Electronic Supplementary Information (ESI)

Graphene encapsulated Fe_3O_4 nanorods to assemble a mesoporous hybrid composite as high-performance lithium-ion battery anode material

Wei Huang,[ab] Xinxin Xiao,[a] Christian Engelbrekt,[b] Minwei Zhang,[b] Shuo Li,[a] Jens Ulstrup,[b] Lijie Ci,[a] Jinkui Feng,[a] Pengchao Si,*[a] Qijin Chi*[b]

[a] *Key Laboratory for Liquid-Solid Structural Evolution and Processing of Materials, Ministry of Education, School of Materials Science and Engineering, Shandong University, Jinan 250061, P. R. China. E-mail address: pcsi@sdu.edu.cn (P.S.), Tel: +86 531 88399858, Fax: +86 531 88395011.*

[b] *Department of Chemistry, Technical University of Denmark, DK-2800 Kongens Lyngby, Denmark. E-mail address: cq@kemi.dtu.dk (Q.C.), Tel: +45 4525 2032, Fax: +45 4588 3136.*

Supporting Figures and Table

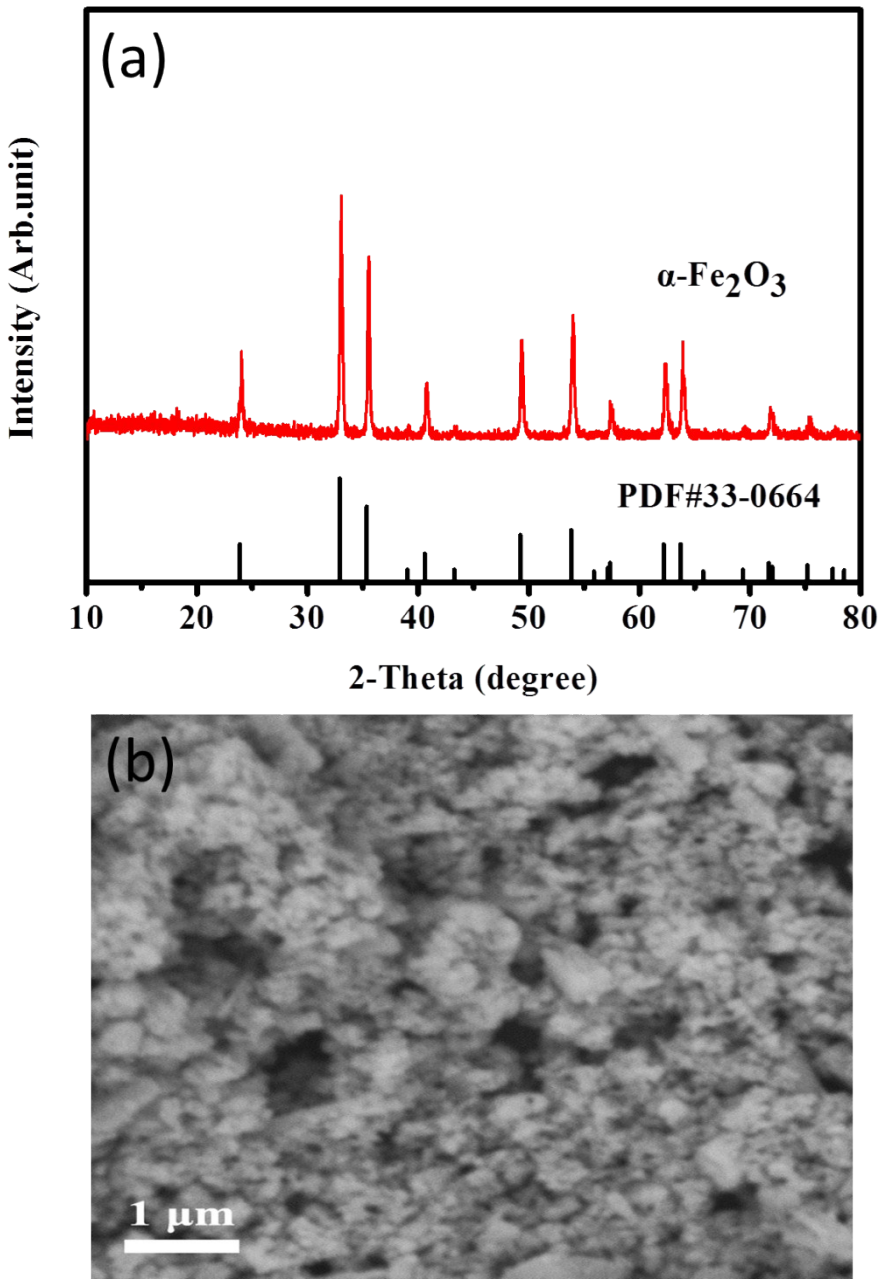

Fig. S1 The XRD pattern (a) and SEM image (b) of α-Fe_2O_3 obtained via protocol without GO.

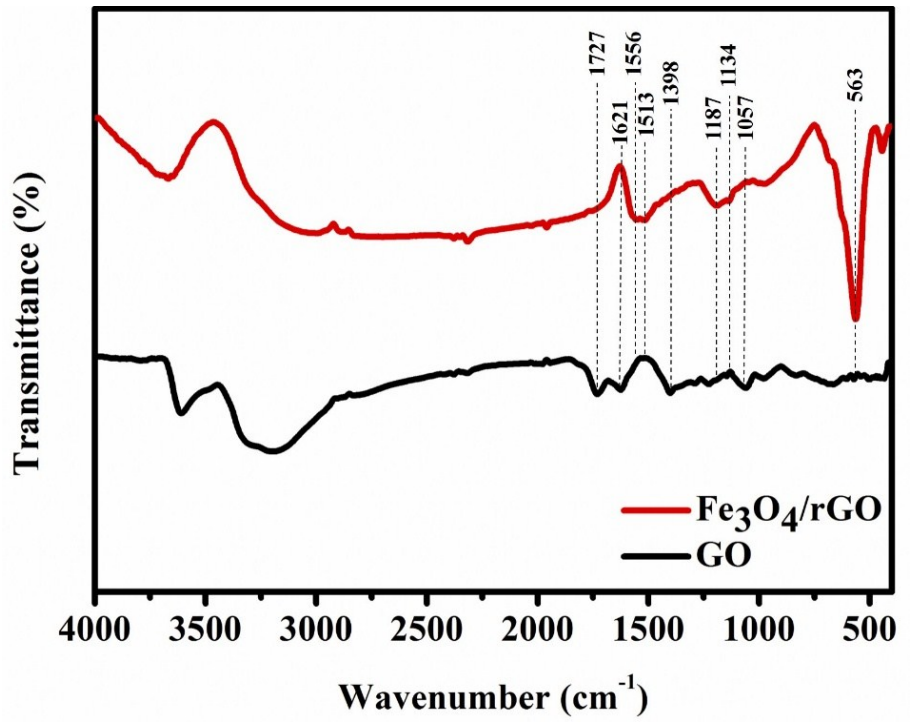

Fig. S2 Comparison of FT-IR spectra of the GO (black curve) and Fe_3O_4/rGO (red curve).

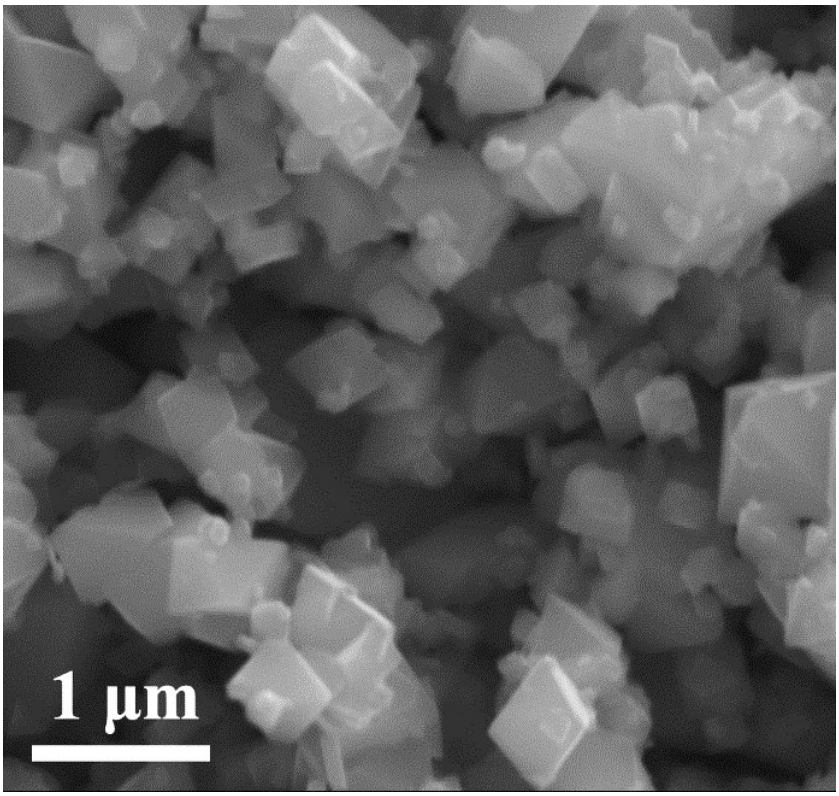

Fig. S3 SEM image of the commercial Fe_3O_4 powder.

Table S1 Comparison of the BET specific surface areas of mesoporous Fe_3O_4/rGO composites with other Fe_3O_4 based composites.

Materials	Specific surface area (m^2 g^{-1})	References
Fe_3O_4/rGO	**152**	**This work**
Conventional Fe_3O_4 powder	**2**	**This work**
Fe_3O_4/GNSs	52.84	1
Fe_3O_4@GS/GF	114.5	2
3D Graphene/Fe_3O_4	95.22	3
Fe_3O_4 NCs–GAs	118	4
Fe_3O_4 decorated Graphene ball	130	5
Fe_3O_4-NS/G composites	121	6
Hollow Fe_3O_4/Graphene	132	7
Fe_3O_4/GNS	53	8
Fe_3O_4/C nanospindles	35.1	9
mesoporous Fe_3O_4 nanocages	133	10
Fe_3O_4/Helical Carbon Nanofibers	126	11
Fe_3O_4 microspheres/Graphene	35.04	12
Fe_3O_4 Hollow Spheres	88.06	13
Fe_3O_4–RGO	81.67	14
Fe_3O_4/GS	83.9	15
Fe_3O_4 Nanoflake/Graphene	92.2	16
Fe_3O_4 nanorods/Graphene	86	17
Fe_3O_4@Polypyrrole Nanocages	69.63	18

Note: GNSs: graphene nanosheets; GS/GF: encapsulated with graphene; NCs: nanoclusters; GAs: graphene aerogels; NS: nanospheres.

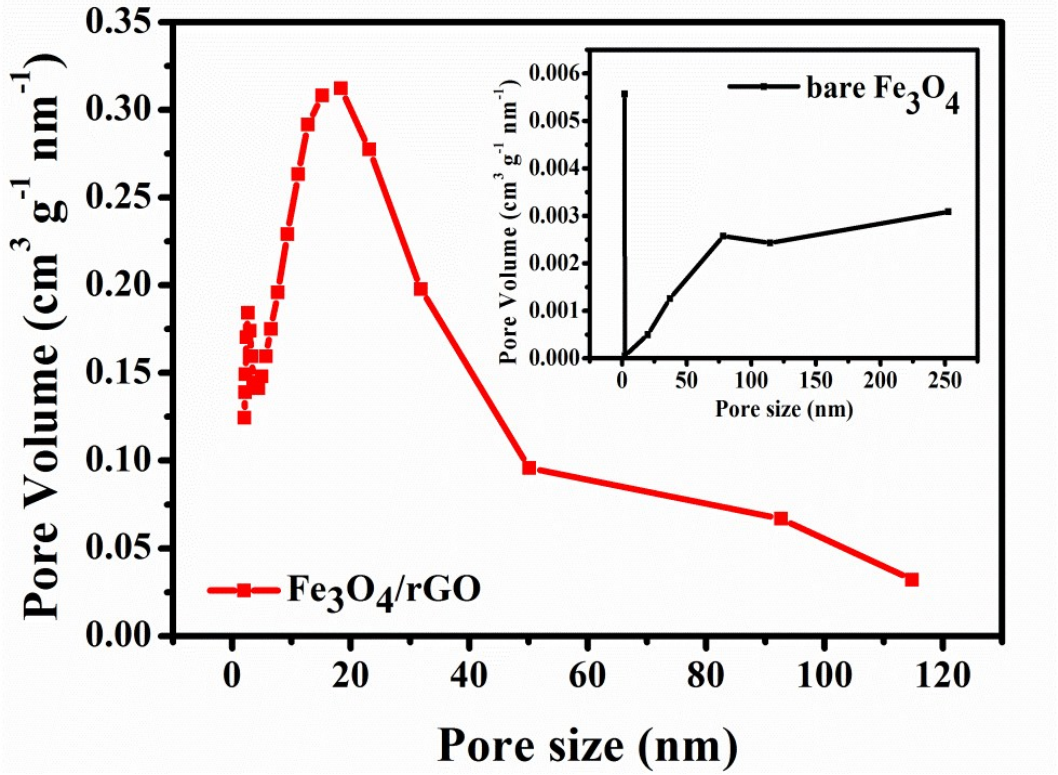

Fig. S4 Pore size distribution of Fe_3O_4/rGO samples; inset: pore size distribution of bare Fe_3O_4 sample.

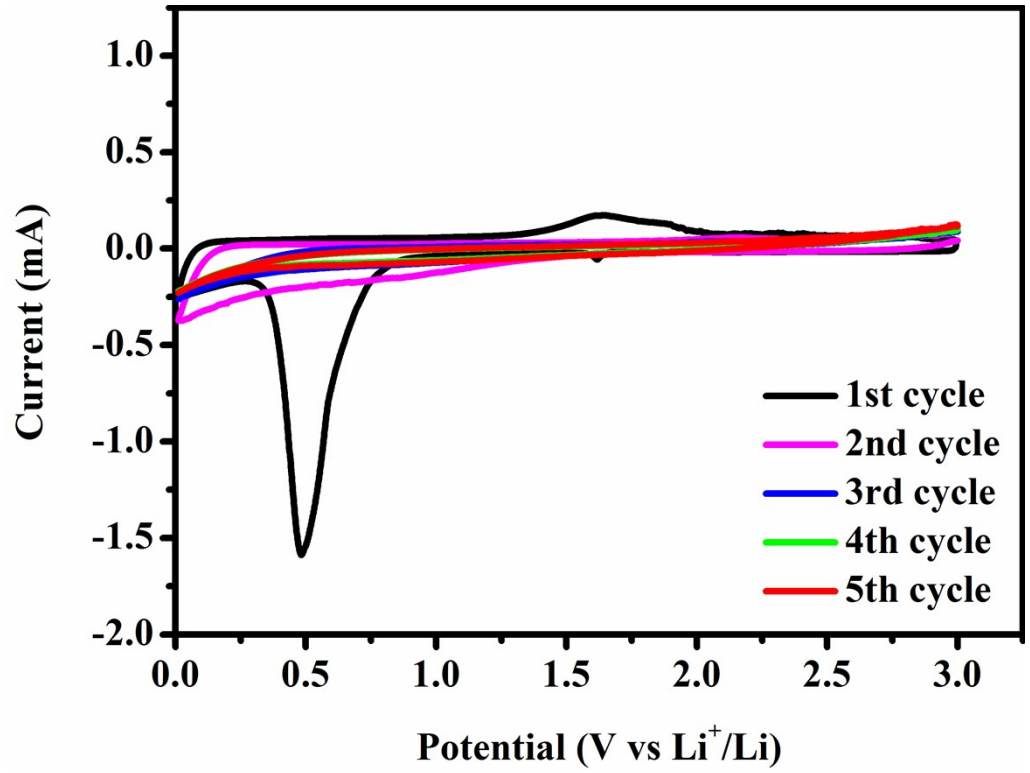

Fig. S5 Cyclic voltammograms for the first to fifth cycle of the bare Fe_3O_4 sample in a voltage range of 0.01-3.0 V at 0.1 mV s^{-1}.

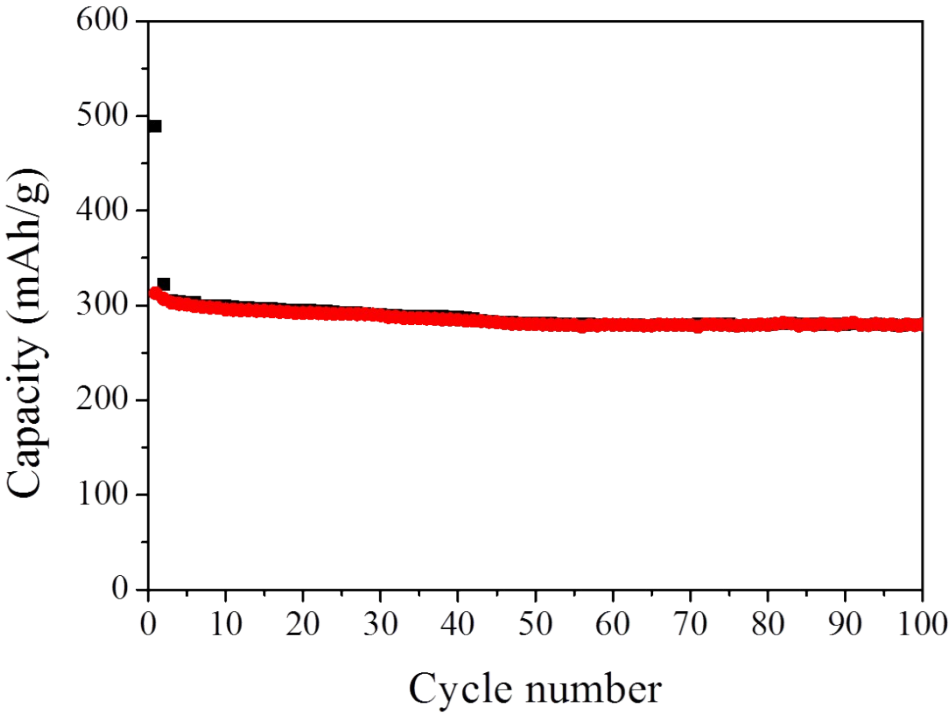

Fig. S6 The cyclic performance of pure rGO anode at 100 mA g^{-1}.

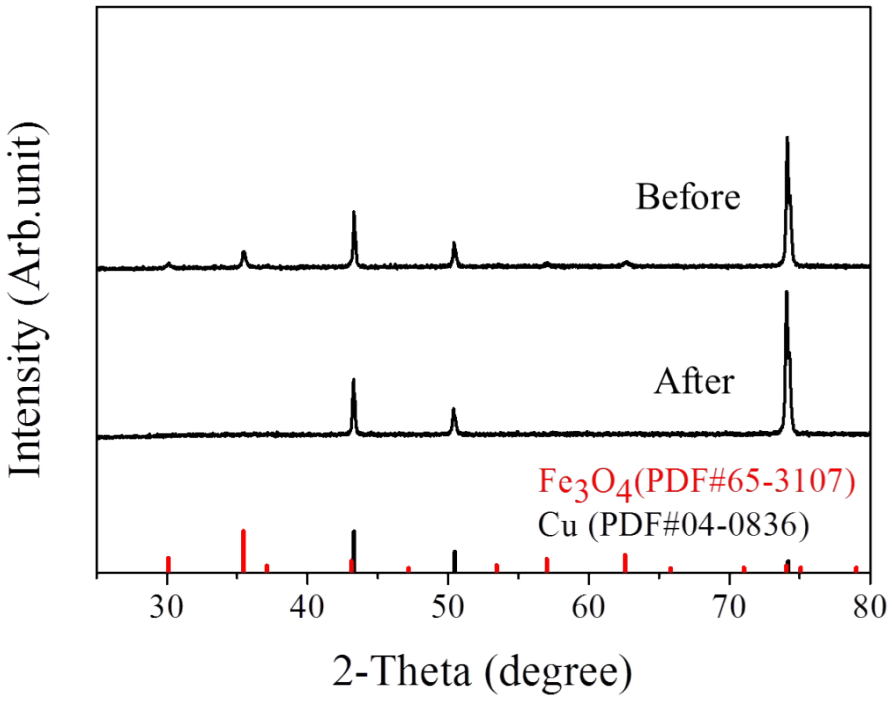

Fig. S7 The XRD patterns of before and after cycles based on Fe_3O_4/rGO electrode material.

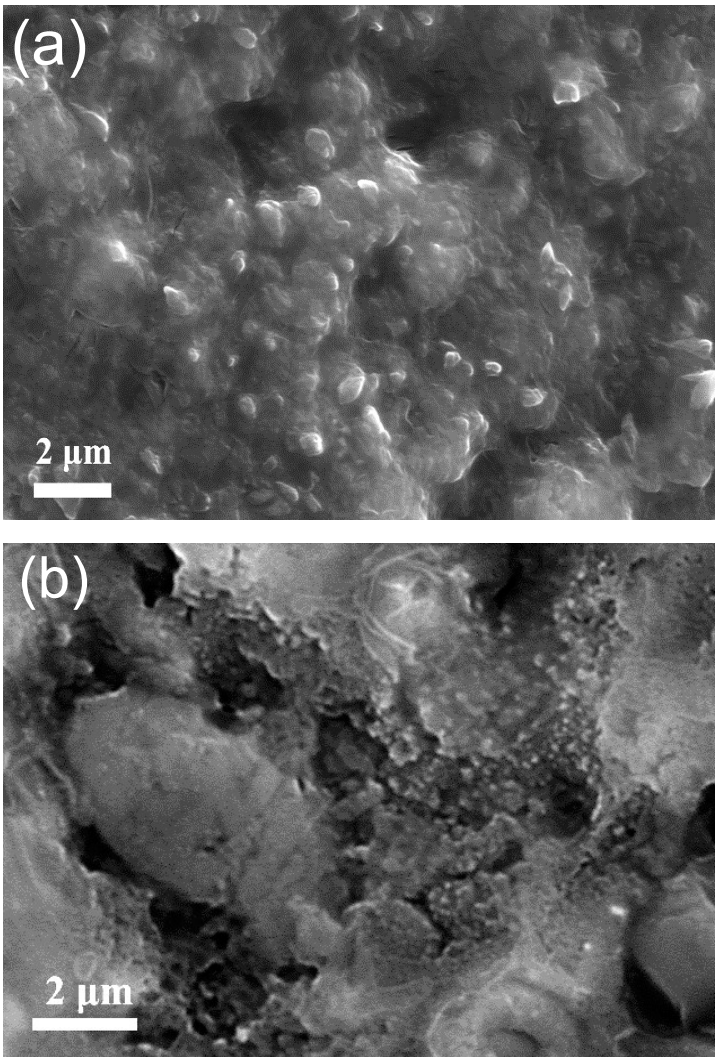

Fig. S8 SEM images of Fe_3O_4/rGO (a) and bare Fe_3O_4 (b) after 100 cycles at 100 mA g^{-1}.

Supporting references

1 X. Li, X. Huang, D. Liu, X. Wang, S. Song, L. Zhou, H. Zhang, *J. Phys. Chem. C*, 2011, **115**, 21567-21573.

2 W. Wei, S. Yang, H. Zhou, I. Lieberwirth, X. Feng, K. Mullen, *Adv. Mater.*, 2013, **25**, 2909-2914.

3 W. Chen, S. Li, C. Chen, L. Yan, *Adv. Mater.*, 2011, **23**, 5679-5683.

4 L. Fan, B. Li, D.W. Rooney, N. Zhang, K. Sun, *Chem. Commun.*, 2015, **51**, 1597-1600.

5 S.H. Choi, Y.C. Kang, *Carbon*, 2014, **79**, 58-66.

6 Y. Dong, K.C. Yung, R. Ma, X. Yang, Y.S. Chui, J.M. Lee, J.A. Zapien, *Carbon*, 2015, **86**, 310-317.

7 D. Chen, G. Ji, Y. Ma, J.Y. Lee, J. Lu, *ACS Appl. Mater. Inter.*, 2011, **3**, 3078-3083.

8 G. Zhou, D.W. Wang, F. Li, L. Zhang, N. Li, Z.S. Wu, L. Wen, G.Q. Lu, H.M. Cheng, *Chem. Mater.*, 2010, **22**, 5306-5313.

9 W.M. Zhang, X.L. Wu, J.S. Hu, Y.G. Guo, L.J. Wan, *Adv. Funct. Mater.*, 2008, **18**, 3941-3946.

10 T. Xia, X. Xu, J. Wang, C. Xu, F. Meng, Z. Shi, J. Lian, J.M. Bassat, *Electrochim. Acta*, 2015, **160**, 114-122.

11 S. Ren, R. Prakash, D. Wang, V.S.K. Chakravadhanula, M. Fichtner, *ChemSusChem*, 2012, **5**, 1397-1400.

12 Y. Jiang, Z.J. Jiang, L. Yang, S. Cheng, M. Liu, *J. Mater. Chem. A*, 2015, **3**, 11847-11856.

13 F.X. Ma, H. Hu, H.B. Wu, C.Y. Xu, Z. Xu, L. Zhen, X.W. Lou, *Adv. Mater.*, 2015, **27**, 4097-4101.

14 S. Bhuvaneswari, P.M. Pratheeksha, S. Anandan, D. Rangappa, R. Gopalan, T.N. Rao, *Phys. Chem. Chem. Phys.*, 2014, **16**, 5284-5294.

15 X. Meng, Y. Xu, X. Sun, J. Wang, L. Xiong, X. Du, S. Mao, *J. Mater. Chem. A*, 2015, **3**, 12938-12946.

16 B. Zhao, Y. Zheng, F. Ye, X. Deng, X. Xu, M. Liu, Z. Shao, *ACS Appl. Mater. Inter.*, 2015, **7**, 14446-14455.

17 Q. Zhou, Z. Zhao, Z. Wang, Y. Dong, X. Wang, Y. Gogotsi, J. Qiu, *Nanoscale*, 2014, **6**, 2286-2291.

18 J. Liu, X. Xu, R. Hu, L. Yang, M. Zhu, *Adv. Eng. Mater.*, 2016, 1600256.