

Rational synthesis of macroporous nanocarbon with phosphorus-doping from pitch  
for high-rate sodium ion batteries

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## Theoretical calculations

To avoid the effect of SEI film formation on diffusion during the first charge-discharge cycle, all samples were subjected to one cycle at a current density of 20 mA g<sup>-1</sup> followed by an intermittent titration at a current density of 20 mA g<sup>-1</sup> for 30 min of pulsed charge-discharge with an intermediate rest period of 2 h. The sodium ion diffusion coefficient D was calculated as follows:

$$D = \frac{4}{\pi\tau} \left( \frac{m_g V_m}{M_B S} \right)^2 \left( \frac{\Delta E_s}{\Delta E_\tau} \right)^2$$

where  $\tau$  represents the pulse time interval;  $m_g$  represents the mass of active substance;

$M_B$  represents the molar mass;  $V_m$  represents the molar volume;  $S$  represents the contact area between electrode and electrolyte;  $L$  represents the thickness of electrode material;  $\Delta E_s$  represents the potential change during the time of applying constant current, and  $\Delta E_\tau$  is the change of steady-state potential.

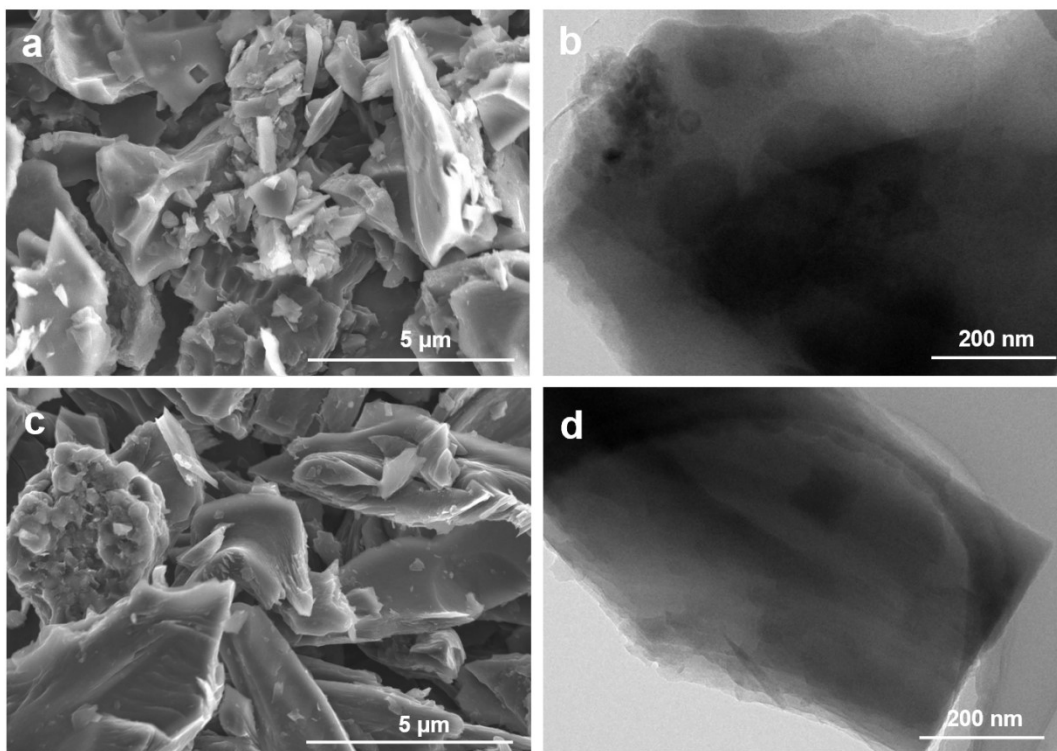


Fig. S1 SEM images of (a) C-3, (c) C-4 and TEM images of (b) C-3, (d) C-4

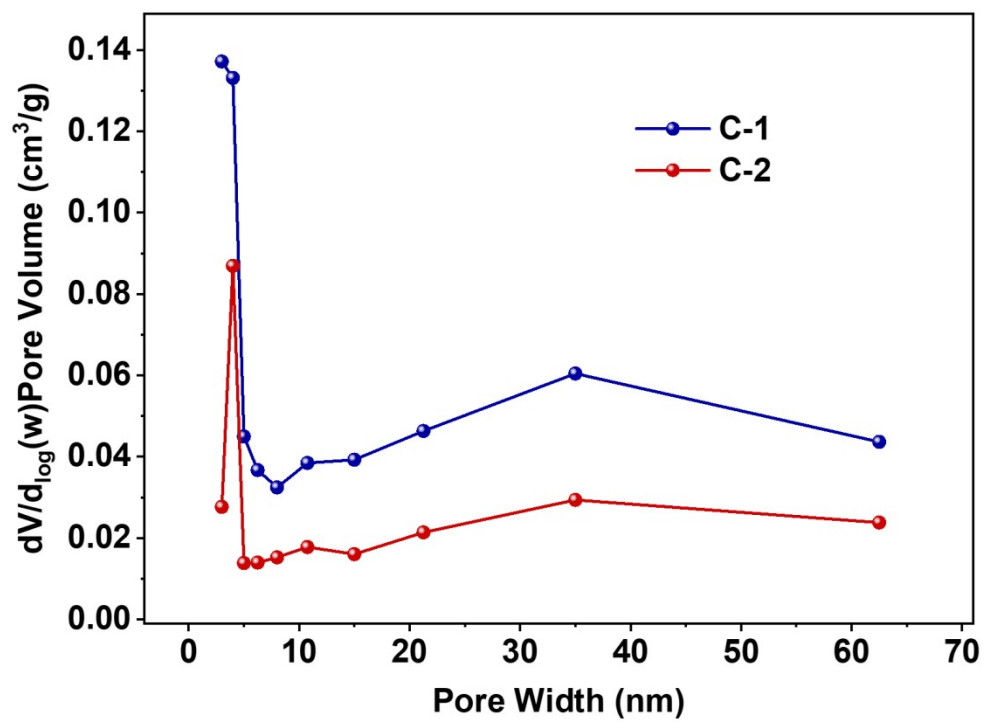


Fig. S2 BJH pore size distribution of C-1 and C-2

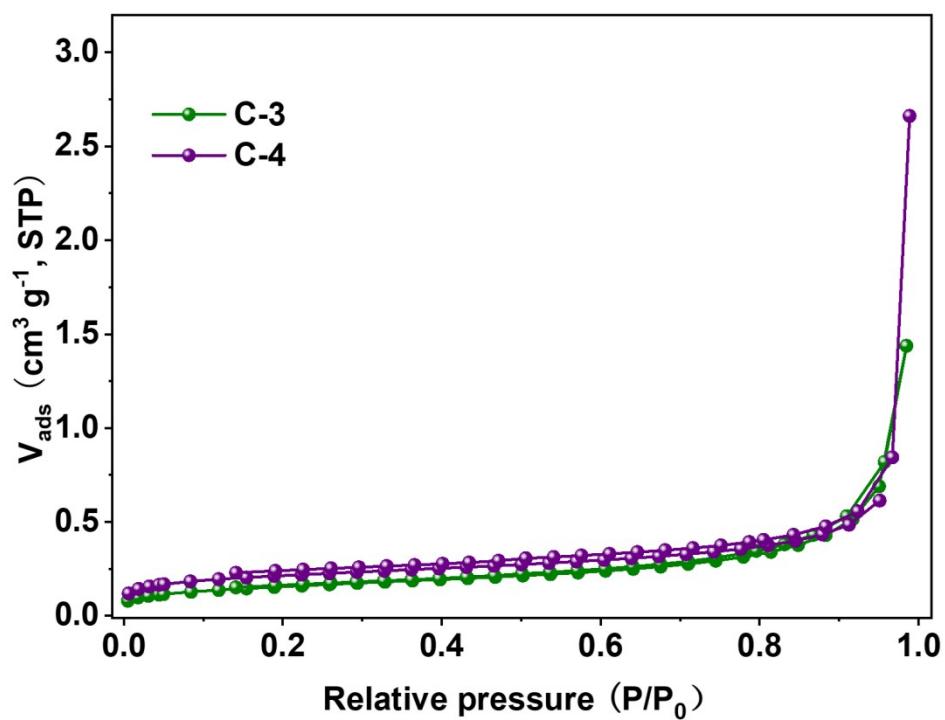


Fig.S3  $\text{N}_2$  adsorption-desorption isotherms of C-3 and C-4

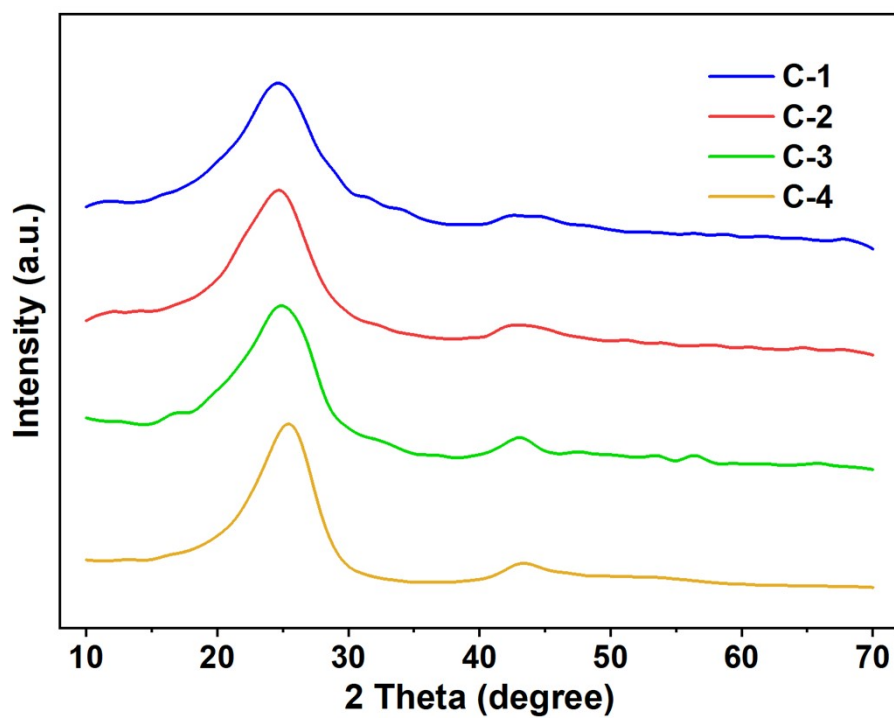


Fig.S4 XRD diffraction patterns of C-1, C-2, C-3 and C-4

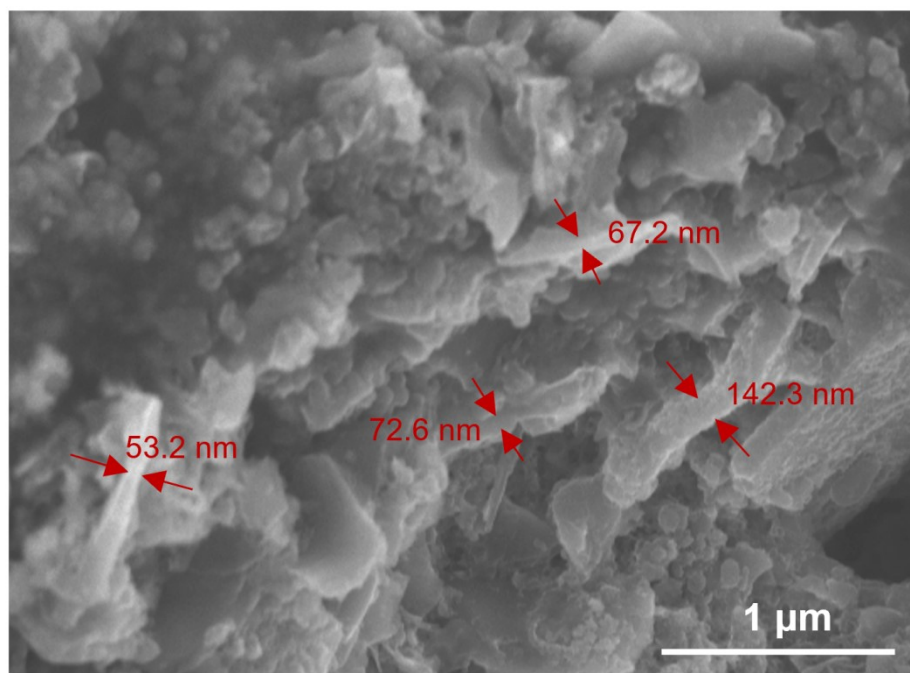


Fig. S5 SEM image of C-1 after cycles

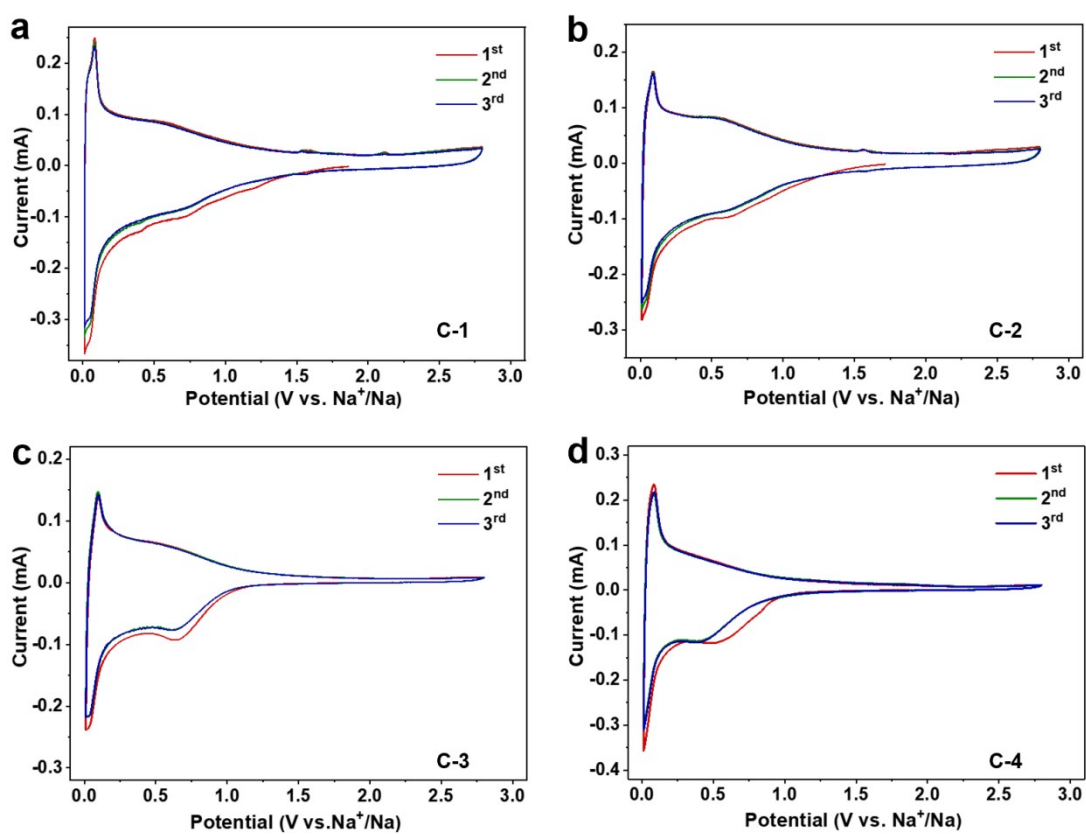


Fig. S6 CV curves of (a) C-1, (b) C-2, (c) C-3, (d) C-4 at 0.2 mV s<sup>-1</sup> scanning rate