Supporting Information

Standing pillar arrays of C-coated hollow SnO$_2$ mesoscale tubules for highly stable lithium ion storage electrode

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To further examine the presence and oxidation state of carbon and tin in the C-coated SnO_2, X-ray photoelectron spectroscopy (XPS, ESCALAB 250) analysis was conducted using a monochromic Al-Kα X-ray source (E=1486.6 eV). Data processing was performed with XPSPEAK software program. Fig. S1a shows high-resolution spectrum of the C 1s region of C-coated SnO_2. The main peak at 284.7 eV is attributed to non-oxygenated carbon (C-C) [1], whereas the minor peaks at 286.3 and 288.7 eV can be assigned to the oxidized carbon species such as C-O and C=O, respectively [2]. As shown in Fig. S1b, O 1s spectra are deconvolved into two peaks. One peak at 530.3 eV corresponds to un-reduced SnO_2 (Sn-O) [3]. Another peak at 532.0 eV is attributed to oxidized carbon (C-O), which is in a good agreement with Fig. S1a [3]. Fig. S1c depicts Sn 3d spectra fitted with two symmetrical peaks at 486.4 and 494.8 eV. The binding energy separation between two peaks is 8.4 eV, which is line with previous reports [3]. Consequently, the XPS results demonstrate that C-coated hollow SnO_2 pillars are composed of SnO_2 and carbon.

Reference

1 C. Zhang, X. Peng, Z. Guo, C. Cai, Z. Chen, D. Wexler, S. Li, H. Liu, *Carbon,* 2012, **50**, 1897.

2 J. Gao, F. Liu, Y. Liu, N. Ma, Z. Wang, X. Zhang, *Chem. Mater.,* 2010, **22**, 2213.

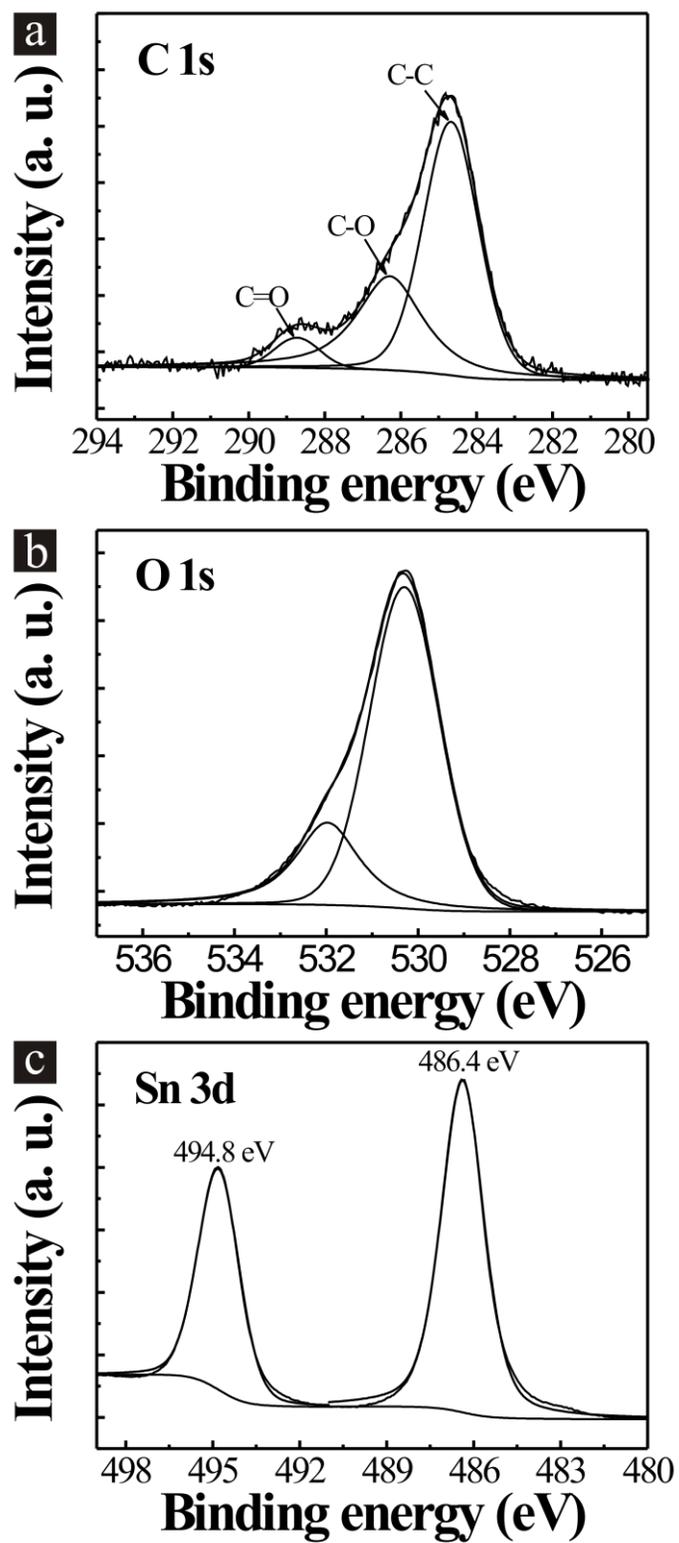3 M.-S. Park, Y.-M. Kang, J.-H. Kim, G.-X. Wang, S.-X. Dou, H.-K. Liu, *Carbon,* 2008, **46**, 35.

a C 1s

C-C

C-O

C=O

Intensity (a. u.)

Binding energy (eV)

294 292 290 288 286 284 282 280

b O 1s

Intensity (a. u.)

Binding energy (eV)

536 534 532 530 528 526

c Sn 3d

486.4 eV

494.8 eV

Intensity (a. u.)

Binding energy (eV)

498 495 492 489 486 483 480

Fig. S1 XPS spectra of (a) C 1s, (b) O 1s, and (c) Sn 3d of C-coated hollow SnO$_2$ pillar arrays.
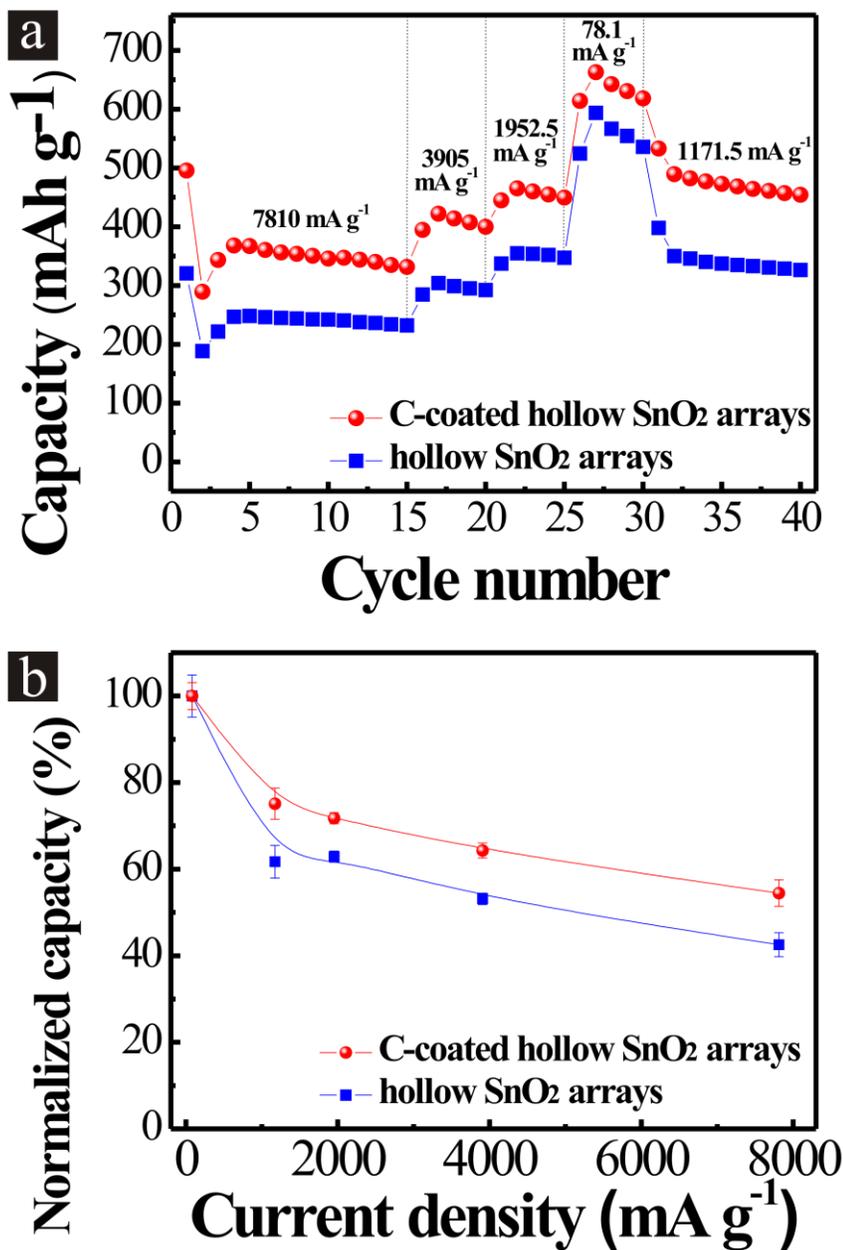
Fig. S2 (a) Cycling performance at various current densities between 0.005 and 2.0 V of C-coated hollow SnO_2 arrays together non-carbon-coated hollow SnO_2 arrays. (b) Normalized capacity values at each current density by the average capacity values under 78.1 mA g^{-1} current density.

Table S1. Summary of the cycle performance for as-prepared SnO_2 electrodes at a rate of 78.1 mA g^{-1}.

electrode	Initial C. E. [%][a]	2nd cycle Discharge capacity [mAh g^{-1}]	50th cycle Discharge capacity [mAh g^{-1}]	Capacity retention after 2nd cycle capacity [%]
C-coated SnO_2 array	58.8	796.0	487.6	61.3
SnO_2 array	52.4	717.8	427.9	59.6
SnO_2 nanopowder	33.0	394.0	0.7	0.2

[a]Initial Coulombic efficiency (C. E.) is the ratio of the extracted lithium to the inserted lithium during the 1st cycle.