Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.


Supporting Information

# Intercalation pseudocapacitance of hollow carbon bubbles with multilayered shells for boosting K-ion storage

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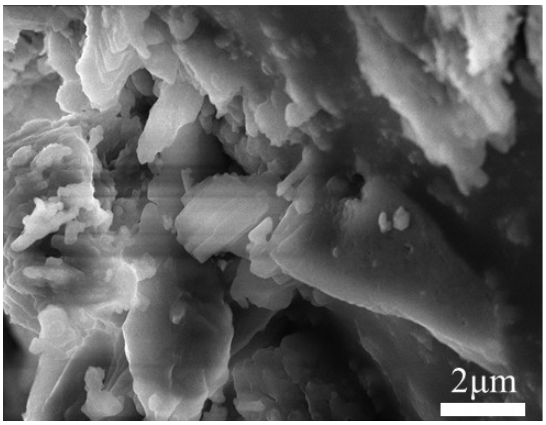


Figure S1 SEM image of FSC without removing $Na_2CO_3$ after heating treatment at 250 °C.

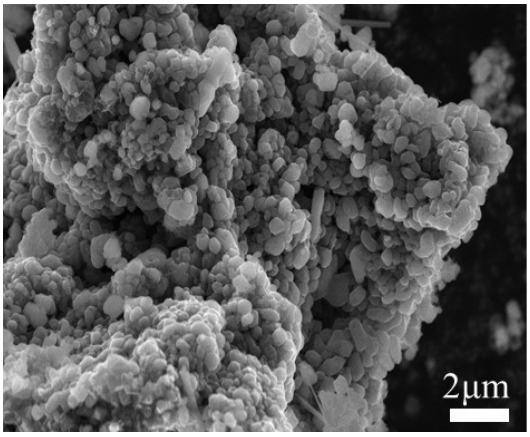


Figure S2 SEM image of FSC without removing $Na_2CO_3$ after heating treatment at 400 °C.

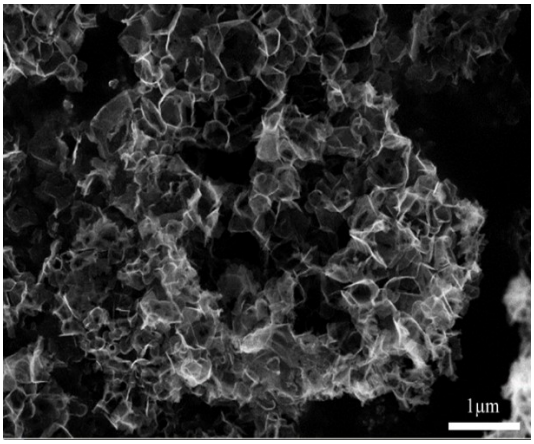


Figure S3 SEM image of FSC after removing $Na_2CO_3$ after heating treatment at 400 °C.

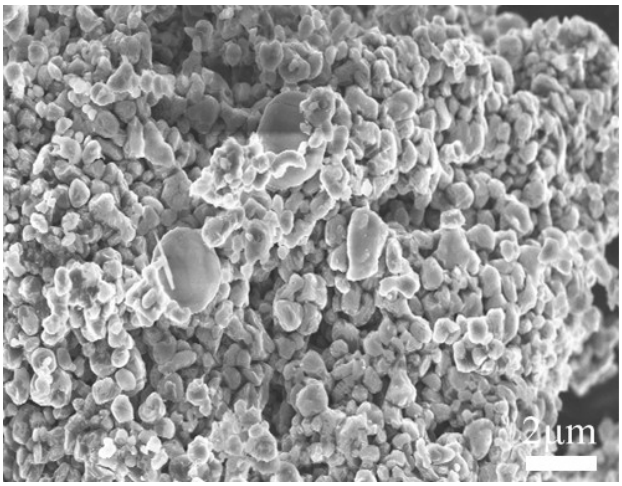


Figure S4 SEM image of FSC without removing $Na_2CO_3$ after heating treatment at 700 °C.

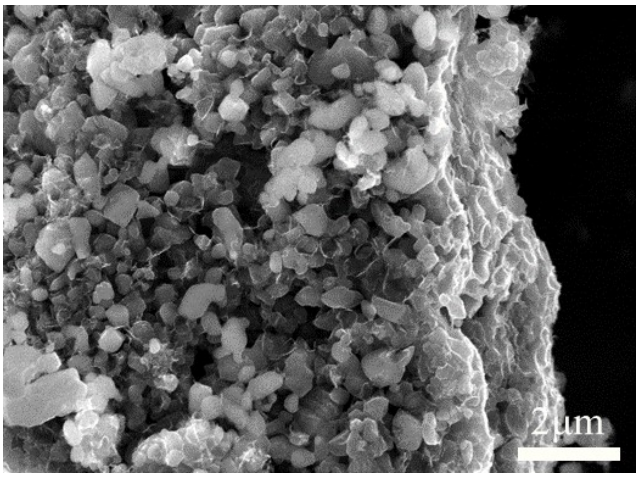


Figure S5 SEM image of FSC without removing $Na_2CO_3$ after heating treatment at 800 °C.

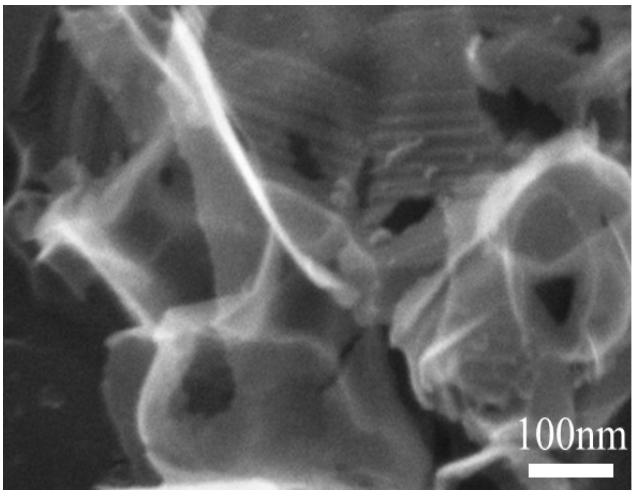


Figure S6 SEM image of HCB-500.

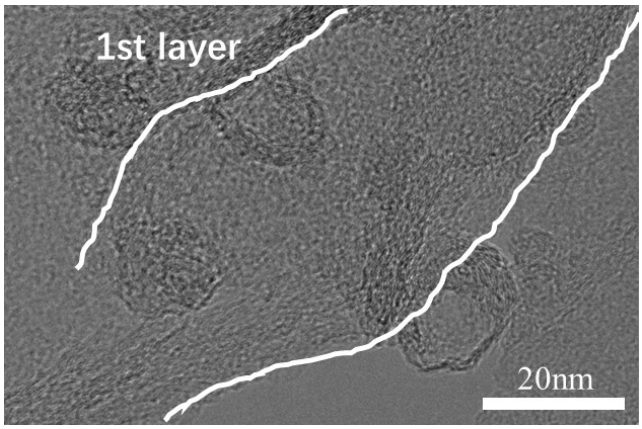


Figure S7 TEM image of HCB-700.

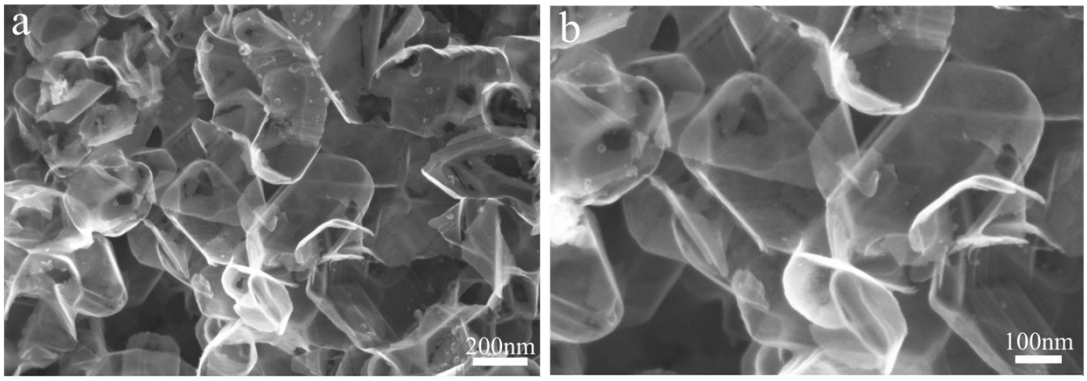


Figure S8 a, b) SEM images of HCB-700.

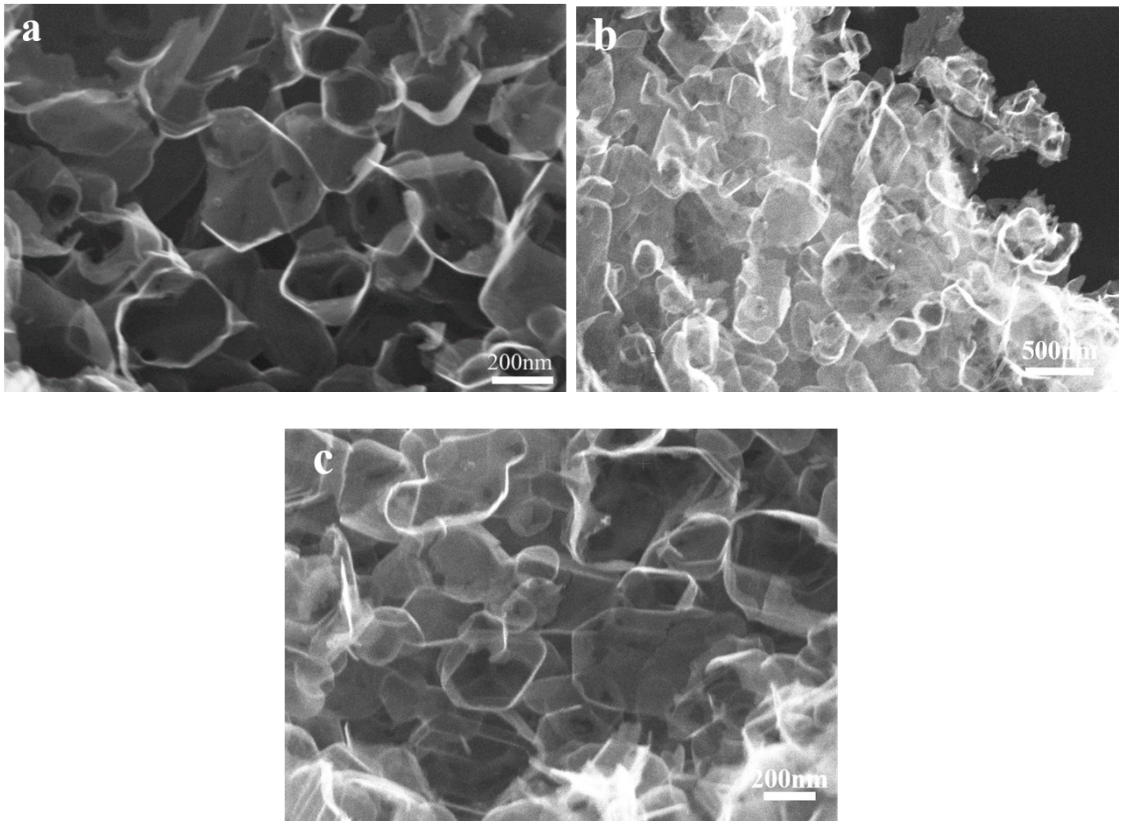


Figure S9 a, b, c) SEM image of CSCC.

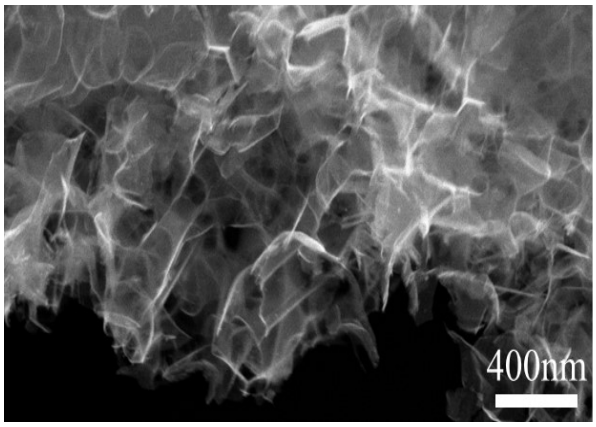


Figure S10 SEM image of HCB-800.

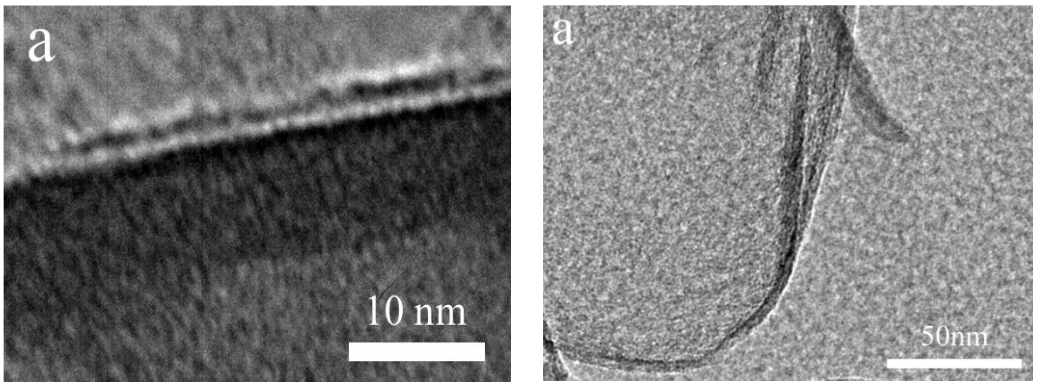


Figure S11 a, b, c) TEM images of HCB-700.

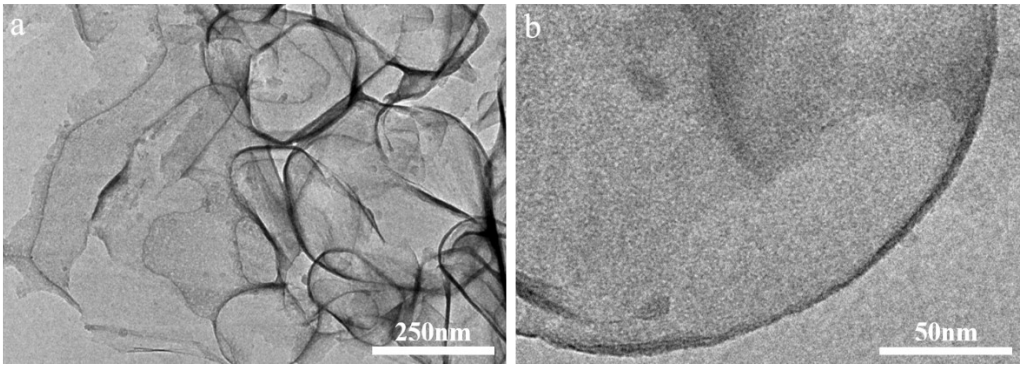


Figure S12 a, b) TEM images of CSCC.

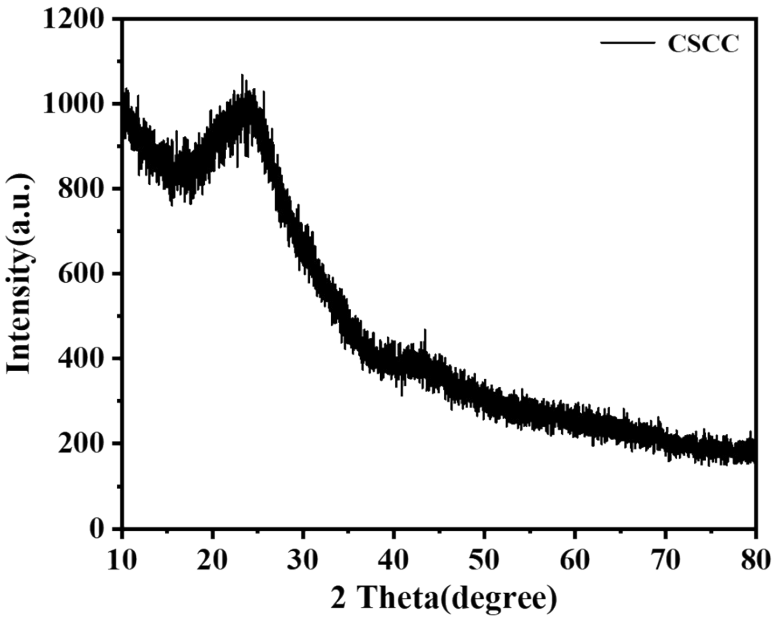


Figure S13 XRD pattern of CSCC.

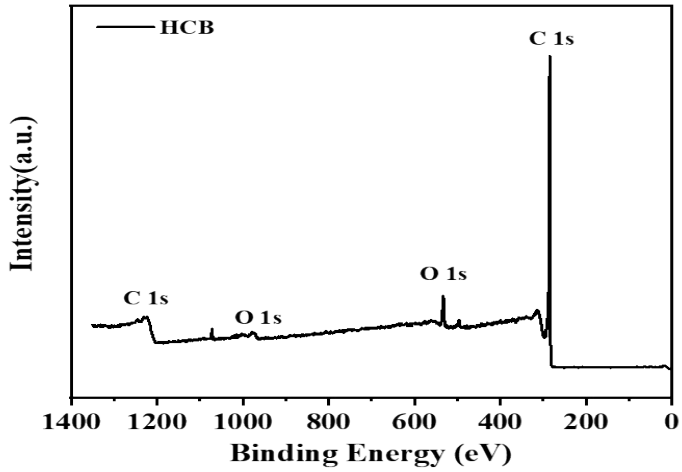


Figure S14 XPS survey spectra of the HCB.

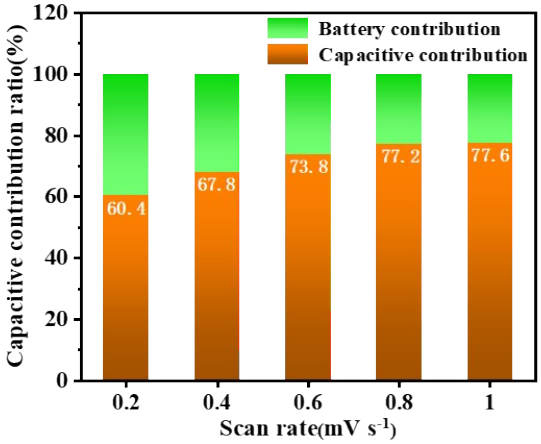

Figure S15 Normalized contribution proportions of capacitance and diffusion at different scan rates of the CSCC anode.

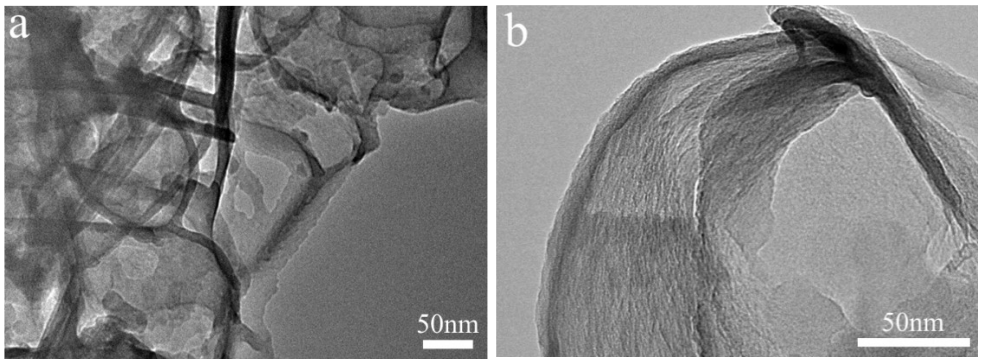


Figure S16 HRTEM images of HCB-700 electrode after cycling.

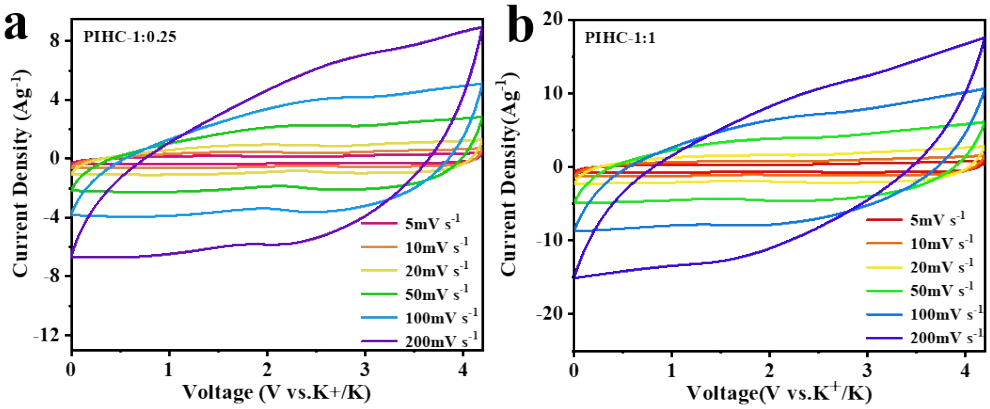


Figure S17 Typical CV curves of the HCB-700 //AC PIHCs at different scan rates of the 5-200 mV $s^{-1}$ for the voltage window of 0-4.2 V.

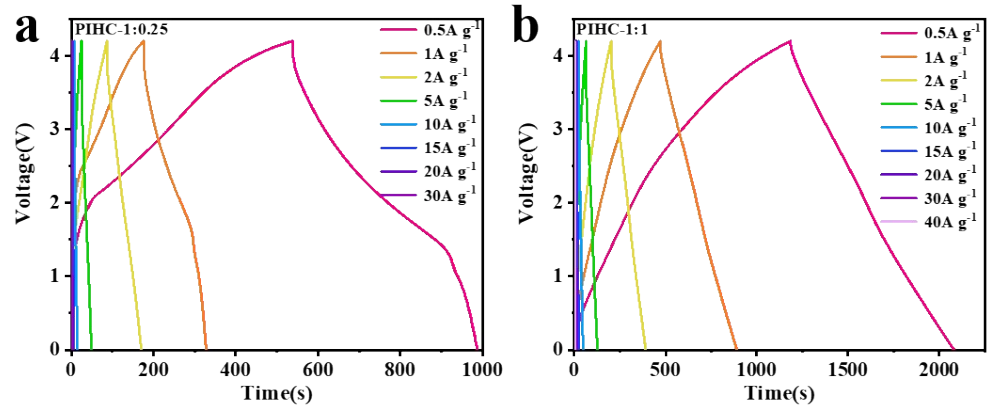


Figure S18 Typical charge-discharge curves of the HCB-700//AC PIHCs at different current densities of the 0.5-30 A $g^{-1}$ for the voltage window of 0-4.2V.

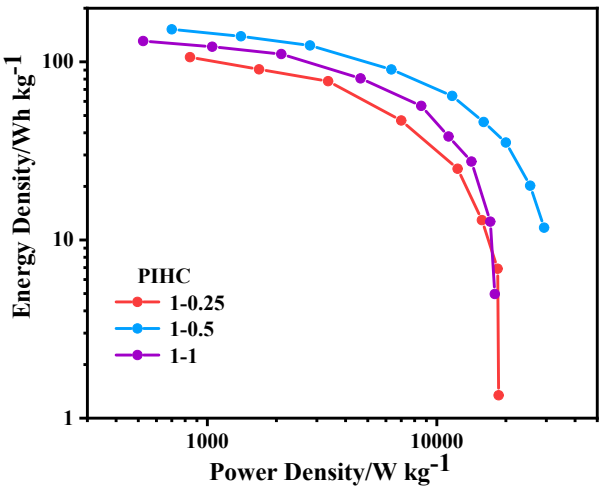


Figure S19 Ragone plots of the HCB-700//AC PIHC with different anode /cathode mass ratio.

Table S1 Comparisons of the cycling performance of HCB-700 electrode with other carbonbased anode materials in PIBs reported in open literature.

| Sample | Cycling performance | Ref |
|---|---|---|
| HCB-700 | 250 mAh $g^{-1}$ (1000 cycles, 2A $g^{-1}$) | This work |
| N/O co-doped carbon | 131 mAh $g^{-1}$ (360 cycles, 0.5A $g^{-1}$) | Ref. [34] of the txt |
| P/N cofunctionalized carbon | 218 mAh $g^{-1}$ (3000 cycles, 1A $g^{-1}$) | Ref. [35] of the txt |
| Short-Range Order carbon | 146.5 mAh $g^{-1}$ (1000 cycles, 1A $g^{-1}$) | Ref. [36] of the txt |
| N doped carbon nanosheets | 151 mAh $g^{-1}$ (1000 cycles, 1A $g^{-1}$) | Ref. [37] of the txt |
| SiC-carbide-derived carbon | 192 mAh $g^{-1}$ (1000 cycles, 1A $g^{-1}$) | Ref. [38] of the txt |
| Bacterial-Derived carbon | 158 mAh $g^{-1}$ (1000 cycles, 1A $g^{-1}$)<br>141 mAh $g^{-1}$ (1500 cycles, 2A $g^{-1}$) | Ref. [39] of the txt |
| N doped carbon nanofibers | 146 mAh $g^{-1}$ (4000 cycles, 2A $g^{-1}$) | Ref. [40] of the txt |
| $Co_2P$@Nitrogen-rich hollow carbon nanocages | 130 mAh $g^{-1}$ (1000 cycles, 1A $g^{-1}$) | [1] |

| | | |
|---|---|---|
| VO/C | 241 mAh $g^{-1}$ (1000 cycles, 1A $g^{-1}$) | [2] |
| $FeS/MoS_2$@N-Doped carbon Nanocubes | 232 mAh $g^{-1}$ (10000 cycles, 1A $g^{-1}$) | [3] |

**References**


1. D. Das, D. Sarkar, S. Nagarajan and D. Mitlin, *Chem Commun (Camb)*, **2020**, 56, 14889.
2. J. Lu, C. Wang, G. Xia, H. Tong, Y. Yang, D. Zhu and Q. Chen, *J. Mater. Chem. A*, **2020**, 8, 23939.
3. J. Chu, Q. Yu, K. Han, L. Xing, C. Gu, Y. Li, Y. Bao and W. Wang, *J. Mater. Chem. A*, **2020**, 8, 23983.