Supporting Information for *Acta Phys. -Chim. Sin.* doi: 10.3866/PKU.WHXB201905034

基于水凝胶衍生的硅/碳纳米管/石墨烯纳米复合材料及储锂性能

安惠芳，姜莉，李峰，吴平*，朱晓舒，魏少华，周益明*
南京师范大学化学与材料科学学院，江苏省新型动力电池重点实验室，江苏省生物医药功能材料协同创新中心，南京 210023

A Hydrogel Derived Three-dimensional Porous Si-CNT@G Nanocomposite with High Performance Lithium Storage

Huifang An, Li Jiang, Feng Li, Ping Wu *, Xiaoshu Zhu, Shaohua Wei, Yiming Zhou *
Jiangsu Key Laboratory of New Power Batteries, Jiangsu Collaborative Innovation Center of Biomedical Functional Materials, School of Chemistry and Materials Science, Nanjing Normal University, Nanjing 210023, P. R. China.

*Corresponding authors. Emails: zhouyiming@njnu.edu.cn (Z.Y.); zjwuping@njnu.edu.cn (W.P.).

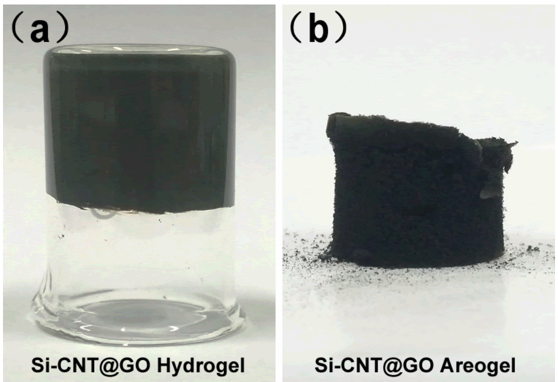


图 S1　Si-CNT@GO 水凝胶(a)和气凝胶(b)照片

Fig. S1　Digital photographs of Si-CNT@GO hydrogel (a) and Si-CNT@GO aerogel (b).

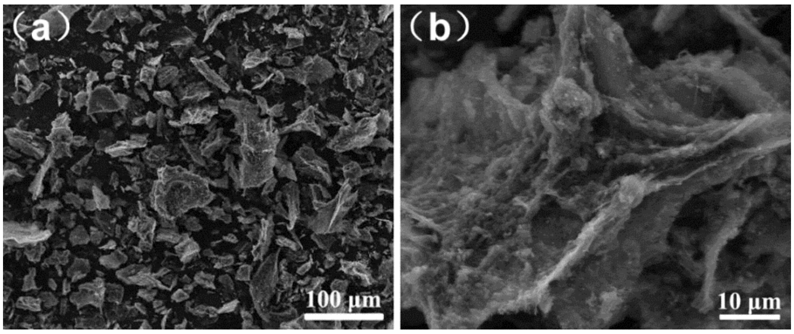


图 S2　不同放大倍数下 Si@G 纳米复合材料的扫描电镜图像

Fig. S2　SEM images of Si@G nanocomposite at different magnifications.

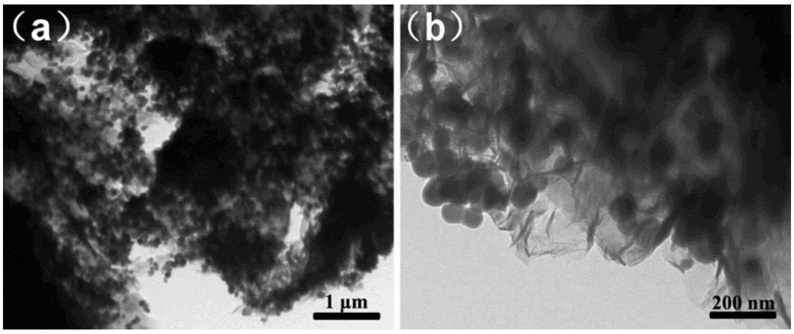
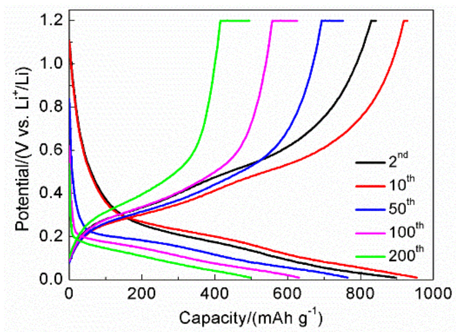


图 S3　Si@G 纳米复合材料的透射电镜图像

Fig. S3　TEM images of Si@G nanocomposite at different magnifications.



图S4　在500 mA·g^{-1}的电流密度下，Si@G纳米复合材料在第2、10、50、100、200圈的充放电曲线

Fig. S4　The discharge and charge profiles of the Si@G nanocomposite for the 2nd, 10th, 50th, 100th, and 200th cycle at the current density of 500 mA·g^{-1}.

表 S1　Si-CNT@G 与文献报道的 Si/C 材料储锂性能对比

Table S1　Comparison of cycle performance and rate capability between Si-CNT@G and other Si/C composite anodes of LIBs.

Si/C composite	Cycle performance/($mAh·g^{-1}$)	Capacity retention	Rate capability/($mAh·g^{-1}$)	References
Si-CNT@G	674 at 0.5 $A·g^{-1}$ (200th cycle)	97% (200/2)	752 at 1 $A·g^{-1}$ 567 at 2 $A·g^{-1}$	This work
Si/C/RGO	760 at 0.1 $A·g^{-1}$ (80th cycle)	~92% (80/2)	412 at 0.5 $A·g^{-1}$ 317 at 1 $A·g^{-1}$	1
Si/Graphite	445 at 0.3 $A·g^{-1}$ (300th cycle)	~77% (300/2)	388 at 1.5 $A·g^{-1}$ 310 at 2.2 $A·g^{-1}$	2
Si@C	616 at 0.1 $A·g^{-1}$ (100th cycle)	~72% (100/2)	449 at 1 $A·g^{-1}$ 351 at 2 $A·g^{-1}$	3
Si@N-CNF	~750 at 0.5 $A·g^{-1}$ (150th cycle)	~75% (150/2)	641 at 2 $A·g^{-1}$ 500 at 4 $A·g^{-1}$	4
Si@Graphite/Graphene	542 at 0.1 $A·g^{-1}$ (100th cycle)	~95% (100/2)	434 at 4 $A·g^{-1}$ 390 at 6 $A·g^{-1}$	5
Si/C	~1000 at 0.2 $A·g^{-1}$ (50th cycle)	~77% (50/2)	~1100 at 5 $A·g^{-1}$ ~1000 at 10 $A·g^{-1}$	6
Si/C	860 at 0.05 $A·g^{-1}$ (50th cycle)	~86% (50/2)	581 at 0.5 $A·g^{-1}$ 484 at 1 $A·g^{-1}$	7
Si/Graphene/MWCNT	425 at 0.01 $A·g^{-1}$ (100th cycle)	~29% (100/2)	NA	8
Si/C	862 at 0.1 $A·g^{-1}$ (50th cycle)	~96% (50/2)	NA	9
Si/rGO	~750 at 0.05 $A·g^{-1}$ (100th cycle)	~75% (100/2)	670 at 0.1 $A·g^{-1}$ 500 at 0.25 $A·g^{-1}$	10
Si@C	1001 at 0.3 $A·g^{-1}$ (200th cycle)	~100% (200/2)	870 at 1.5 $A·g^{-1}$ 767 at 3 $A·g^{-1}$	11

References

(1) Yu, K.; Zhang, H.; Qi, H.; Liang, J.; Liang, C. *New J. Chem.* **2018,** *42*, 19811. doi: 10.1039/c8nj05098h

(2) Zhu, S.; Zhou, J.; Guan, Y.; Cai, W.; Zhao, Y.; Zhu, Y.; Zhu, L.; Zhu, Y.; Qian, Y. *Small* **2018,** *14*, 1802457. doi: 10.1002/smll.201802457

(3) Xiao, Z.; Xia, N.; Song, L.; Li, L.; Cao, Z.; Zhu, H. *J. Electron. Mater.* **2018,** *47*, 6311. doi: 10.1007/s11664-018-6513-1

(4) Park, S.-W.; Shim, H.-W.; Kim, J.-C.; Kim, D.-W. *J. Alloys Compd.* **2017,** *728*, 490. doi: 10.1016/j.jallcom.2017.09.023

(5) Lin, N.; Xu, T.; Li, T.; Han, Y.; Qian, Y. *ACS Appl. Mater. Interfaces* **2017,** *9*, 39318. doi: 10.1021/acsami.7b10639

(6) Min, S. H.; Jo, M. R.; Song, D. H.; song, K.; Yang, J.; Kang, Y.-M. *Electrochim. Acta* **2016,** *220*, 511. doi: 10.1016/j.electacta.2016.10.111

(7) Ren, W.; Wang, Y.; Tan, Q.; Zhong, Z.; Su, F. *J. Power Sources* **2016,** *332*, 88. doi: 10.1016/j.jpowsour.2016.09.110

(8) Toçoğlu, U.; Hatipoğlu, G.; Alaf, M.; Kayış, F.; Akbulut, H. *Appl. Surf. Sci.* **2016,** *389*, 507. doi: 10.1016/j.apsusc.2016.07.135

(9) Nava, R.; Cremar, L.; Agubra, V.; Sanchez, J.; Alcoutlabi, M.; Lozano, K. *ACS Appl. Mater. Interfaces* **2016,** *8*, 29365. doi: 10.1021/acsami.6b06051

(10) Botas, C.; Carriazo, D.; Zhang, W.; Rojo, T.; Singh, G. *ACS Appl. Mater. Interfaces* **2016,** *8*, 28800. doi: 10.1021/acsami.6b07910

(11) Agyeman, D. A.; Song, K.; Lee, G.-H.; Park, M.; Kang, Y. M. *Adv. Energy Mater.* **2016,** *6*, 1600904. doi: 10.1002/aenm.201600904