Electronic Supplementary Information

Facile Fabrication of Chinese Lantern-like MnO@N-C: A High-Performance Anode Material for Lithium-Ion Batteries

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1. **Synthesis and the formation mechanism of Chinese lantern-like $MnCO_3$**

$MnCO_3$ precursor was synthesized as follows. Li_2CO_3 (0.2 mole) was added into the deionized water (100 mL) under stirring for 30 min to form Li_2CO_3 suspension (the solubility of Li_2CO_3 is ~1.3 g at room temperature). Then, 100 mL $MnSO_4 \cdot H_2O$ (0.2 mole) was added to the suspension using a peristaltic pump at a flow rate of 1.5 $mL \cdot min^{-1}$. In the process of adding the $MnSO_4$ aqueous solution to the Li_2CO_3 suspension, the intermediate products were obtained at 1, 5, 10, 20, 40 and 60 min, FESEM images of which are shown in Fig. S1 in the SI. The surface of Li_2CO_3 was smooth (Fig. S1a). In the Li_2CO_3 suspension, a part of Li_2CO_3 was dissolved into the water to provide CO_3^{2-} and the remaining Li_2CO_3 was used as hard template. When Mn^{2+} was added to the suspension, $MnCO_3$ nanoplates were formed on the surface of the template (Li_2CO_3). With increasing the amount of Mn^{2+}, more and more $MnCO_3$ nanoplates were interconnected to each other to form a self-supported three dimensional structure and Li_2CO_3 was gradually dissolved at the same time. At last, a Chinese lantern-like $MnCO_3$ with a hollow was formed. The schematic illustration of the formation mechanism of the Chinese lantern-like $MnCO_3$ was estimated in Scheme S1.

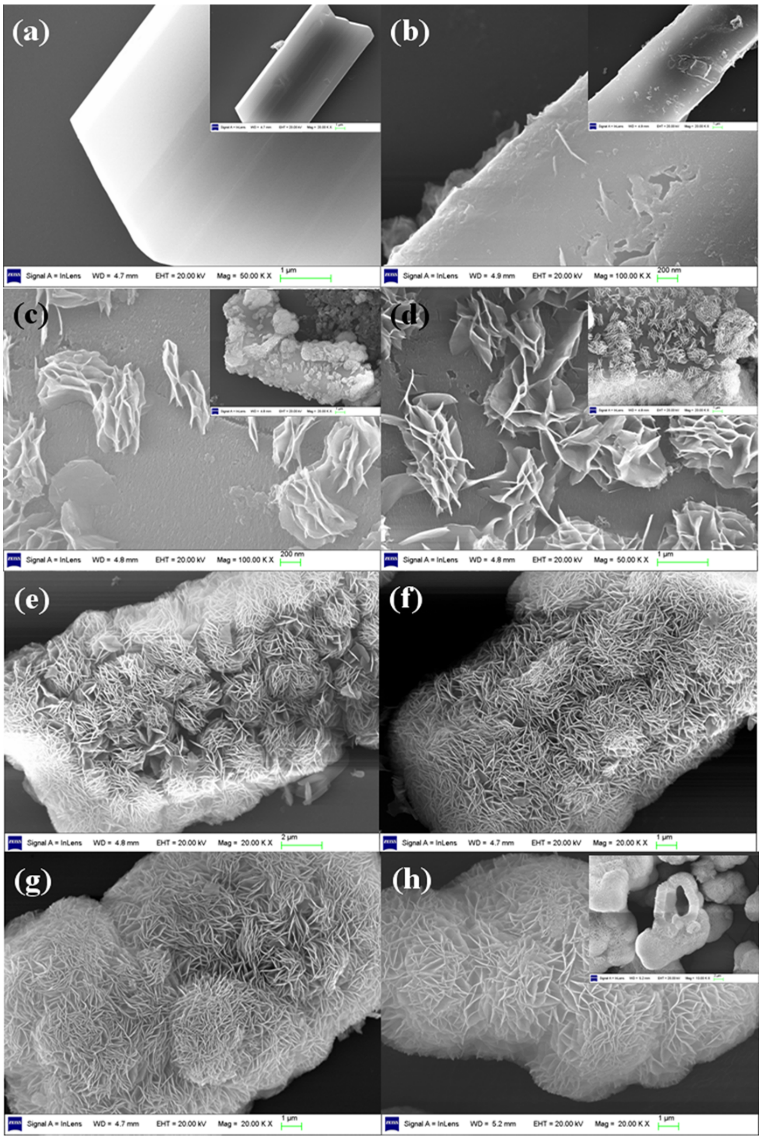
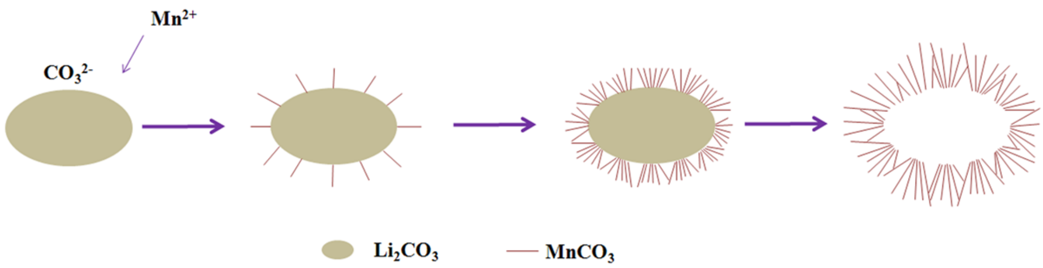


Figure S1. FESEM images of (a) Li_2CO_3 and intermediate products obtained at (b) 1, (c) 5, (d) 10, (e) 20, (f) 40, (g) 60 min and (h) final $MnCO_3$ precursor. The insets in (a-d) are the corresponding FESEM images at low magnification. The inset in (h) is a cross section from a broken particle.



Scheme S1. Schematic illustration of the formation mechanism of the Chinese lantern-like $MnCO_3$.

2. BET analysis of MnO@N-C and MnO

N_2 adsorption–desorption isotherms of MnO@N-C and MnO are shown in Fig. S2. Specific surface area (Brunauer–Emmett–Teller, BET) of MnO@N-C and MnO are 179.05 $m^2 \cdot g^{-1}$ and 2.38 $m^2 \cdot g^{-1}$, respectively.

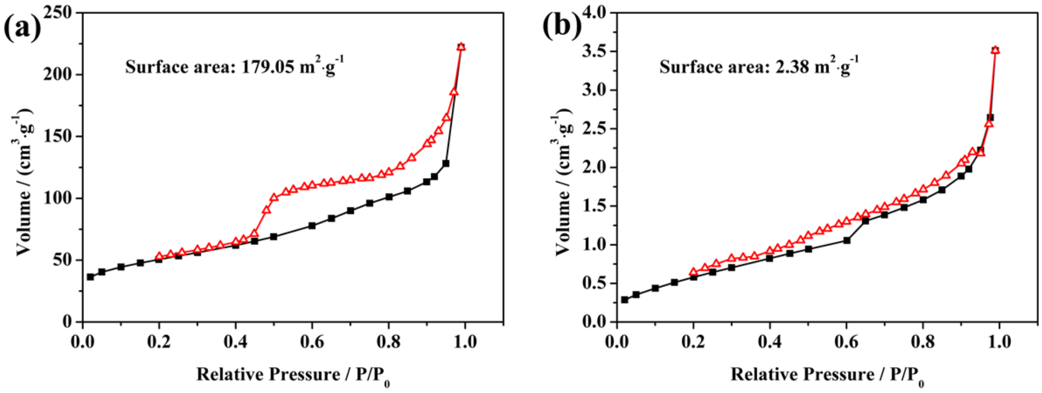


Figure S2. N_2 adsorption–desorption isotherms of (a) MnO@N-C and (b) MnO, measured at 77 K.

3. The morphology of MnO during cycling

The structural morphologies of MnO following 0, 3, and 250 cycles are shown in Fig. S3. The surface of MnO became more and more rough with the increase of cyclic numbers, which indicated that the structure of MnO was damaged during the repeated conversion reaction. The damaged structure of MnO led to the decreased reversible capacity.

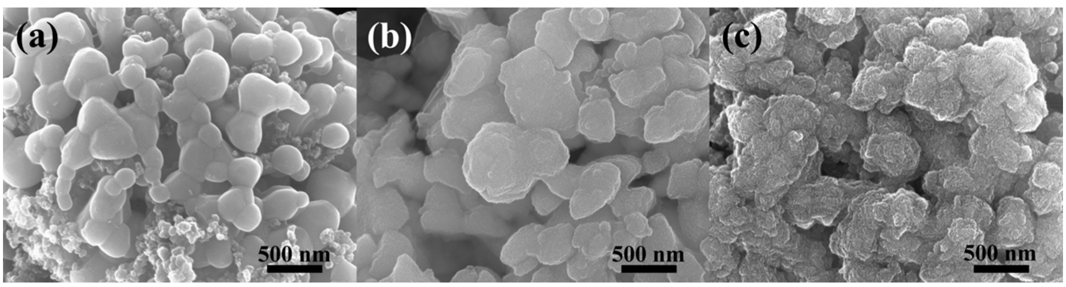


Figure S3. FESEM images of MnO after (a) 0 cycle, (b) 3 cycles, and (c) 250 cycles.