**Supporting Information**

**Polypyrrole-coated triple-layer yolk-shell Fe2O3 anode materials with their enhanced cycling stability and capacity in lithium-ion batteries**

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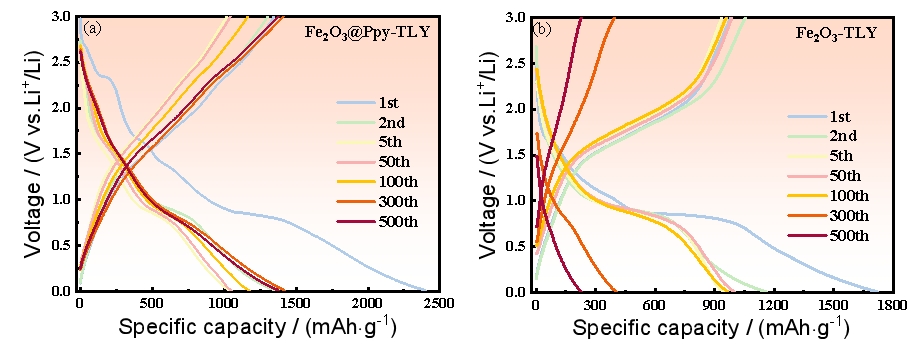


**Fig. S1.** Scanning electron microscopy (SEM) image of carbon sphere acted as a template, *d*: diameter.

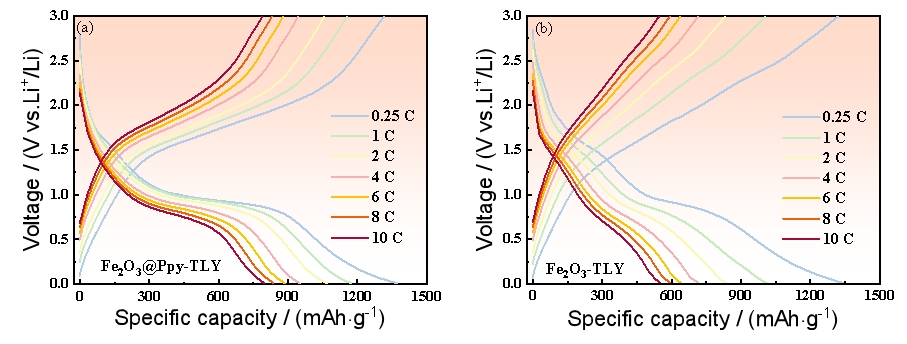
The cyclic voltammetry (CV) curve of the Fe2O3-TLY in Fig. S2 demonstrates a pronounced reduction peak at 0.75 V during the initial cathodic scan. This substantial reduction peak is attributed to the embedding of Li+ ions, forming Li*x*Fe2O3, followed by a conversion reaction where Fe3+/Fe2+ is reduced to Fe [1]. Subsequent irreversible reduction peaks at 1.03 V and 1.63 V are owing to the formation of the solid electrolyte interface (SEI) layer [2] and Li+ insertion into the Fe2O3 lattices [3]. In the anodic scan, reversible oxidation peaks at 1.68 V and 1.86 V correspond to the delithiation process where Fe is oxidized to Fe3+[4]. In subsequent cycles, the reduction and oxidation peaks stabilize around 0.80 V and 1.56 V, indicating good redox reversibility [5]. The prominent reduction peak shifts from 0.75 V to 0.80 V, and the peak height decreases due to irreversible structural rearrangement and electrolyte loss during the formation of the SEI layer in the first cycle.



**Fig. S2.**  CV curve of the Fe2O3-TLY electrode at a scan rate of 0.1 mV·s−1.



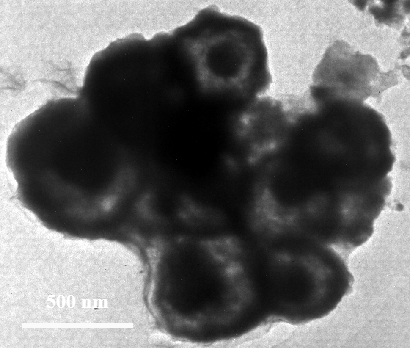
**Fig. S3.** Charge–discharge curves of the (a) Fe2O3@Ppy-TLY and (b) Fe2O3-TLY electrodes at 1 C running after different cycles.



**Fig. S4.** Charge–discharge curves of the (a) Fe2O3@Ppy-TLY and (b) Fe2O3-TLY electrodes at different current densities.



**Fig. S5.** Long cycling performance of Fe2O3@Ppy-TLY electrode at 6 C, after rate performance test.



**Fig. S6.** Transmission electron microscopy (TEM) image of Fe2O3@Ppy-TLY electrode after 50 cycles at 0.2 C.

Table S1. Impedance parameters recorded on Fe2O3@Ppy-TLY and Fe2O3-TLY electrodes before and after 250 cycles

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Situation | Sample | *R*ct / Ω | CPE1 / F | CPE1 / F |
| After cycling | Fe2O3@Ppy-TLY | 22.01 | 3.05×10−5 | 0.82 |
| Fe2O3-TLY | 193.7 | 5.15×10−5 | 0.70 |
| Before cycling | Fe2O3@Ppy-TLY | 51.35 | 4.89×10−5 | 0.75 |
| Fe2O3-TLY | 74.74 | 5.16×10−5 | 0.71 |

CPE1 represents capacitance, and CPE2 is the degree of similarity to a pure capacitor; *R*ct is the charge transfer impedance.

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