Supporting information

Homologous V_2O_3/C box-in-box and V_2O_5 box for lithium-ion full cells

Xue Liu, Yanjie Hu, Guiqi Jia, Haoxuan Zhang, Hao Jiang, Chunzhong Li**

Key Laboratory for Ultrafine Materials of Ministry of Education, School of Materials Science and Engineering, East China University of Science and Technology, Shanghai 200237, China

*Corresponding author: Tel.: +86-21-64250949, Fax: +86-21-64250624

E-mail: jianghao@ecust.edu.cn (Prof. H. Jiang) and czli@ecust.edu.cn (Prof. C. Z. Li)

1. Experimental Section

Synthesis of V_2O_3 NPs. The VO_x precursors were firstly synthesized according to Balkus' work with a minor revision.[1] In a tipical synthesis, 0.3 g of ammonium metavanadate and 0.5 g of P123 ($EO_{20}P_{70}E_{20}$) were dispersed into 30 mL of deionized water containing 2 mL of 1 M HNO_3 under stirring for 7 h at room temperature, and then transferred into an autoclave and maintained at 200 °C for 12 h. Finally, the V_2O_3 NPs can be obtained by treating as-obtained hydrothermal products at 600 °C for 10 h in argon.

Synthesis of V_2O_3 HNSs. The synthesis of V_2O_3 HNSs was according to Lou's work with a minor revision.[2] In a tipical synthesis, 3 mL of 0.33 M VOC_2O_4 and 30 mL of isopropanol were mixed in a 50 mL autoclave under stirring for 1 h and then heated at 200 °C for 10 h. The V_2O_3 HNSs can be obtained by annealing the precursor in argon at 600 °C for 10 h.

2. Figures

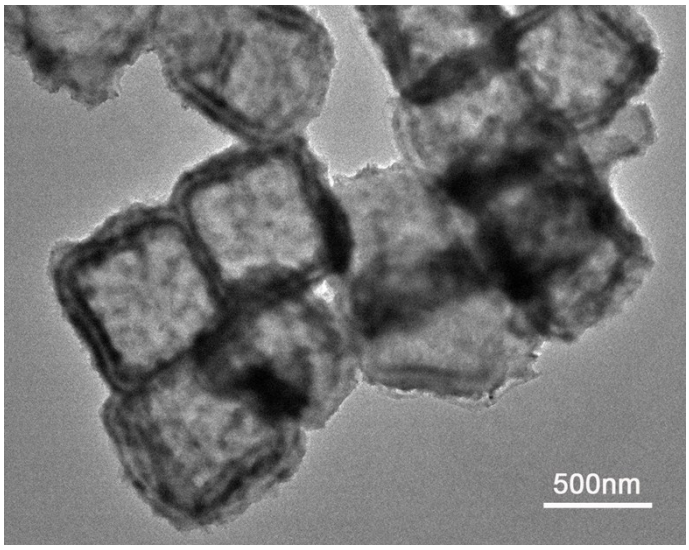

Figure S1. TEM image of the carbon box-in-box.

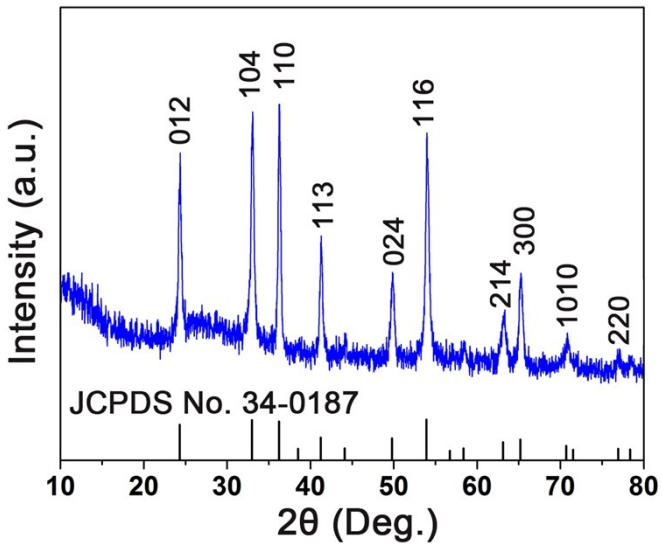

Figure S2. XRD pattern of the V_2O_3/C box-in-box.

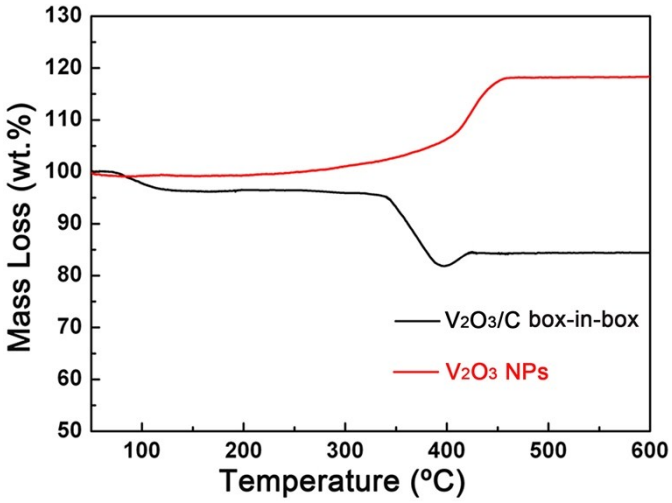

Figure S3. TGA curves of V_2O_3/C box-in-box and V_2O_3 NPs.

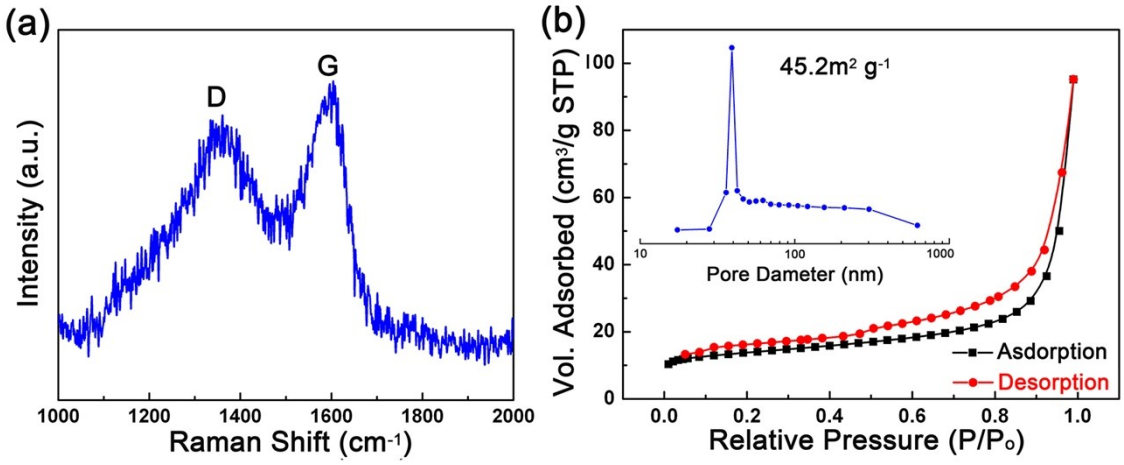

Figure S4. (a) Raman spectrum and (b) N_2 adsorption-desorption isotherms of the V_2O_3/C box-in-box (the insert of part b shows the corresponding pore-size distribution curve).

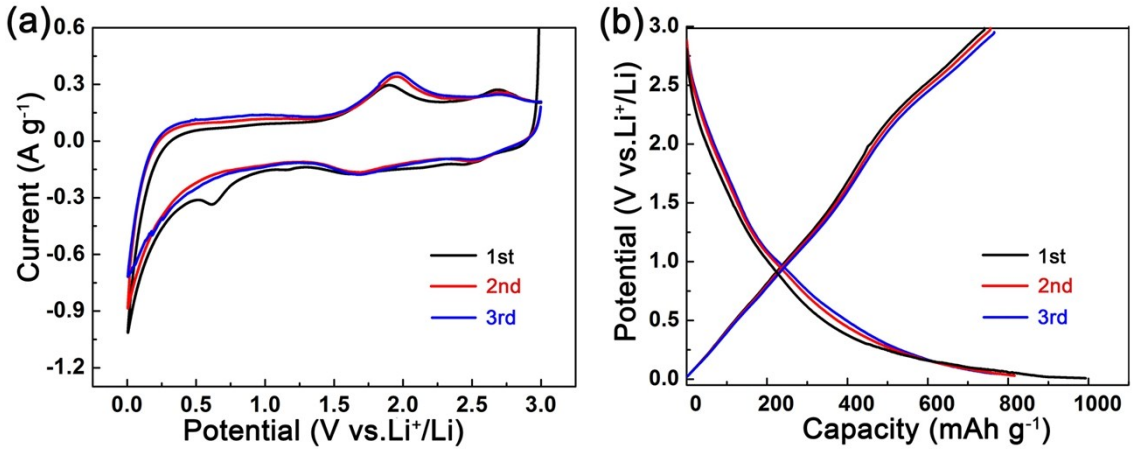

Figure S5. (a) CV curves at 0.2 mV s^{-1}, (b) charge-discharge curves at 100 mA g^{-1} of the V_2O_3/C box-in-box for the initial 3 cycles.

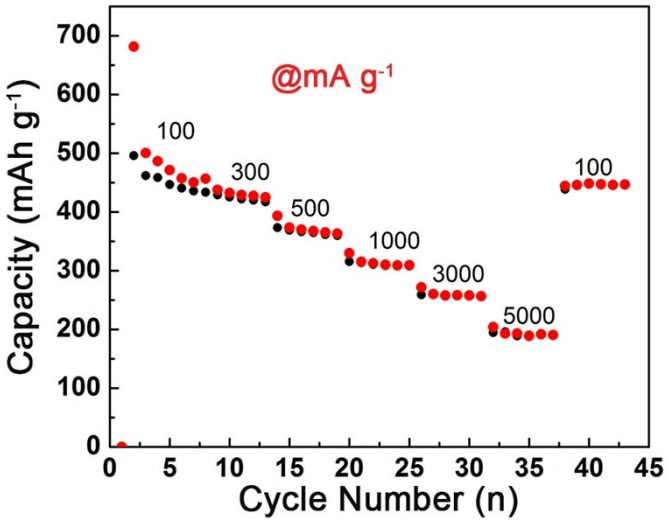

Figure S6. Rate performance of the pure carbon box electrodes.

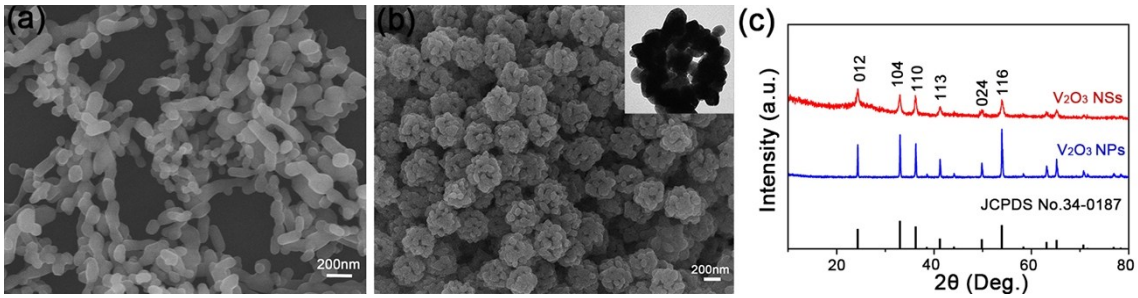

Figure S7. (a) SEM image of V_2O_3 NPs, (b) SEM image of V_2O_3 HNSs (the inset showing the corresponding TEM image), (c) XRD patterns of V_2O_3 HNSs (red line) and V_2O_3 NPs (blue line).

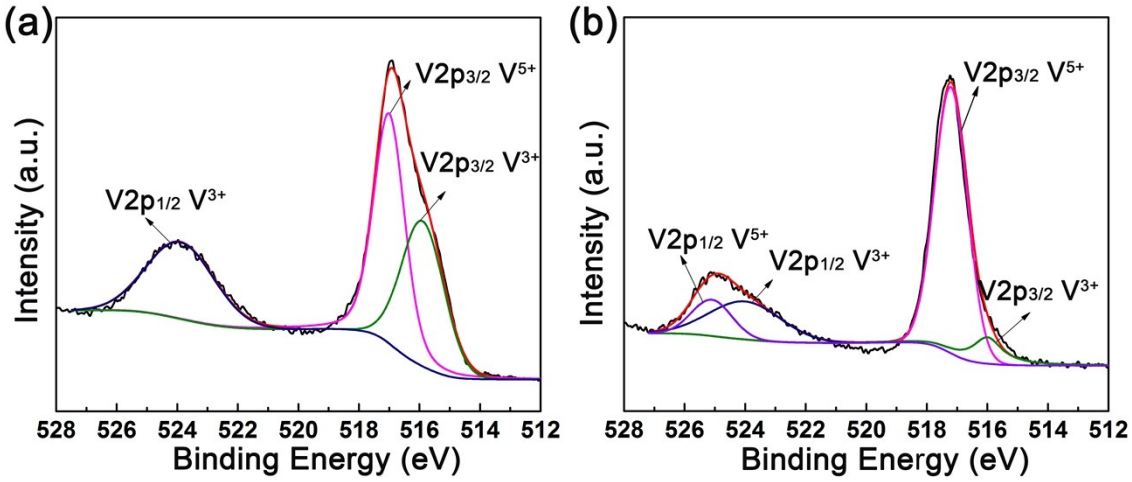

Figure S8. High-resolution V2p XPS spectra of the V_2O_3/C box-in-box (a) before cycling and (b) after cycling.

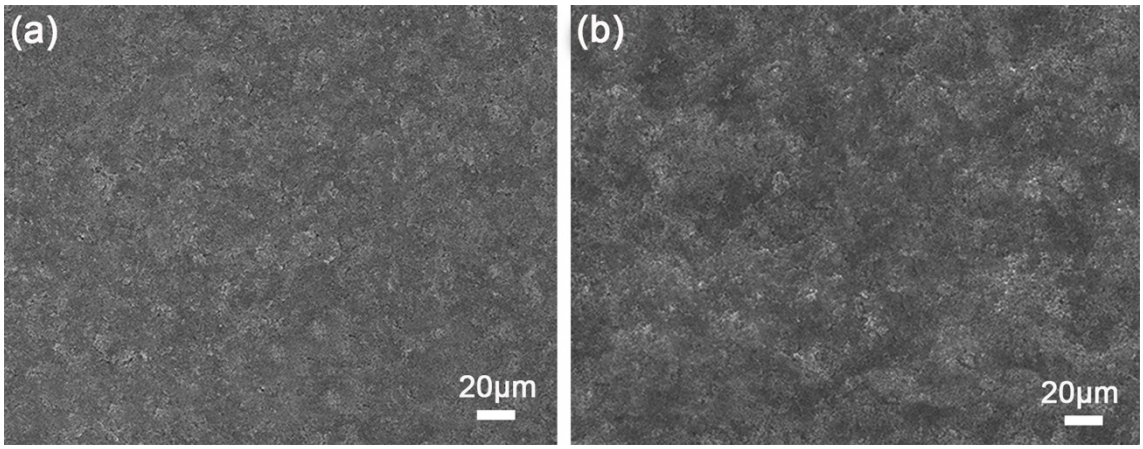

Figure S9. SEM images of the V_2O_3/C electrode (a) before cycles and (b) after cycles.

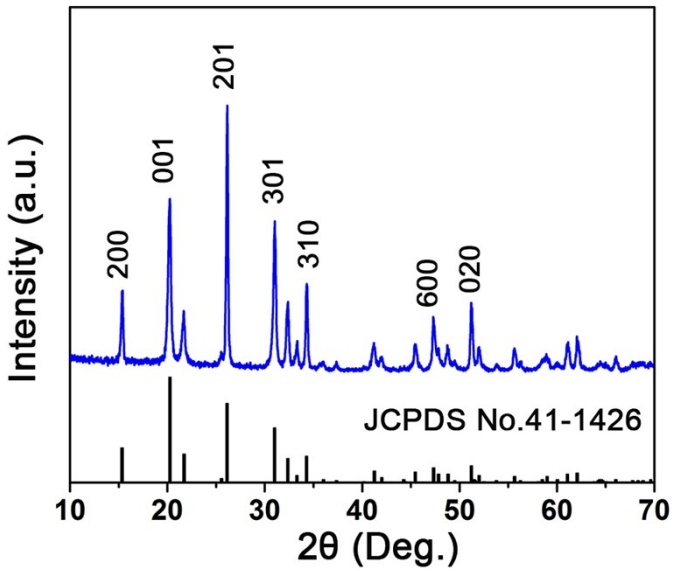

Figure S10. XRD pattern of the V_2O_5 box.

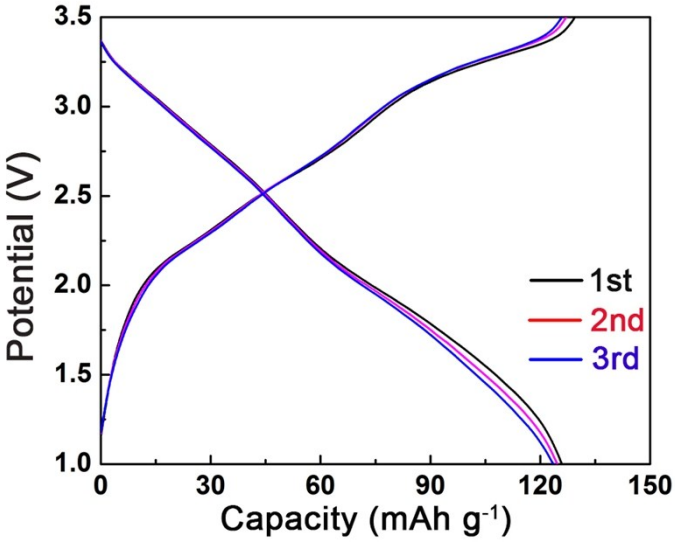

Figure S11. Charge-discharge curves at 100 mA g^{-1} of the full cell for the initial 3 cycles.

3. Table

Table S1. A summary table for recent reports on lithium-ion full cells.

Cathode	Anode	Rate capability	Cycling behavior	Ref.
$Ni_{1/3}Mn_{1/3}Co_{1/3}O_2$	Si/RGO	-	77 mAh g^{-1} (70%) 1/4C for 15 cycles	S3
$LiMn_2O_4$	MnO_x/C	85 mAh g^{-1} (0.2C) 25 mAh g^{-1} (5C)	-	S4
$LiCoPO_4$	$Li_4Ti_5O_{12}$	-	93 mAh g^{-1} (76%) 0.1 C for 20 cycles	S5
$LiNi_{0.5}Mn_{1.5}O_4$	CuO-MCMB	125 mAh g^{-1} (1C) 95 mAh g^{-1} (5C)	-	S6
$LiMn_2O_4$	Mn_2O_3	-	80 mAh g^{-1} (81%) 1C for 40 cycles	S7
$LiMn_2O_4$	TNSTs	100 mAh g^{-1} (0.2 A g^{-1}) 58 mAh g^{-1} (1.6 A g^{-1})	-	S8
V_2O_5	**V_2O_3/C**	**130 mAh g^{-1} (2/3 C) 43 mAh g^{-1} (33 C)**	**81 mAh g^{-1} (80%) 3.3 C for 100 cycles**	**This work**

The specific capacities of all those full cells shown in the table are based on the cathode material weight. For this work, 1 C=0.15 A g^{-1}.

4. References

1 C. Xiong, A. E. Aliev, B. Gnade, Jr. K. J. Balkus, ACS Nano 2008, **2**, 293.

2 A. Pan, H. B. Wu, L. Yu, X. W. Lou, *Angew. Chem.* 2013, **52**, 2226.

3 L. Ji, H. Zheng, A. Ismach, Z. Tan, S. Xun, E. Lin, V. Battaglia, V. Srinivasan, Y. Zhang, *Nano Energy* 2011, **1**, 164.

4 C. Chae, H. Park, D. Kim, J. Kim, E. S. Oh, J. K. Lee, *J. Power Sources* 2013, **244**, 214.

5 J. Ni, W. Liu, J. Liu, L. Gao, J. Chen, *Electrochem. Commun*. 2013, **35**, 1.

6 R. Verrelli, J. Hassoun, A. Farkas, T. Jacob, B. Scrosati, *J. Mater. Chem. A* 2013, **1**, 15329.

7 Y. Wang, Y. Wang, D. Jia, Z. Peng, Y. Xia, G. Zheng, *Nano Lett.* 2014, **14**, 1080.

8 H. Ming, P. Kumar, W. Yang, Y. Fu, J. Ming, W. J. Kwak, L. J. Li, Y. K. Sun, V. Zheng, *ACS Sustainable Chem. Eng.* 2015, **3**, 3086.