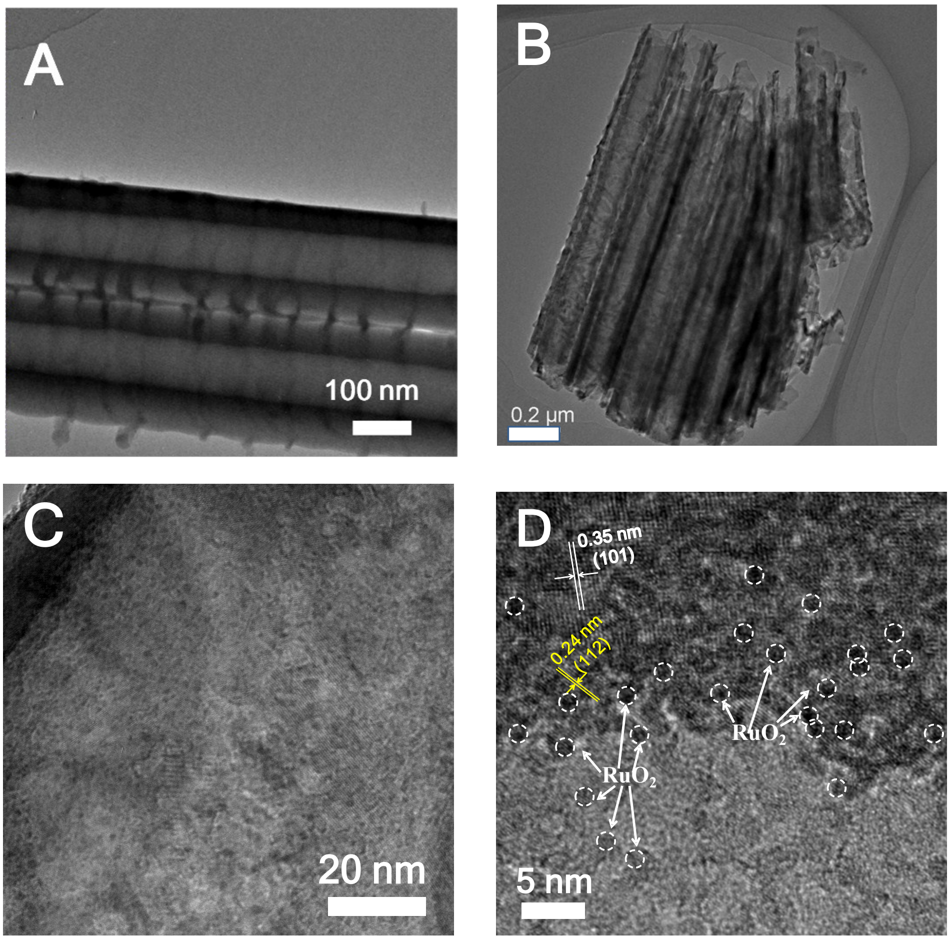


Fig. S2. TEM images of (A) the bare TiNTs before annealing, (B) bare TiNTs after annealing,(C) RuO_2 decorated C/TiNTs samples, and (D) the high-resolution image.

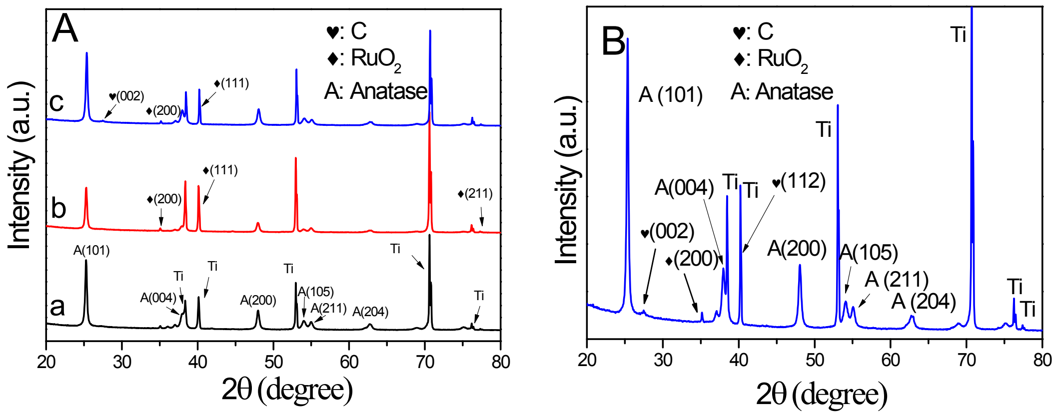


Fig. S3. XRD patterns for (A) bare anatase nanotubes (curve a), TiO_2-RuO_2 NTs (curve b), and TiO_2/C-RuO_2NTs (curve c), and (B) the details for TiO_2/C-RuO_2NTs.

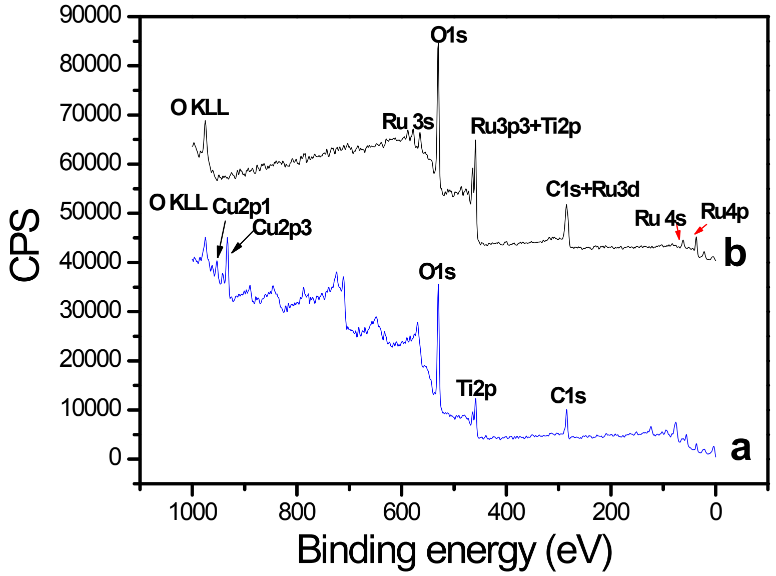
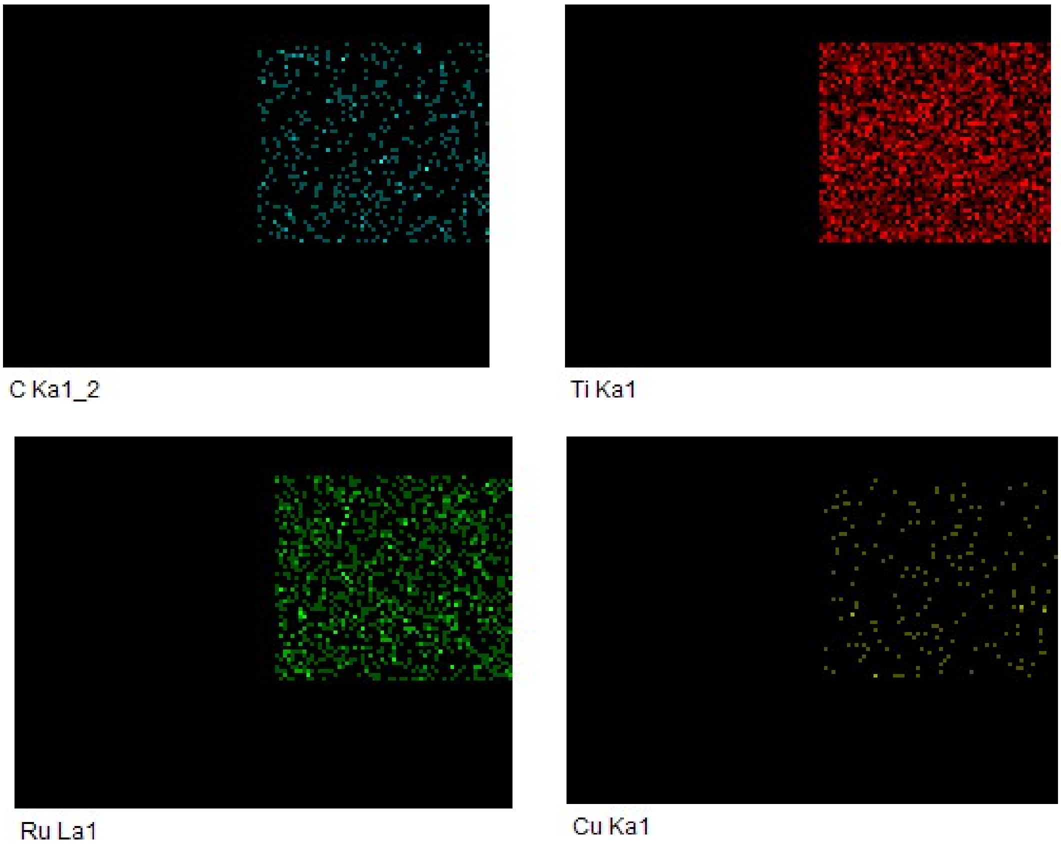
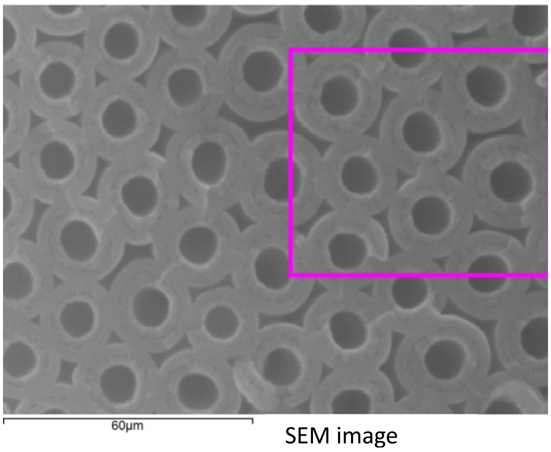


Fig. S4.XPS spectra of the TiO_2/C NTs samples after decorating by Cu nanoparticles (curve a), and after the RuO_2 formed by galvanic displacement of Cu (curve b).



Elements	wt%	atm%
Ti	54.60	29.00
O	40.35	64.16
C	2.90	6.14
S	0.27	0.22
Cu	0.04	0.02
Ru	1.85	0.46



SEM image

Fig. S5.EDS analysis on cross-section of tubes. Rectangle indicate the EDS mapping area.

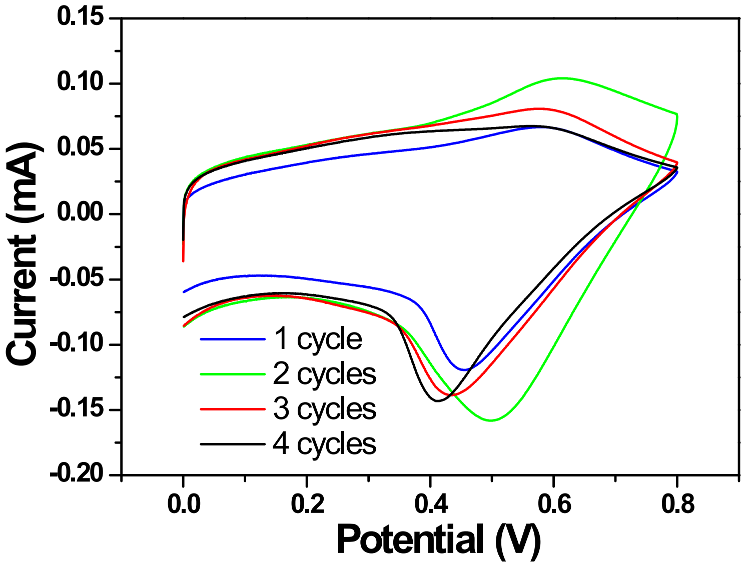


Fig. S6. The influence of the number of PSS-Cu^{2+}bilayersduring LBL process on the electrochemical currents of TiO_2/C-RuO_2NTs based electrodes.

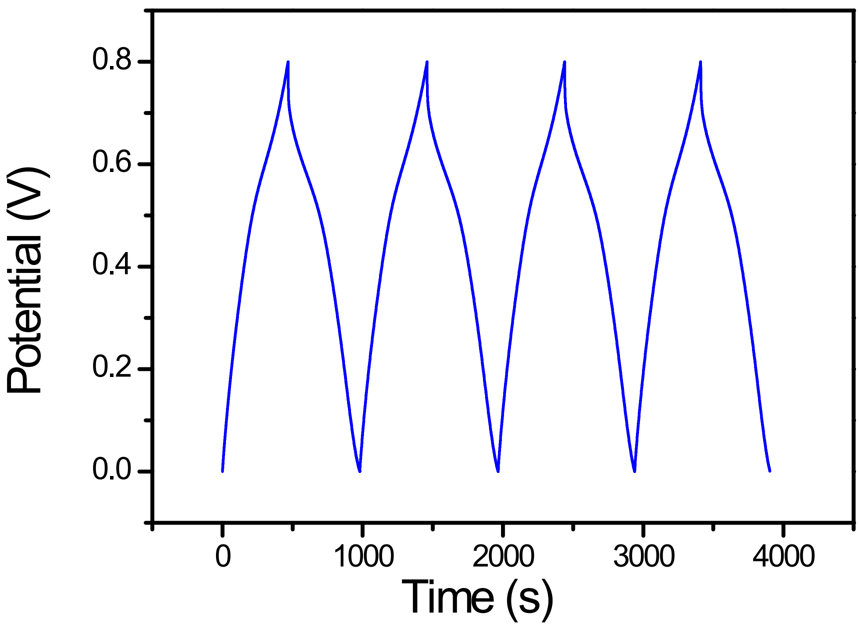


Fig. S7. Typical charge-discharge cycle curves of the TiO_2/C-RuO_2NTs obtained at current density of 0.05 $mAcm^{-2}$.

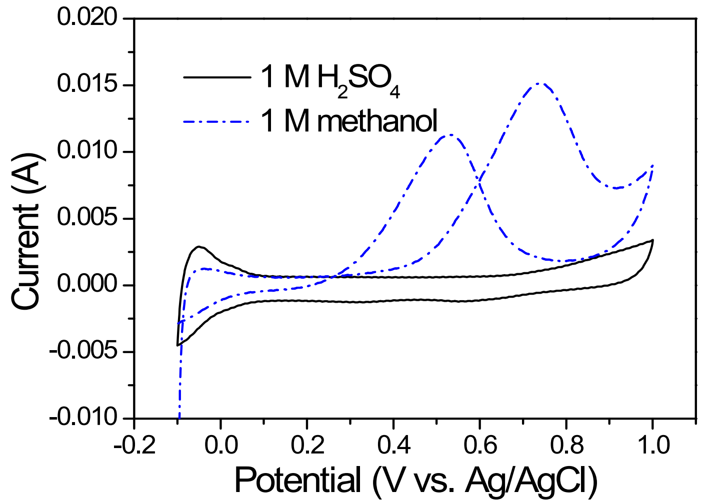


Fig. S8. Cyclic voltammograms of TiO_2/C-PtNTs samples in a 1 M H_2SO_4 and 1 M CH_3OH + 1M H_2SO_4 solution at a scan rate of 50 mV s^{-1}.