Supporting Information

Carbon Emcoating Architecture Boosts Lithium Storage of Nb_2O_5

Qing Ji[1,2†], Zhuijun Xu[1,3†], Xiangwen Gao[4,5†], Ya-Jun Cheng[1,4*], Xiaoyan Wang[1], Xiuxia Zuo[1], George Z. Chen[2, 6], Binjie Hu[2*], Jin Zhu[1], Peter G. Bruce[4,7,8], Yonggao Xia[1, 9*]

1. Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, 1219 Zhongguan West Road, Zhenhai District, Ningbo, Zhejiang Province 315201, People's Republic of China

2. The University of Nottingham Ningbo China, 199 Taikang East Road, Ningbo, Zhejiang Province 315100, People's Republic of China

3. University of Chinese Academy of Sciences, 19A Yuquan Rd, Shijingshan District, Beijing 100049, People's Republic of China

4. Department of Materials, University of Oxford, Parks Rd, OX1 3PH, Oxford, United Kingdom

5. Materials Science and Engineering Program and Texas Materials Institute, University of Texas at Austin, Austin, TX 78712, USA

6. University of Nottingham, University Park, Nottingham NG7 2RD, United Kingdom

7. The Henry Royce Institute, Parks Road, Oxford OX1 3PH, United Kingdom.

8. The Faraday Institution, Quad One, Becquerel Avenue, Harwell Campus, Didcot

OX11 OR1, United Kingdom

9. Center of Materials Science and Optoelectronics Engineering, University of Chinese Academy of Sciences, 19A Yuquan Rd, Shijingshan District, Beijing 100049, P. R. China

AUTHOR INFORMATION

[*]Corresponding Author

E-mail Address: chengyj@nimte.ac.cn, binjie.hu@nottingham.edu.cn, xiayg@nimte.ac.cn

[†]These authors contributed equally to this work.

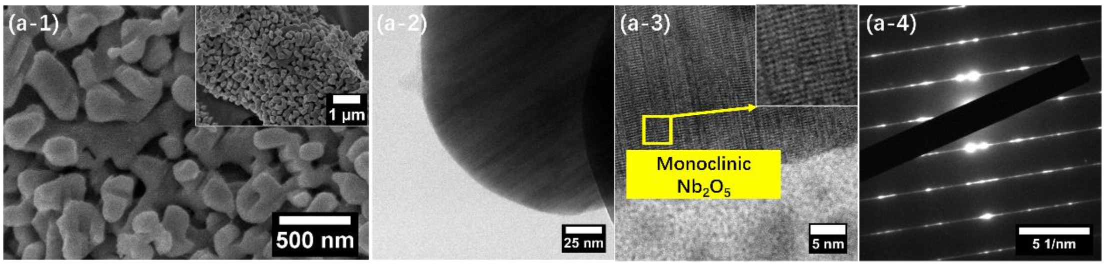

Figure S1. SEM (a-1), TEM (a-2), HRTEM (a-3) and SAED (a-4) images of coral Nb_2O_5 (activated at 900 ºC for 2 h).

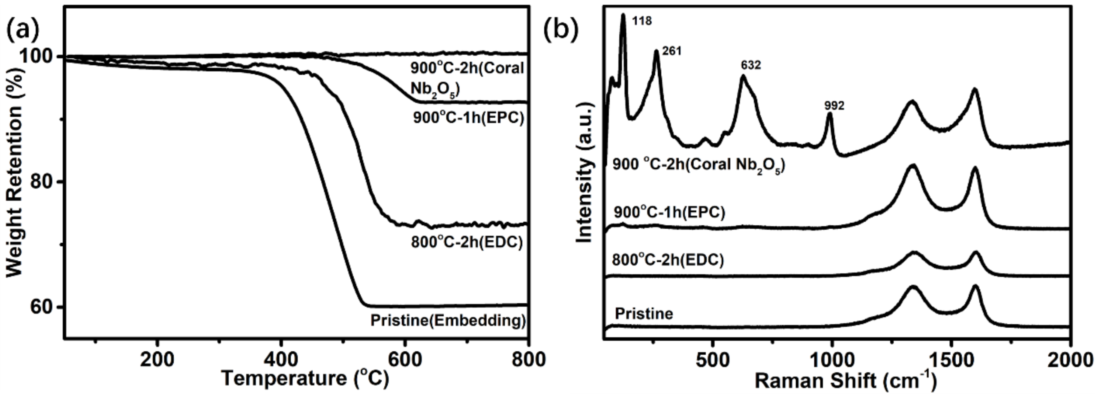

Figure S2. Thermogravimetric profiles (a) and Raman spectroscopy (b) of the pristine carbon embedding and CO_2-activated Nb_2O_5/carbon nanohybrids.

Table S1. Carbon content and relative intensities of D band &G band of the Nb_2O_5/carbon nanohybrids prepared with different CO_2 activation conditions

Carbon Structure	Pristine	800ºC-2h	900ºC-1h	900ºC-2h
Carbon Content (%)	40	27	8	0
I_D:I_G	1.36	1.39	1.36	1.00

Table S2. BET surface area of the pristine and CO_2-activated Nb_2O_5/carbon nanohybrids at various condition

Porosity and carbon content	Pristine	EDC (800˚C-2h)	EPC (900˚C-1h)	Coral Nb_2O_5 (900˚C-2h)
BET Surface Area (m^2g^{-1})	57.7	100	221	15.9
Pore Volume (cm^3g^{-1})	0.146	0.391	0.348	0.0225
Carbon Content (%)	40	27	8	0

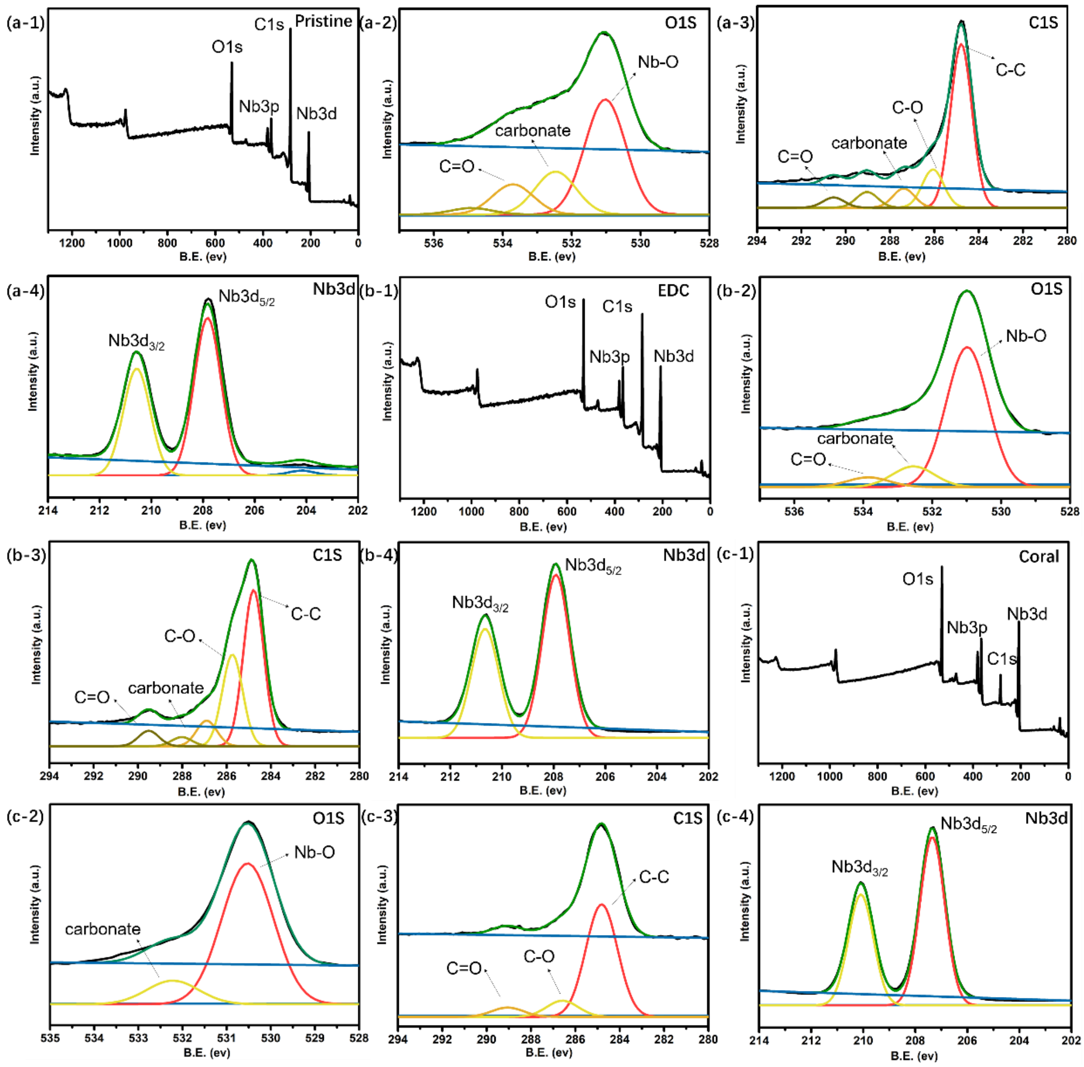

Figure S3. XPS survey and high resolution of O1s, C1s and Nb3d of the pristine carbon embedding Nb_2O_5 (a), EDC structured Nb_2O_5 (b) and coral Nb_2O_5 (c).

Table S3. Peak area comparison of carbonate (288 eV) and C-C (284.6 eV) & carbonate (532 eV) and Nb-O (530 eV).

Sample	Carbonate/C-C	C-O/Nb-O
Embedding	0.20	0.37
EDC(800-1h)	0.17	0.147
EDC(800-2h)	0.058	0.32
EPC	0.072	0.23
Coral Nb_2O_5	/	0.17

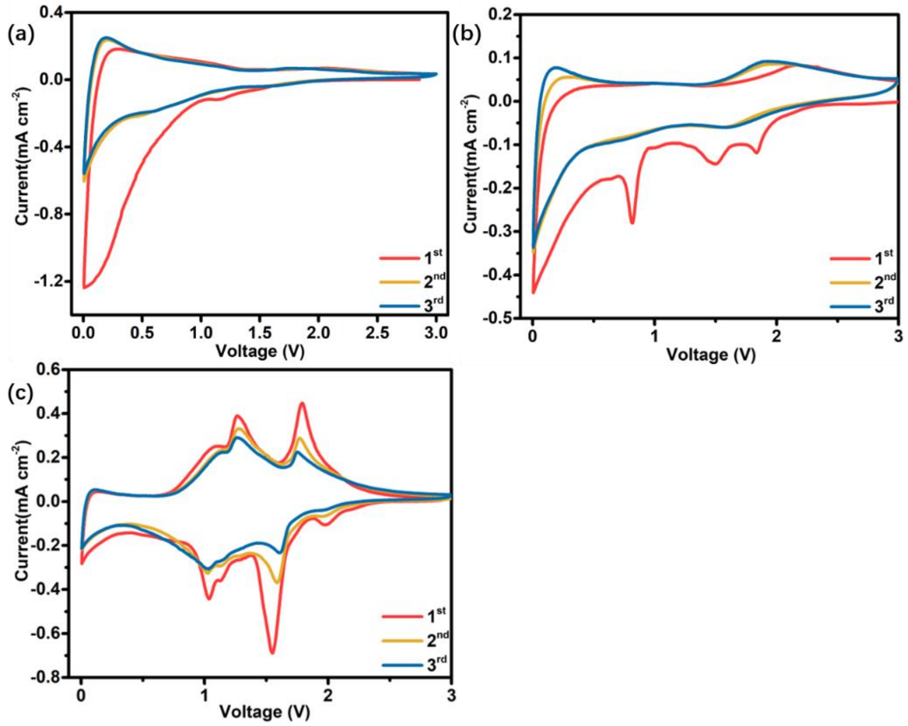

Figure S4. CV profiles of the pristine (a), EDC structured Nb_2O_5 (b) and coral Nb_2O_5 (c).

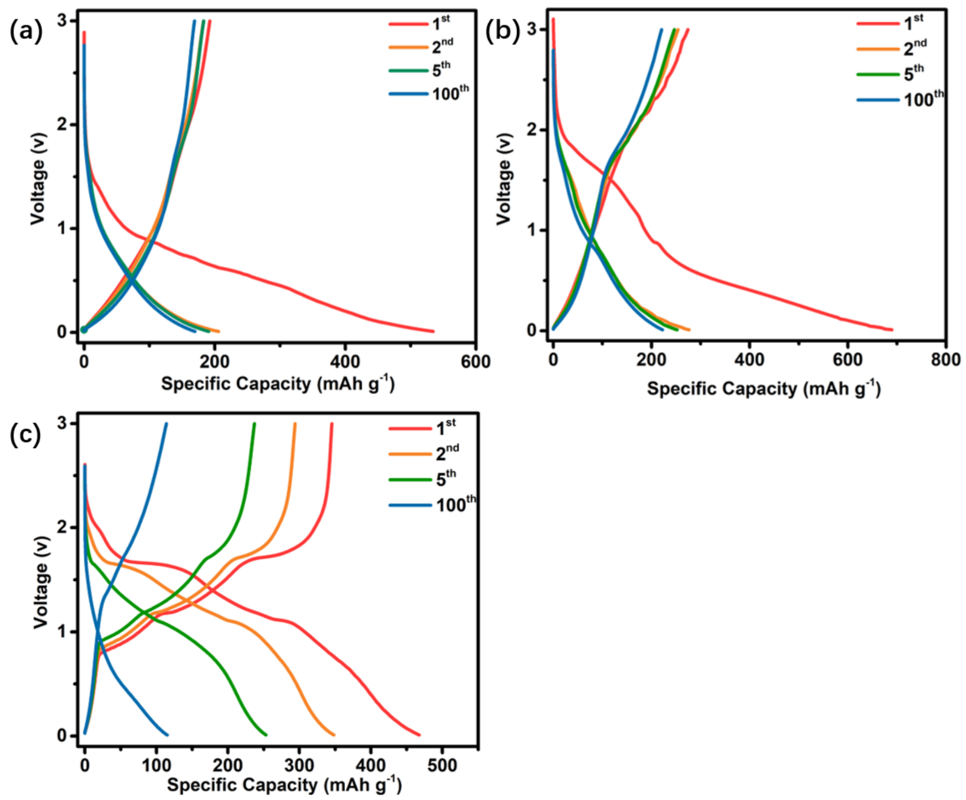

Figure S5. Charge/discharge curves of the pristine (a), EDC structured Nb_2O_5 (b) and coral Nb_2O_5 (c).

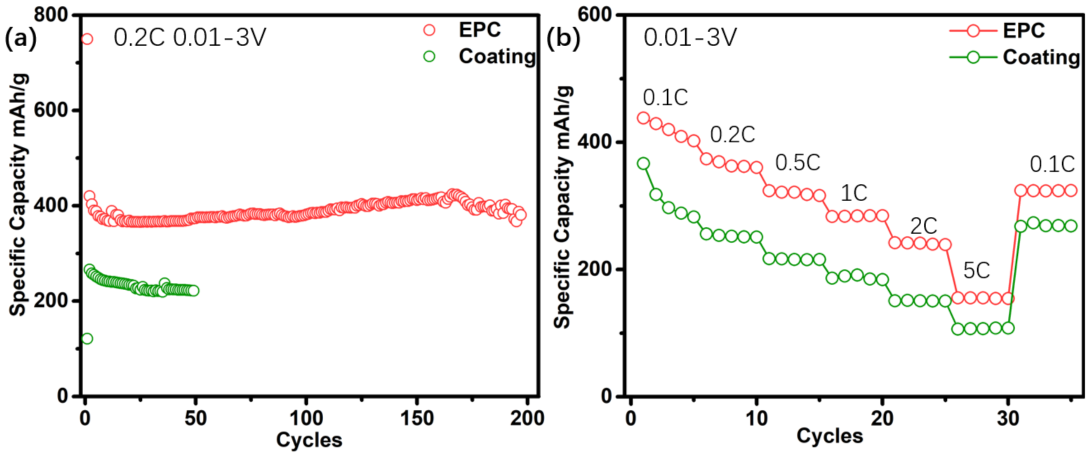

Figure S6. Performance comparison of the EPC structured Nb_2O_5 and carbon coated Nb_2O_5. Note that the carbon coated Nb_2O_5 is prepared by ball milling the coral Nb_2O_5 with dental resin-derived carbon (1C=200 mA g^{-1}).

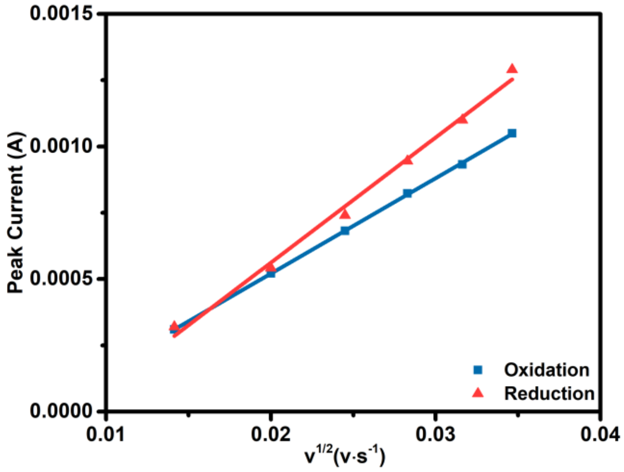

Figure S7. The relationship between peak current (I_P) and the square root of scan rate ($v^{1/2}$) of the EPC structured Nb_2O_5.

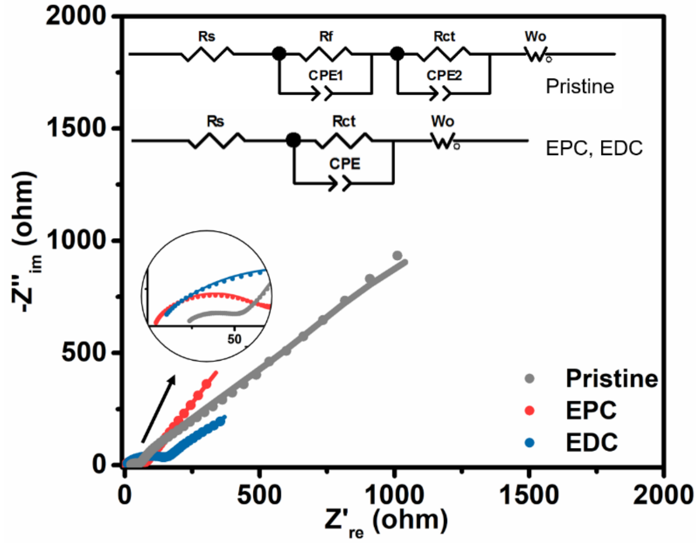

Figure S8. Nyquist plots of pristine, EPC and EDC structured Nb_2O_5 (Inset: the corresponding equivalent circuit model).

The EPC (2.96 Ω) and EDC (3.88 Ω) structured Nb_2O_5/C nanohybrids both present lower Rs (ohmic resistance of all cell components) than pristine sample (21.8 Ω). In addition, a decrease trend is observed after CO_2 activation in the semicircle of Rct. The decreased resistance could be assigned to the unique carbon structure, which improves the diffusion behavior.