Supplementary Material

N-doped Order Mesoporous Carbon Prepared by Solid-solid Grinding for Supercapacitor

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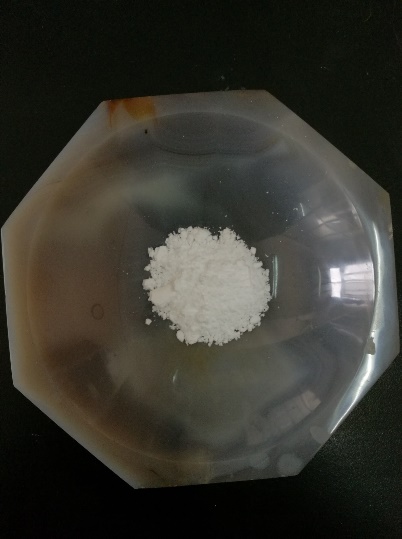
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(c)

(d)

(a)

(b)



**FIG. S1.** Digital photographs of preparing the composites of N-OMC: SBA-15 (a), composite of SBA-15 and Co(NO3)2·6H2O (b), ZIF-67/SBA-15 (c) and N-OMC (d).



**FIG. S2.** FT-IR spectra of ZIF-67-S, ZIF-67-G and ZIF-67/SBA-15 (a), small angle XRD patterns of SBA-15 and ZIF-67/SBA-15 (b), wide angle XRD patterns of ZIF-67-G and ZIF-67/SBA-15 (c) and TGA curves of Hmim, ZIF-67-G and ZIF-67/SBA-15 (d).



**FIG. S3.** Nitrogen isothermal adsorption-desorption and pore size distribution (inset) of porous carbon obtained by carbonization of ZIF-67-S.



**FIG. S4.** TEM images of N-OMC.



**FIG. S5.** CV curves from 40 to 200 mV s-1 (a) and GCD curves (b) from 3 to 20 A g-1 of N-OMC in three-electrode system.



**FIG. S6.** GCD curves at different current density of N-OMC and porous carbon obtained by carbonization of ZIF-67-S.



**FIG. S7.** CV (a) and GCD (b) curves of N-OMC in two-electrode system.

**Table SⅠ** Comparison in charge/discharge cycling stability of N-OMC with previously reported mesoporous carbon materials.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Synthesis method | Cycles | Retention (%) | Current density  (A g-1) | Electrolyte | Ref. |
| Hard template | 10 000 | 99.97 | 5 | 6 M KOH | This work |
| Microwave-assisted | 5000 | 85.8 | 5a | 6 M KOH | 1 |
| Hard template | 5000 | 96.2 | 10 | 1M H2SO4 | 2 |
| Soft template | 1000 | 91 | 10b | 6 M KOH | 3 |
| Soft template | 1000 | 98.2 | 0.5 | 6 M KOH | 4 |
| Soft template | 1000 | 91.5 | 0.5c | 1M H2SO4 | 5 |
| Hard template | 1000 | 90.4 | 1c | 1M H2SO4 | 6 |
| Soft template | 10 000 | 70 | 0.5 | 6 M KOH | 7 |
| Hard template | 5000 | 91 | 200a | 6 M KOH | 8 |
| Hydrothermal emulsion | 500 | 90 | 1 | 6 M KOH | 9 |
| Hard template | 200 | 85 | 1.25 | 2 M KOH | 10 |
| Hard template | 1800 | 88 | 1c | 1M Et4BF4 | 11 |
| Soft template | 10 000 | 98 | 3c | 1M H2SO4 | 12 |
| Hard template | 300 | 98 | 1 | 6 M KOH | 13 |
| Hard template | 700 | 96.6 | 3c | 6 M KOH | 14 |
| Soft template | 10 000 | 93 | 2 | 1M H2SO4 | 15 |

amV s-1; bmA cm-1; cElectrochemical experiments were tested by two-electrode.

**REFERENCES**

1. U.B. Nasini, V.G. Bairi, S.K. Ramasahayam, S.E. Bourdo, T. Viswanathan and A.U. Shaikh: Phosphorous and nitrogen dual heteroatom doped mesoporous carbon synthesized via microwave method for supercapacitor application *J. Power Sources.* **250**, 257 (2014).

2. Y.H. Dai, H. Jiang, Y.J. Hu, Y. Fu and C.Z. Li: Controlled synthesis of ultrathin hollow mesoporous carbon nanospheres for supercapacitor applications *Ind. Eng. Chem. Res..* **53**, 3125 (2014).

3. M. Li and J.M. Xue: Integrated Synthesis of Nitrogen-Doped Mesoporous Carbon from Melamine Resins with Superior Performance in Supercapacitors *J. Phys. Chem. C.* **118**, 2507 (2014).

4. X.L. Yu, J.G. Wang, Z.H. Huang, W.C. Shen and F.Y. Kang: Ordered mesoporous carbon nanospheres as electrode materials for high-performance supercapacitors *Electrochem. Commun..* **36**, 66 (2013).

5. Y.F. Yan, Q.L. Cheng, Z.J. Zhu, V. Pavlinek, P. Saha and C.Z. Li: Controlled synthesis of hierarchical polyaniline nanowires/ordered bimodal mesoporous carbon nanocomposites with high surface area for supercapacitor electrodes *J. Power Sources.* **240**, 544 (2013).

6. Y.F. Yan, Q.L. Cheng, G.C. Wang and C.Z. Li: Growth of polyaniline nanowhiskers on mesoporous carbon for supercapacitor application, *J. Power Sources* **196**, 7835 (2011).

7. X.L. Dong, Z.Y. Guo, Y.F. Song, M.Y. Hou, J.Q. Wang, Y.G. Wang and Y.Y. Xia: Flexible and Wire-Shaped Micro-Supercapacitor Based on Ni(OH)2-Nanowire and Ordered Mesoporous Carbon Electrodes *Adv. Funct. Mater..* **24**, 3405 (2014).

8. Q.W. Wang, J. Yan, T, Wei, J. Feng, Y.M. Ren, Z.J. Fan, M.L. Zhang, and X.Y. Jing, Two-dimensional mesoporous carbon sheet-like framework material for high-rate supercapacitors, Carbon 60 (2013) 481-487, J. Yan, T. Wei, J. Feng, Y.M. Ren, Z.J. Fan, M.L. Zhang and X.Y. Jing: Two-dimensional mesoporous carbon sheet-like framework material for high-rate supercapacitors *Carbon.* **60**, 481 (2013).

9. M.X. Liu, L.H. Gan, W. Xiong, F.Q. Zhao, X.Z. Fan, D.Z. Zhu, Z.J. Xu, Z.X. Hao and L.W. Chen: Nickel-Doped Activated Mesoporous Carbon Microspheres with Partially Graphitic Structure for Supercapacitors *Energy Fuels.* **27**, 1168 (2013).

10. J.W. Lang, X.B. Yan, X.Y. Yuan, J. Yang and Q.J. Xue: Study on the electrochemical properties of cubic ordered mesoporous carbon for supercapacitors *J. Power Sources.* **196**, 10472 (2011).

11. D. Bhattacharjya, M.S. Kim, T.S. Bae and J.S. Yu: High performance supercapacitor prepared from hollow mesoporous carbon capsules with hierarchical nanoarchitecture *J. Power Sources* **244**, 799 (2013).

12. D.D. Zhou, W.Y. Li, X.L. Dong, Y.G. Wang, C.X. Wang and Y.Y. Xia: A nitrogen-doped ordered mesoporous carbon nanofiber array for supercapacitors *J. Mater. Chem. A..* 8488 (2013).

13. Y.Y. Lv, F. Zhang, Y.Q. Dou, Y.P. Zhai, J.X. Wang, H.J. Liu, Y.Y. Xia, B. Tu and D.Y. Zhao: A comprehensive study on KOH activation of ordered mesoporous carbons and their supercapacitor application *J. Mater. Chem .* **22**, 93 (2012).

14. Z.B. Lei, N. Christov, X.S. Zhao and L.L. Zhang: Mesoporous carbon nanospheres with an excellent electrocapacitive performance *J. Mater. Chem..* **21**, 2274 (2011).

15. Z. Li, Z.W. Xu, X.H. Tan, H.L. Wang, C.M.B. Holt, T. Stephenson, B.C. Olsen and D. Mitlin: Mesoporous nitrogen-rich carbons derived from protein for ultra-high capacity battery anodes and supercapacitors *Energy Environ. Sci..* **6**, 871 (2013).

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