

## Electronic Supplementary Material

### **Fe<sub>3</sub>O<sub>4</sub> nanoparticles encapsulated in graphitized and in-plane porous carbon nanocages derived from emulsified asphalt for a high-performance lithium-ion battery anode**

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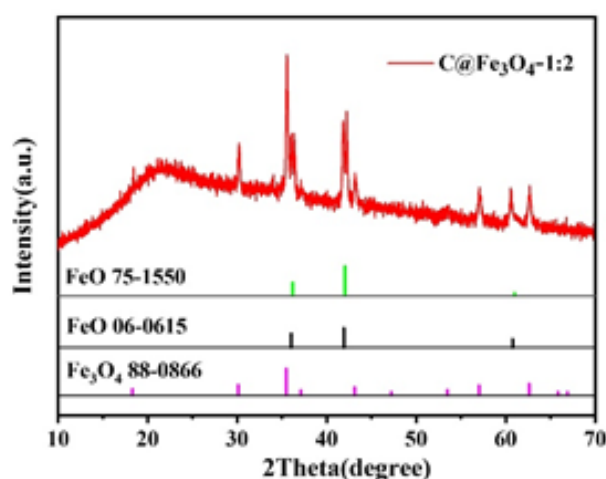


Fig. S1 XRD pattern of the C@Fe<sub>3</sub>O<sub>4</sub>-1:2 composite.

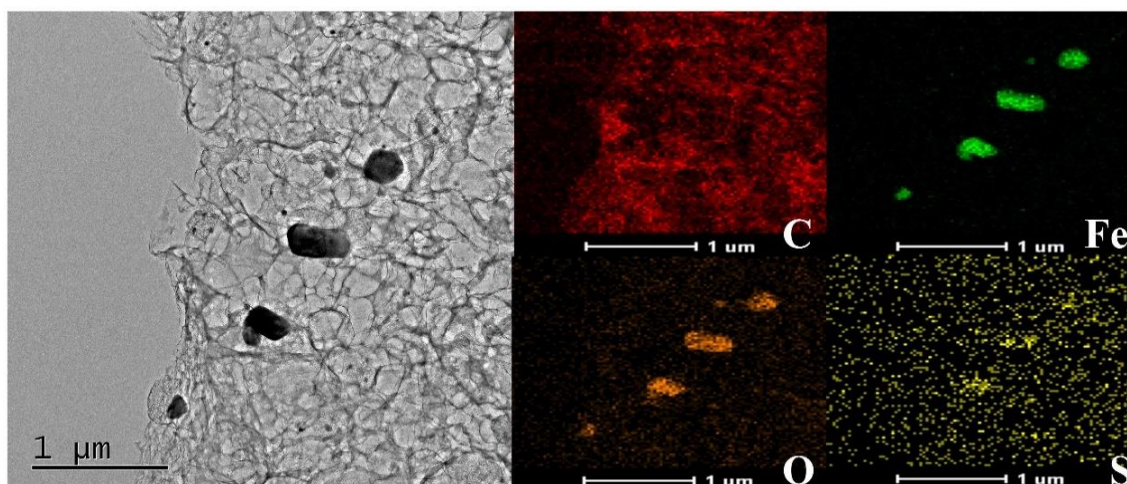


Fig. S2 Elemental mapping images of C@Fe<sub>3</sub>O<sub>4</sub>-1:2.

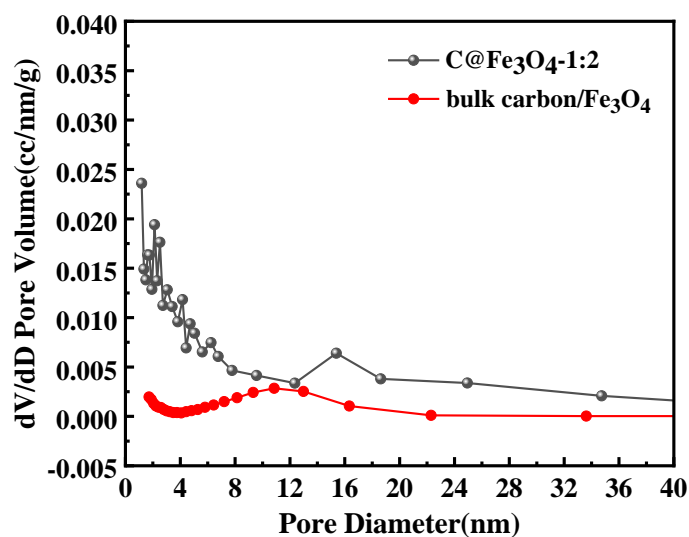


Fig. S3 Pore size distributions of C@Fe<sub>3</sub>O<sub>4</sub>-1:2 and bulk carbon/Fe<sub>3</sub>O<sub>4</sub>.

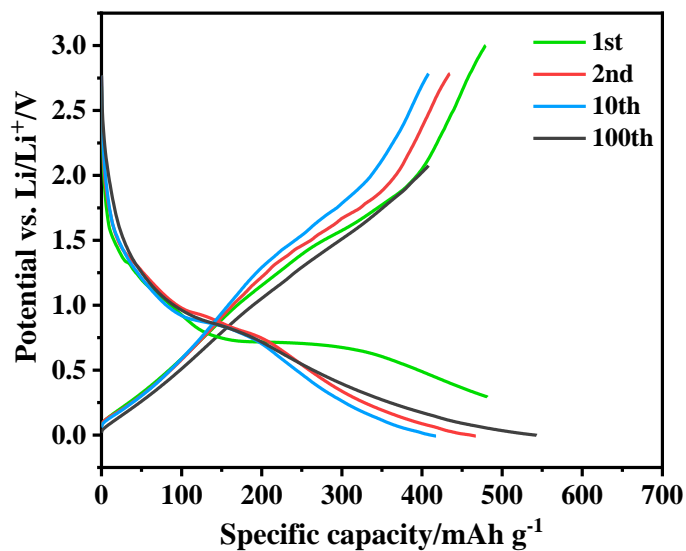


Fig. S4 GCD profiles of the C@Fe<sub>3</sub>O<sub>4</sub>-1:0.5 electrode.

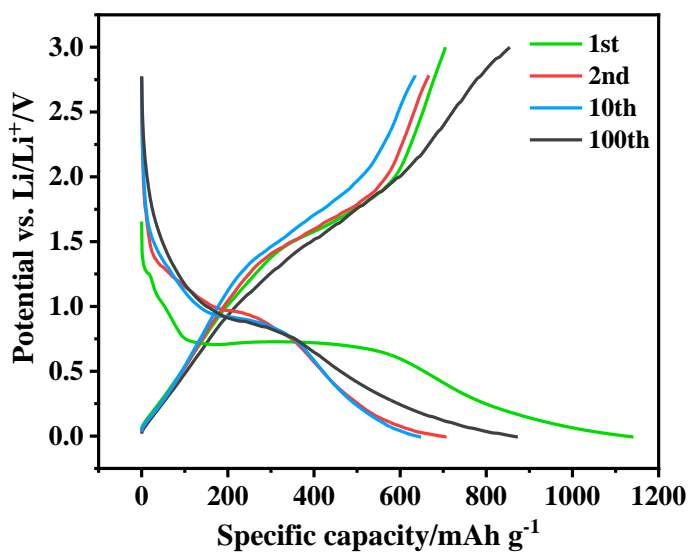


Fig. S5 GCD profiles of the C@Fe<sub>3</sub>O<sub>4</sub>-1:1.5 electrode.

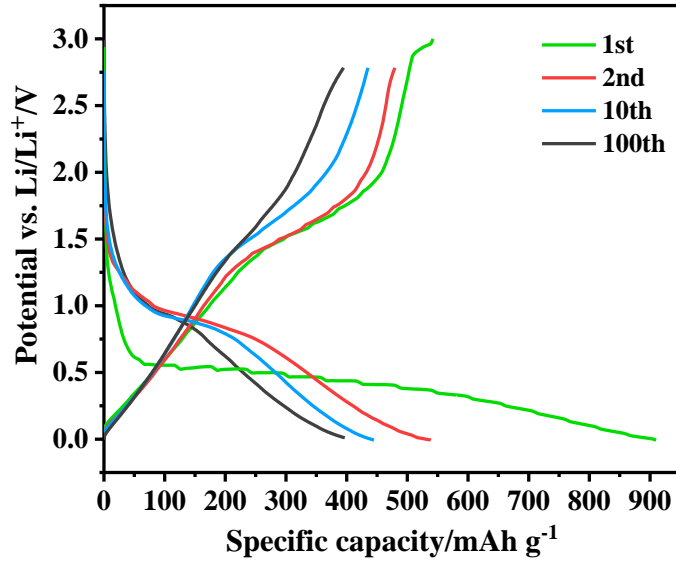


Fig. S6 GCD profiles of the bulk carbon/Fe<sub>3</sub>O<sub>4</sub> electrode.

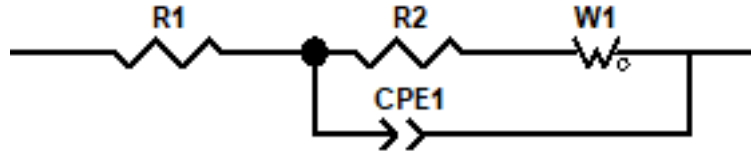


Fig. S7 Equivalent circuit diagram of C@Fe<sub>3</sub>O<sub>4</sub>-1:0.5, C@Fe<sub>3</sub>O<sub>4</sub>-1:1.5, C@Fe<sub>3</sub>O<sub>4</sub>-1:2, and bulk carbon/Fe<sub>3</sub>O<sub>4</sub> electrodes.

The Li<sup>+</sup> diffusion coefficient ( $D(\text{Li}^+)$ ) is calculated according to the following simplified equation:

$$D(\text{Li}^+) = \frac{4}{\pi t} \cdot \left( \frac{m_B V_M}{M_B A} \right)^2 \left( \frac{\Delta E_s}{\Delta E_t} \right)^2 \quad (\text{S1})$$

where,  $t$  is the current pulse duration ( $t = 1800$  s);  $m_B$ ,  $M_B$ , and  $V_M$  are the mass, molar mass, and molar volume of the active material, respectively;  $A$  is the interfacial area of electrode–electrolyte;  $\Delta E_s$  is the difference in open circuit voltage measured at the end of two sequential open-circuit relaxation steps; and  $\Delta E_t$  is the cell voltage at the time of current of flux during charging (discharging).