Electronic Supplementary Information (ESI):

$Li_3V_2(PO_4)_3$ particles embedded in porous N-doped carbon as high-rate and long-life cathode material for Li-ion batteries

Feifan Guo,[a] Xiaoxin Zou,[a] Kai-Xue Wang,[b] Yipu Liu,[a] Feng Zhang,[c] Yuanyuan Wu, [a] and Guo-Dong Li[a]*

[a] State Key Laboratory of Inorganic Synthesis and Preparative Chemistry, College of Chemistry, Jilin University, 2699 Qianjin Street, Changchun 130012, China E-mail : lgd@jlu.edu.cn

[b] School of Chemistry and Chemical Engineering, Shanghai Jiao Tong University, Shanghai, 200240, China.

[c] School of Light Industry and Chemical Engineering, Dalian Polytechnic University, Dalian, 116034, China.

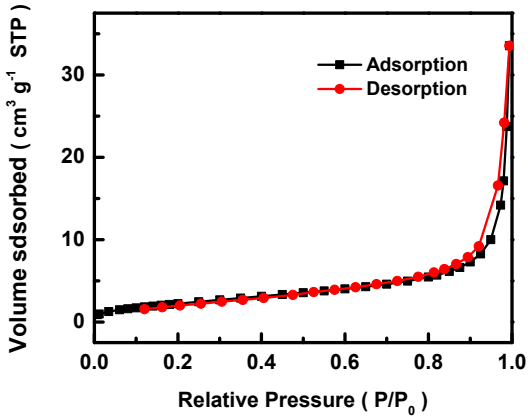

Fig. S1. Nitrogen adsorption-desorption isotherms of LVP@PNC.

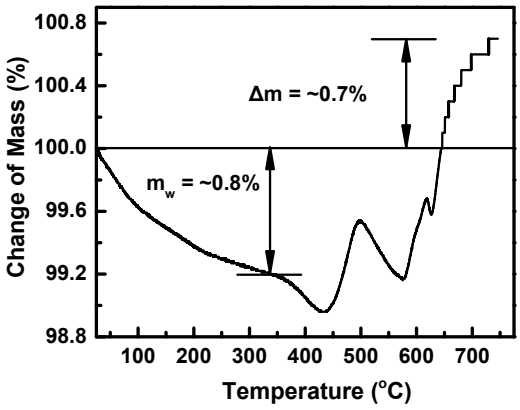

Fig. S2. TG curve of LVP@PNC at a heating rate of 10 °C min^{-1} under air.

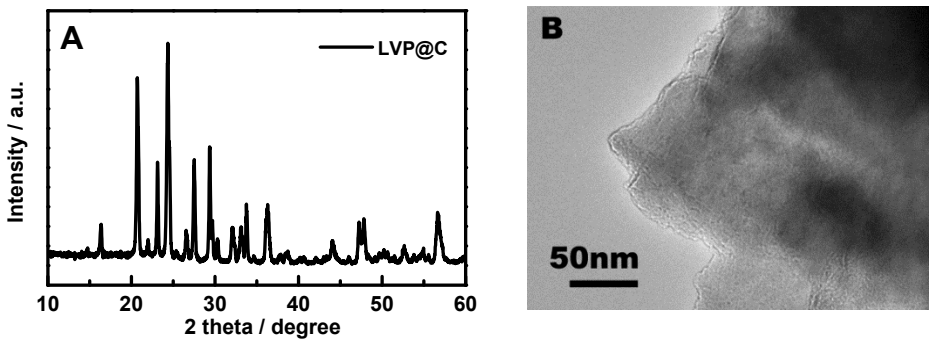

Fig. S3. (A) XRD pattern of LVP@C. (B) TEM image of LVP@C.

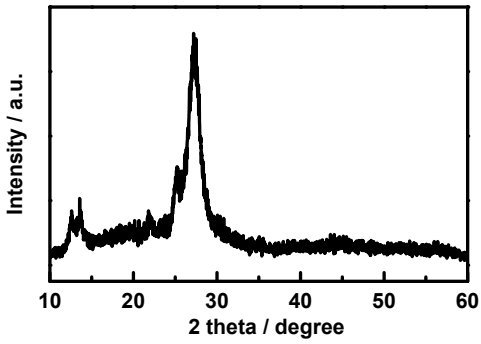

Fig. S4. XRD pattern of the dicyandiamide calcined at 500 °C.

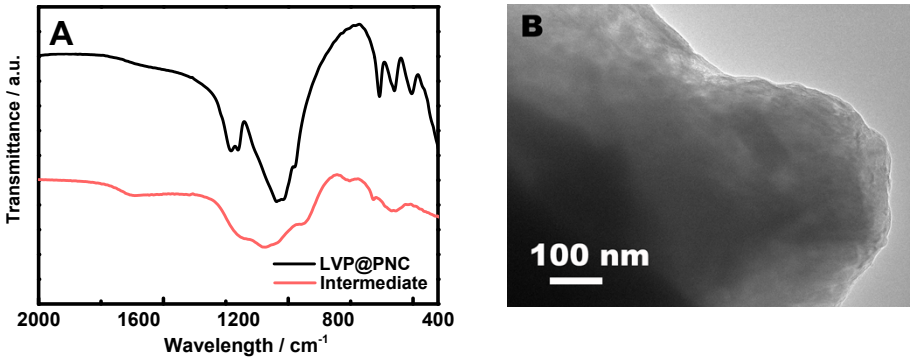

Fig. S5. (A) FT-IR spectra of LVP@PNC and the intermediate, (B) TEM image of the intermediate.

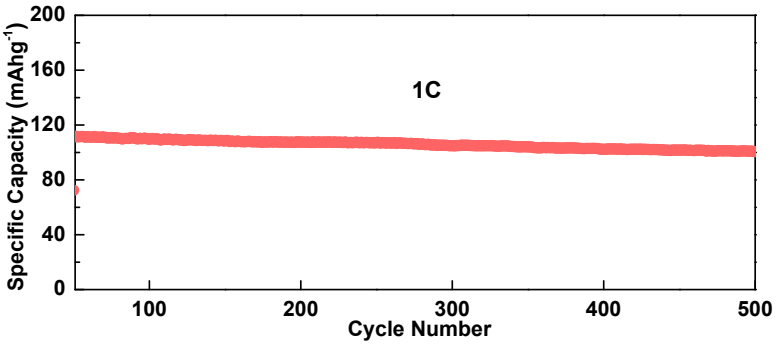

Fig. S6. The specific discharge capacities of LVP@PNC at 1 C after different rate test from 0.5 C to 10 C.

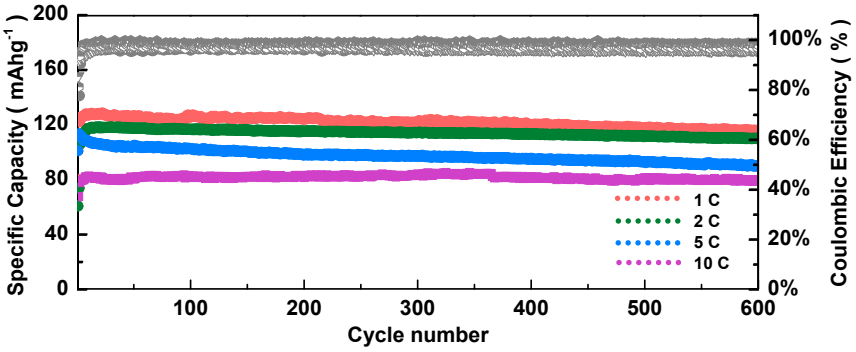

Fig. S7. The cycling performance of LVP@PNC at the rate of 1 C, 2 C, 5 C and 10 C for 600 cycles.

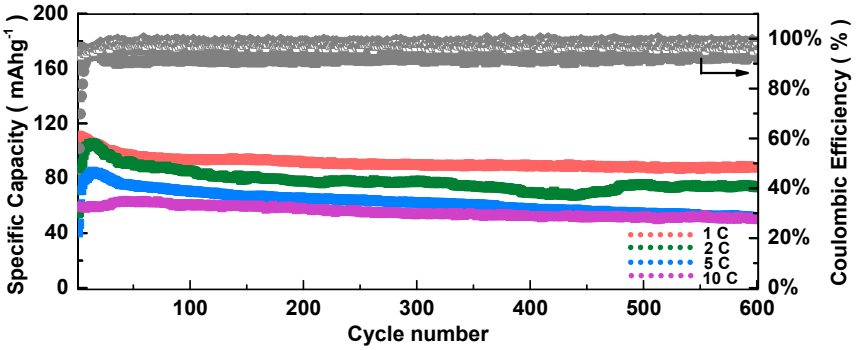

Fig. S8. The cycling performance of LVP@C at the rate of 1 C, 2 C, 5 C and 10 C for 600 cycles.

Table S1. Comparison of the electrochemical performance of the material reported here with some recently-reported carbon coated $Li_3V_2(PO_4)_3$ cathode materials

	Electrochemical performance	ref.
Hierarchical carbon decorated $Li_3V_2(PO_4)_3$	117 mA h g^{-1} at 5 C after 700 cycles and 94 mA h g^{-1} at 20 C after 4000 cycles.	8
Nanocomposite $Li_3V_2(PO_4)_3$/carbon	101.8 mA h g^{-1} at 20 C after 3000 cycles.	9
Hierarchical nanostructured $Li_3V_2(PO_4)_3$/C (HN-LVP@C)	90 mA h g^{-1} at 10 C after 1200 cycles.	10
Homogeneous core–shell structured $Li_3V_2(PO_4)_3$@C	107.8 mA h g^{-1} at 10 C after 300 cycles.	11
Hierarchical $Li_3V_2(PO_4)_3$/C mesoporous nanowires (LVP/C-M-NWs)	107 mAh g^{-1} at 5 C after 1000 cycles.	12
Three-dimensional-network $Li_3V_2(PO_4)_3$/C	85.4 mAh g^{-1} at 10 C after 500 cycles.	1
This work	90.5 and 79.8 mA h g^{-1} at 5 C and 10 C, respectively, after 600 cycles.	
Mesoporous $Li_3V_2(PO_4)_3$@CMK-3	95.4 and 73.5 mA h g^{-1} at 5 C and 10 C, respectively, after 300 cycles.	13
Carbon-coated Li3V2(PO4)3	102.7 mA h g^{-1} at 5 C after 400 cycles.	14
Plate-like $Li_3V_2(PO_4)_3$/C	111.8 mA h g^{-1} at 3C after 500 cycles.	15
Carbon-coated monoclinic $Li_3V_2(PO_4)_3$	83.1 and 88.9 mA h g^{-1} at 3 C after 600 cycles for the LVP1/C and LVP2/C, respectively.	16
$Li_3V_2(PO_4)_3$/C	84.3 mA h g^{-1} at 3 C after 500 cycles	17

Reference:

1 J. Xu, S. L. Chou, C. Zhou, Q. F. Gu, H. K. Liu and S. X. Dou, *J. Power Sources*, 2014, **246**, 124-131.

2 Q. Kuang, Y. Zhao, X. An, J. Liu, Y. Dong and Ling Chen, *Electrochimica Acta*, 2010, **55**, 1575-1581

3 L. Fei, W. Lu, L. Sun, J. Wang, J. Wei, H. L. W. Chan and Y. Wang, *RSC Adv.*, 2013, **3**, 1297-1301.

4 X. Zou, J. Su, R. Silva, A. Goswami, B. R. Satheab and T. Asefa, *Chem. Commun*., 2013, **49**, 7522-7524

5 Z. Chen, C. Dai, G. Wu, M. Nelson, X. Hu, R. Zhang, J. Liu and J. Xia, *Electrochimica Acta*, 2010, **55**, 8595-8599.

6 R. von Hagen, A. Lepcha, X. Song, W. Tyrra and S. Mathur, *Nano Energy*, 2013, **2**, 304-313.

7 L. Wang, X. Jiang, X. Li, X. Pi, Y. Ren and F. Wu, *Electrochimica Acta*, 2010, **55**, 5057-5062.

8 Y. Luo, X. Xu, Y. Zhang, Y. Pi, Y. Zhao, X. Tian, Q. An, Q. Wei and L. Mai, *Adv. Energy Mater.*, 2014, **4**, 1-8.

9 P. Xiong, L. Zeng, H. Li, C. Zheng and M. Wei, *RSC Adv.*, 2015, **5**, 57127-57132.

10 L. Fei, L. Sun, W. Lu, M. Guo, H. Huang, J. Wang, H. L. W. Chan, S. Fan and Yu Wang, *Nanoscale*, 2014, 6, 12426-12433.

11 C. Wang, H. Liu and W. Yang, *J. Mater. Chem.*, 2012, **22**, 5281-5285.

12 Q. Wei, Q. An, D. Chen, L. Mai, S. Chen, Y. Zhao, K. M. Hercule, L. Xu, A. Minhas-Khan, and Q. Zhang, *Nano Lett.*, 2014, **14**, 1042-1048.

13 S. Wang, Z. Zhang, Z. Jiang, A. Deb, L. Yang and S. Hirano, *J. Power Sources*, 2014, **253**, 294-299.

14 J. Su, X. L. Wu, J. S. Lee, J. Kimb and Y. G. Guo, *J. Mater. Chem. A*, 2013, **1**, 2508-2514.

15 Y. Q. Qiao, X. L. Wang, Y. J. Mai, J. Y. Xiang, D. Zhang, C. D. Gu and J. P. Tu, *J. Power Sources*, 2011, **196**, 8706-8709.

16 L. Wang, X. Zhou and Y. Guo, *J. Power Sources*, 2010, **195**, 2844-2850.

17 X. Zhou, Y. Liu and Y. Guo, *Solid State Commun.*, 2008, **146**, 261-264.