Supporting Information

Solid Electrolyte Interface Stabilization via Surface Oxygen Species Functionalization in Hard Carbons for Superior Performance Sodium-Ion Batteries

Hanjie Xie, Zhiliang Wu, Zhenyu Wang, Ning Qin, Yingzhi Li, Yulin Cao, * Zhenguang Lu *

Department of Materials Science and Engineering South University of Science and Technology of China Shenzhen, 518055, China.

Physics Laboratory, Industrial Training Center, Shenzhen Polytechnic, Shenzhen, China.

* Corresponding authors, emails: luzg@sustech.edu.cn (Z. Lu), caoyulin@szpt.edu.cn (Y. Cao).
Fig. S1 (a) SEM image of hard carbon (HC) microspheres, (b) is magnified image of (a), inset of (b) is corresponding EDS result. (c) SEM image of hydrophilic hard carbon (HHC) microspheres, (d) is magnified image of (c), inset of (d) is corresponding EDS result.
Fig. S2 XPS survey spectra of (a) HC and (b) HHC microspheres.
Fig. S3 FTIR spectra of HC and HHC microspheres.
Fig. S4 TEM-mapping images of the hydrophilic hard carbon (HHC) microspheres.
Fig. S5 (a) Nitrogen adsorption-desorption isotherms for HC and HHC microspheres, (b) the pore-size distributions of HC and HHC microspheres.
Fig. S6 Galvanostatic charge and discharge profiles of HC (a) and HHC (b) at different cycles at 100 mA\text{g}$^{-1}$; Galvanostatic charge and discharge profiles of HC (c) and HHC (d) at different current densities.
Fig. S7 Kinetics analysis of the electrochemical behavior towards Na$^+$ for the HC electrode. (a) CV curves from 1st to 5th cycles at a scan rate of 0.1 mV s$^{-1}$ in SIB. (b) CV curves of various scan rates from 0.1 to 5 mV s$^{-1}$ in SIB. (c) Determination of the b-value using the relationship between peak current and scan rate in SIB. Kinetics analysis of the electrochemical behavior towards Na$^+$ for the HHC electrode. (d) CV curves from 1st to 5th cycles at a scan rate of 0.1 mV s$^{-1}$ in SIB. (e) CV curves of various scan rates from 0.1 to 5 mV s$^{-1}$ in SIB. (f) Determination of the b-value using the relationship between peak current and scan rate in SIB.
Fig. S8 (a) GITT profiles of HC/Na and HHC/Na cells; (b) Current step diagram at 0.73 V vs. Na$^+$ /Na of second sodiation process of the HC electrode for NIBs; Diffusion coefficients calculated from the GITT potential profiles for HC/Na and HHC/Na cells as a function of state of charge during the second cycle (c) insertion and (d) extraction.
Fig. S9 EIS curves of HC and HHC samples for the initial cycle (a), tenth cycle (c,d), long cycle (e,f), (b) is the relationship between Zre and $\omega^{-1/2}$ at low frequency for the HC and HHC electrode.
Fig. S10 Contact angle of electrolyte on HC (a) and HHC (b) electrode.
Fig. S11 XRD pattern of original electrode of HHC and HC.
Fig. S12 (a-c) TEM, HRTEM and TEM-mapping images of HHC microspheres after being charged at 1V.
Fig. S13 (a) Raman spectrum of HC at different state, (b) Raman spectrum of HC at different state, the figures represent $I_G/I_D$. 