

## Supplementary information

The layer stacking distance ( $L_c$ ) and the longitudinal size of structural elements ( $L_a$ ) were calculated according to the formula (Scherrer equation):

$$L_c = \frac{K\lambda}{\beta \cos \theta} \quad (1)$$

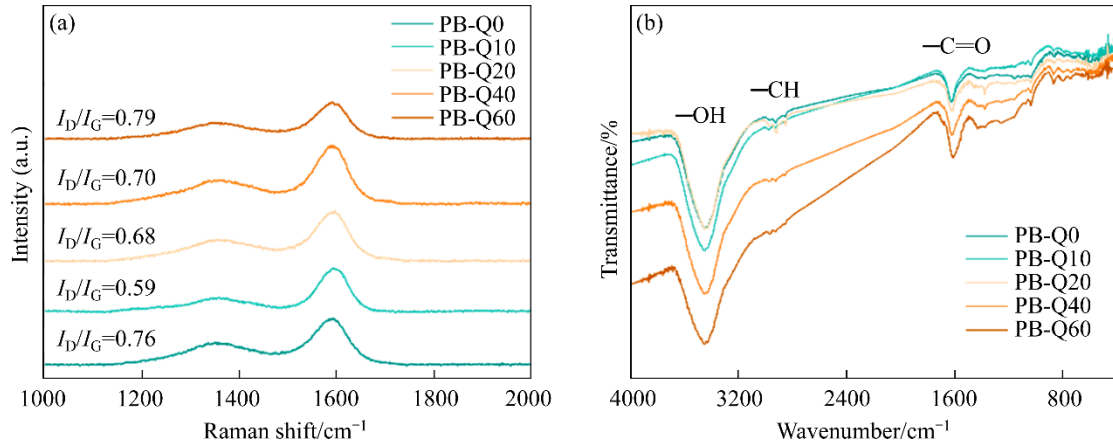
where  $K=0.89$ ;  $\lambda$  is the X-ray wavelength ( $\lambda_{Cu}=0.154056$  nm);  $\beta$  is the half-height width of diffraction peak;  $\theta$  is the diffraction angle.

$$L_a = \frac{2.4 \times 10^{-10} \times \lambda^4}{I_D/I_G} \quad (2)$$

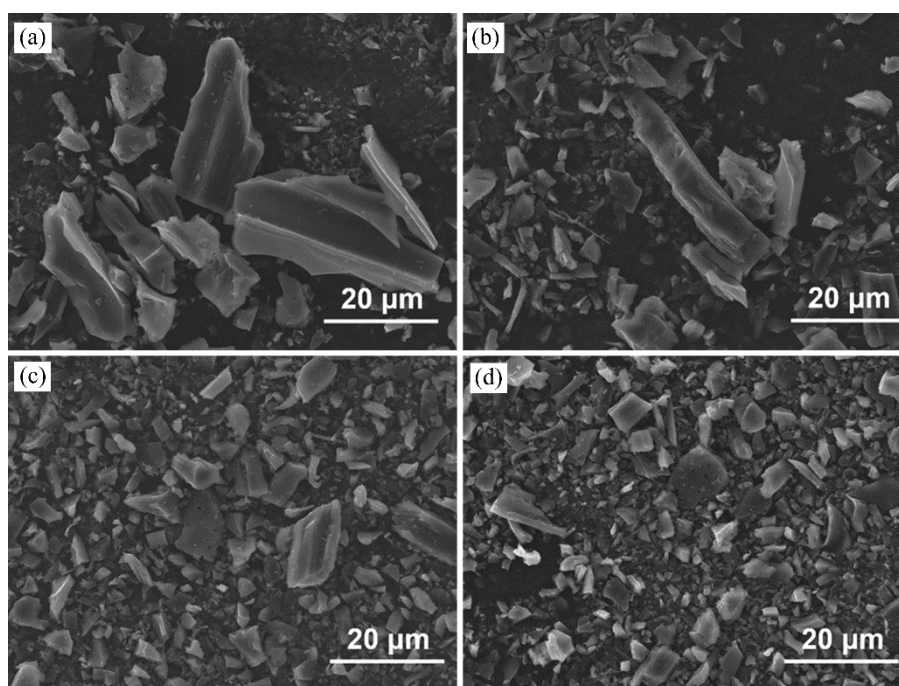
Based on Fick's second law, the  $Na^+$  diffusion coefficient can be calculated by the following general equation:

$$D_{Na^+} = \frac{4}{\pi\tau} \left( \frac{m_B V_M}{M_b S} \right)^2 \left( \frac{\Delta E_S}{\Delta E_\tau} \right)^2 \quad (3)$$

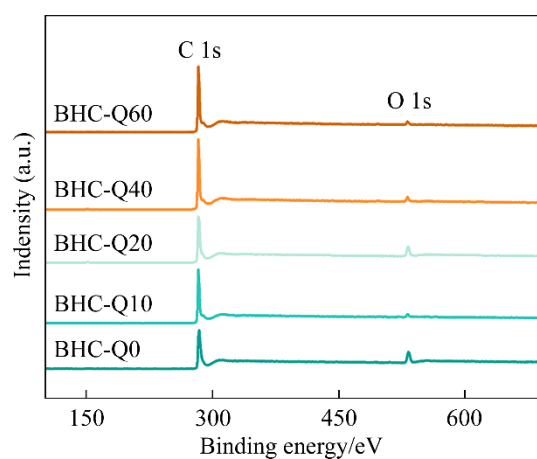
where  $\tau$  is the current pulse time (s);  $M_b$ ,  $V_M$  and  $m_R$  are the molecular weights (g/mol), molar volume ( $cm^3/mol$ ), and mass of the active material (g), respectively;  $S$  is the explored area ( $cm^2$ ); and  $\Delta E_S$  and  $\Delta E_\tau$  are the change in steady-state voltage and cell voltage caused by the current pulse, respectively.



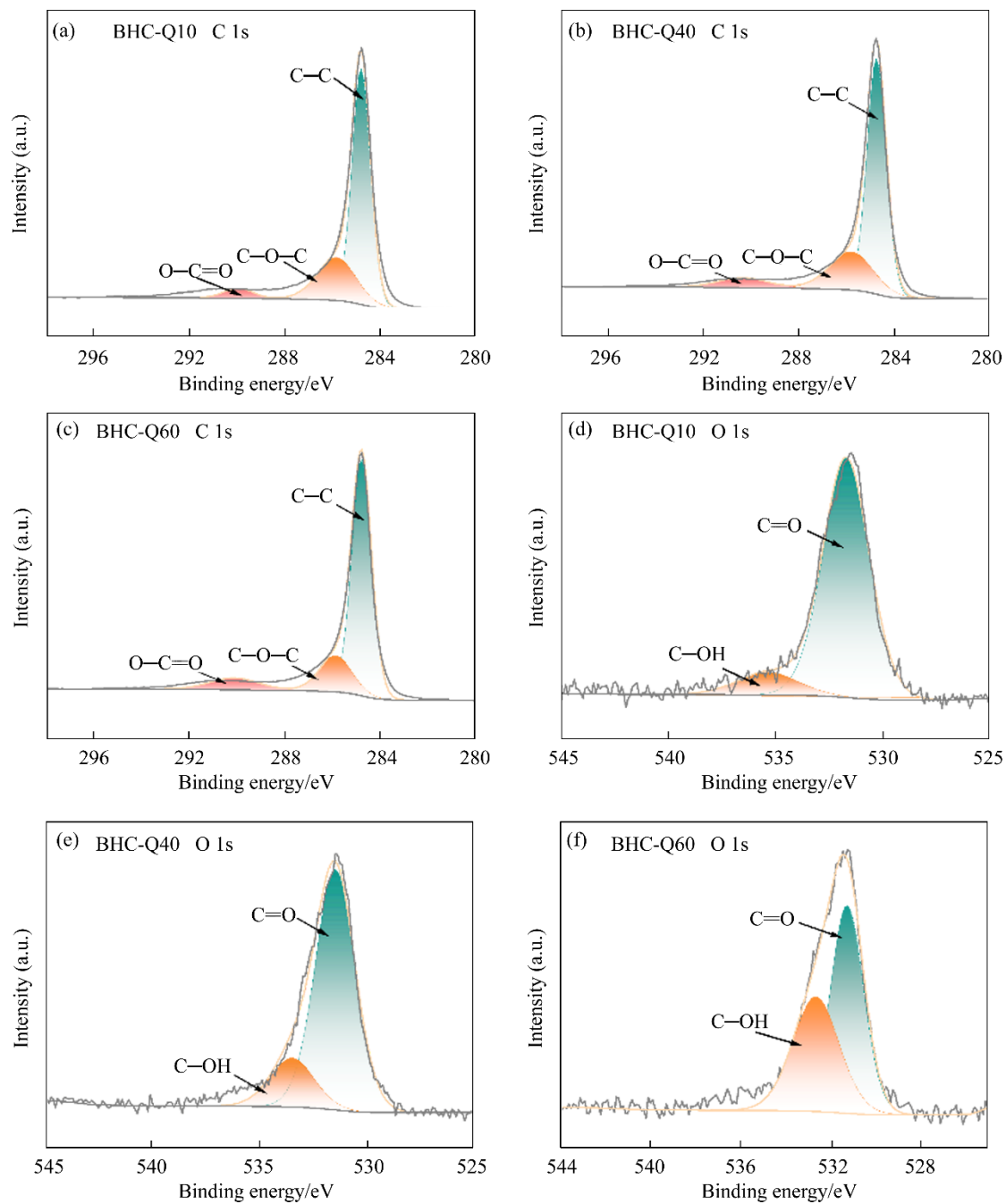
**Figure S1** (a) Raman spectra of mid-product after ball-milling; (b) FT-IR of mid-product after ball-milling



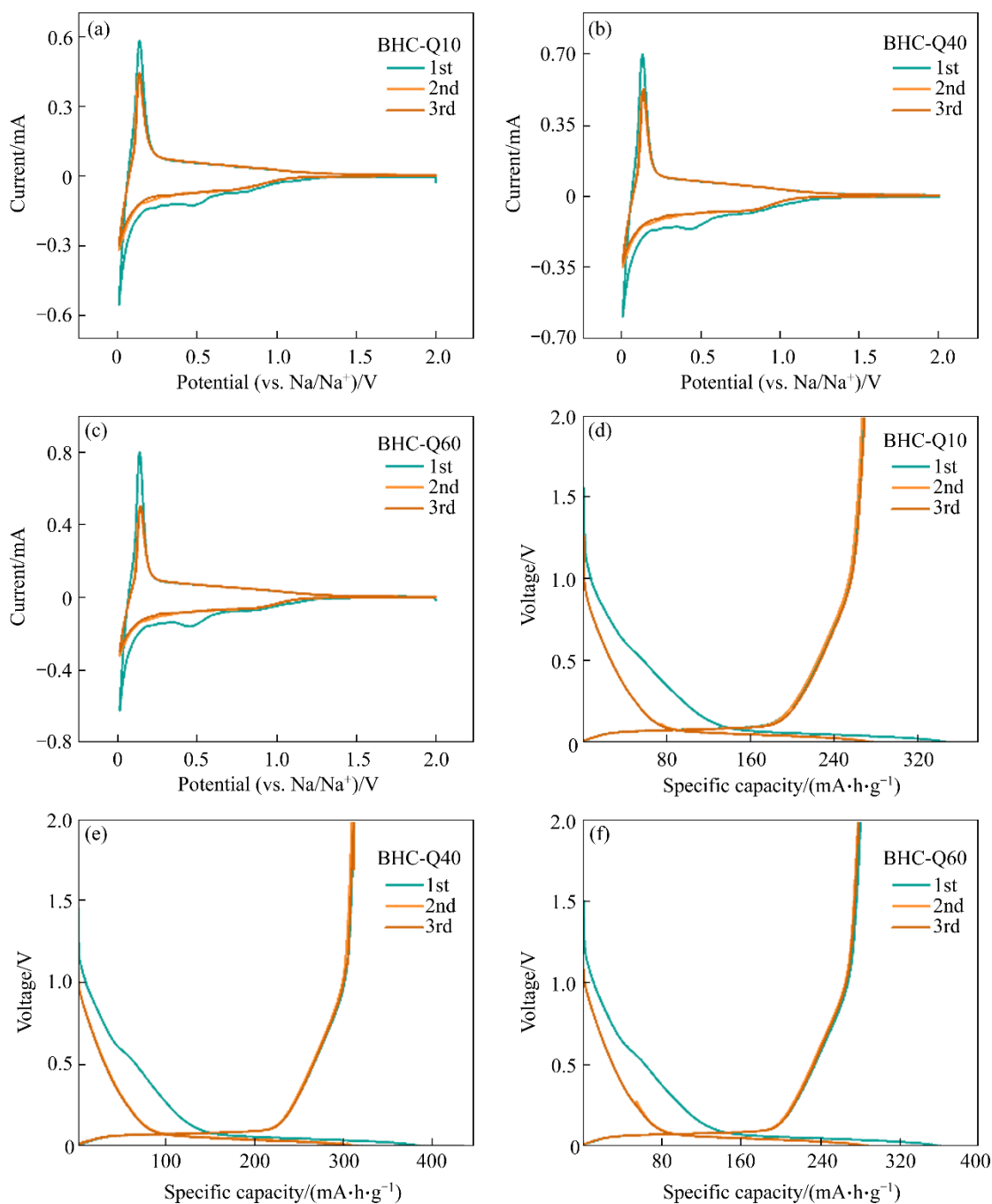
**Figure S2** SEM images of different bamboo-derived hard carbon samples: (a) BHC-Q10; (b) BHC-Q20; (c) BHC-Q40; (d) BHC-Q60



**Figure S3** XPS spectra hard carbon samples derived from bamboo



**Figure S4** (a–c) C 1s and (d–f) O 1s high-resolution spectra of hard carbon samples derived from bamboo: (a, d) BHC-Q10; (b, e) BHC-Q40; (c, f) BHC-Q60



**Figure S5** Cyclic voltammograms recorded at a scan rate of 0.1 mV/s for (a) BHC-Q10, (b) BHC-Q40, and (c) BHC-Q60; Galvanostatic charge/discharge profiles at a current rate of 0.05C for (d) BHC-Q10, (e) BHC-Q40 and (f) BHC-Q60

**Table S1**  $S_{\text{BET}}$  of mid-product after ball-milling

| Mid-product                                     | PB-Q0  | PB-Q10 | PB-Q20 | PB-Q40 | PB-Q60 |
|-------------------------------------------------|--------|--------|--------|--------|--------|
| $S_{\text{BET}}/(\text{m}^2\cdot\text{g}^{-1})$ | 255.76 | 395.87 | 277.87 | 444.49 | 352.73 |

**Table S2** Proportion of carbon and oxygen elements and functional groups in bamboo-derived hard carbon

| Sample  | Carbon content | %     |       |       |                |       |       |
|---------|----------------|-------|-------|-------|----------------|-------|-------|
|         |                | C—C   | C—O—C | O—C=O | Oxygen content | C=O   | C—OH  |
| BHC-Q0  | 89.01          | 22.45 | 68.15 | 9.40  | 10.99          | 52.41 | 47.59 |
| BHC-Q10 | 96.83          | 51.54 | 39.82 | 8.65  | 3.17           | 88.81 | 11.18 |
| BHC-Q20 | 94.36          | 50.78 | 40.64 | 8.59  | 5.64           | 77.69 | 22.31 |
| BHC-Q40 | 95.91          | 57.07 | 33.44 | 9.49  | 4.09           | 81.61 | 18.39 |
| BHC-Q60 | 96.81          | 51.12 | 40.11 | 8.78  | 3.19           | 56.34 | 43.63 |