

Supporting Information

Branched Carbon-Encapsulated MnS Core/Shell Nanochains

Prepared Via Oriented Attachment for Lithium-Ion Storage

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Supporting Data:

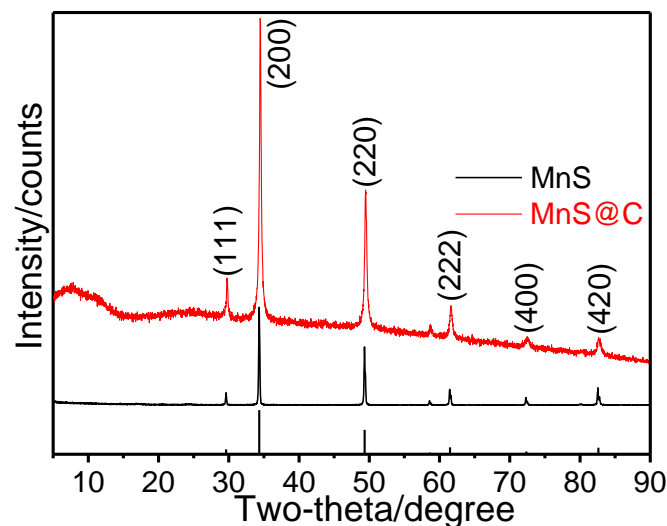


Fig. S1: XRD patterns of the pure MnS obtained from Mn_2O_3 and MnS@C nanochains prepared at 500°C for 3h using in a manganocene/S molar ratios of 1:4.

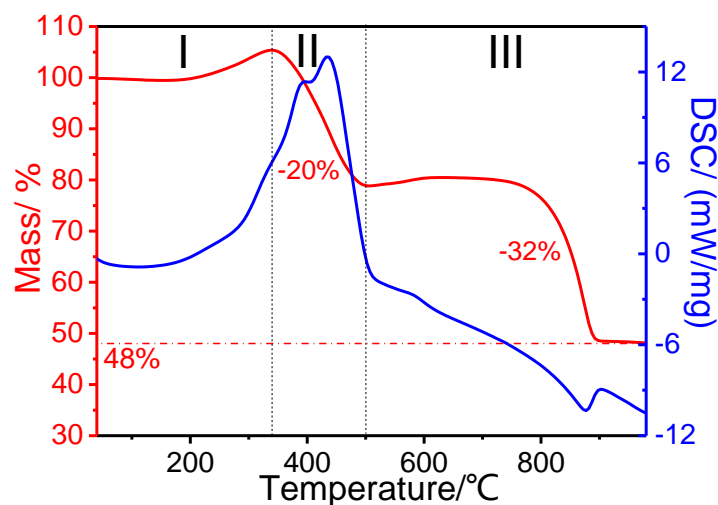


Fig. S2: TG pattern of MnS@C nanochains measured at air atmosphere. (Based on the mass content of residues (MnO), it can be calculated the mass content of MnS is ca. 59%)

The TG pattern can be divided into three stages based on the mass changes. At stage I, mass keeps constant from room temperature to 200 °C. After 200 °C, mass increases gradually, and at ca. 350 °C, increasing of mass can be up to maximum value of ca. 105%. The mass increase at the stage I maybe involve the process of MnS to MnSO₄ according to previous report¹. At stage II from 350 to ca. 500 °C, there is a drastic drop on the TG line, which should be attributed to the oxidation of carbon into CO₂/CO, so there are two obvious exothermal peaks on the corresponding temperature range of DSC line. At the stage III, when temperature is up to ca. 770 °C there is also a drastic drop on the TG line, which should be corresponding to decomposition of MnSO₄ into MnO.

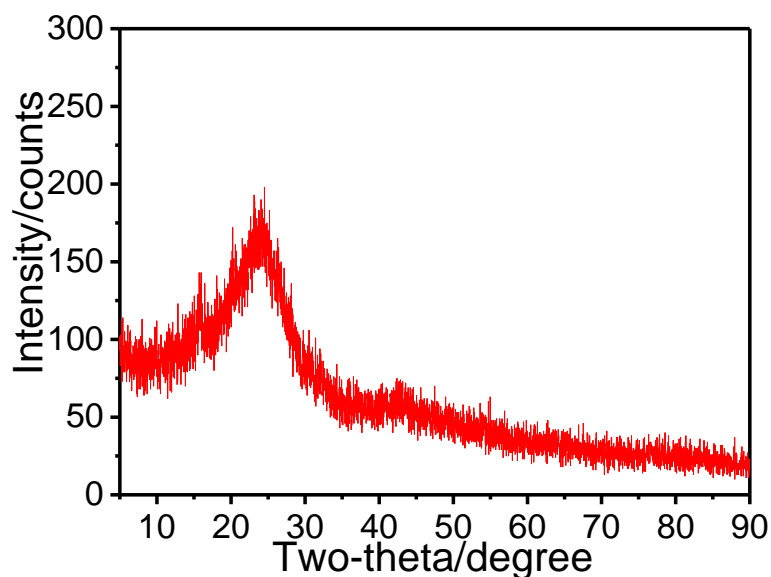


Fig. S3: the XRD pattern of the hollow carbon chains obtained after removing MnS in MnS@C nanochains by HCl.

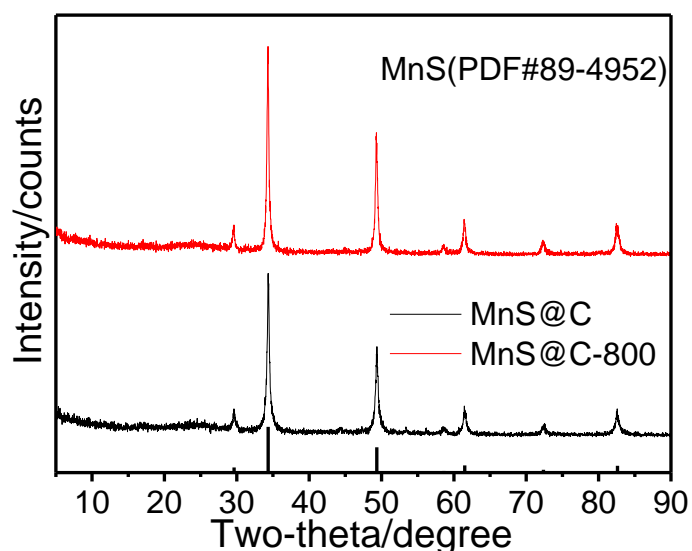


Fig. S4: XRD patterns of the products obtained before and after annealing at 800 °C for 2h.

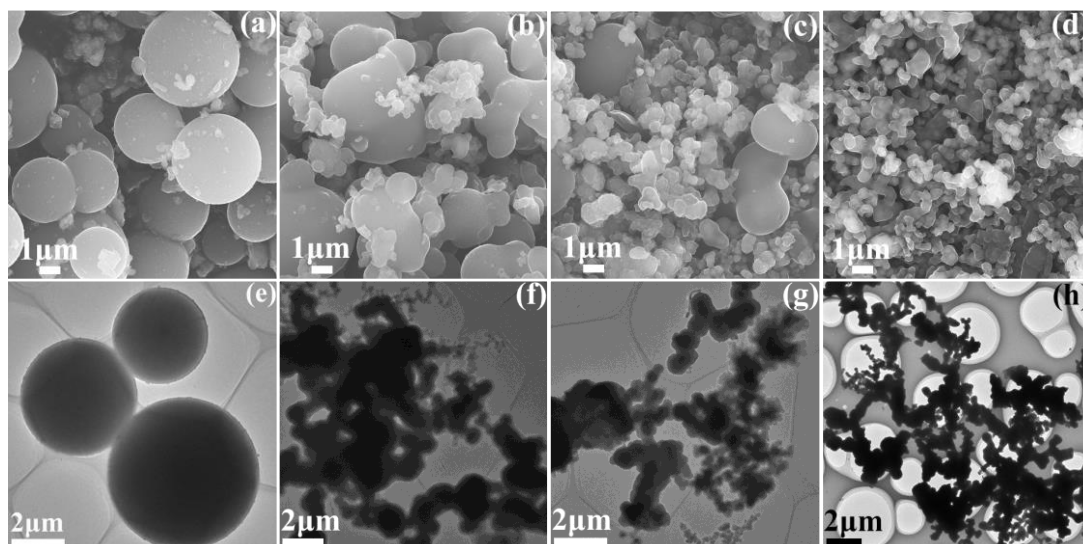


Fig. S5 the SEM images of the products prepared at 500 °C for 2h using (a) pure manganocene without S, and the mixtures of manganocene and S in various molar ratios of manganocene/S at (b)1:1, (c)1:2 and (d)1:4; (e-h) the corresponding TEM images.

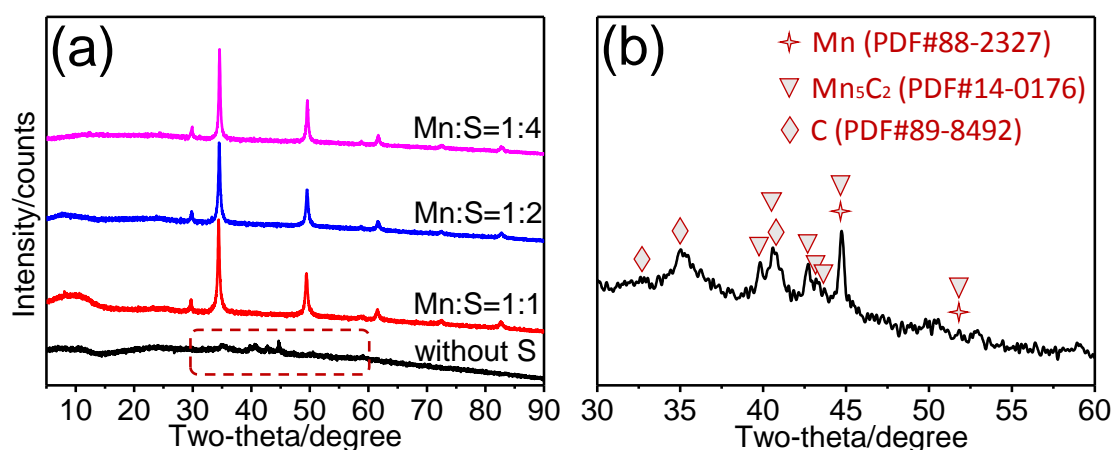


Fig. S6: (a) the XRD patterns of the products prepared at 500 °C for 2h using pure manganocene without S, and the mixtures of manganocene and S in various molar ratios of manganocene/S at 1:1, 1:2 and 1:4; (b) the enlarged XRD patterns of the cycled area in image (a).

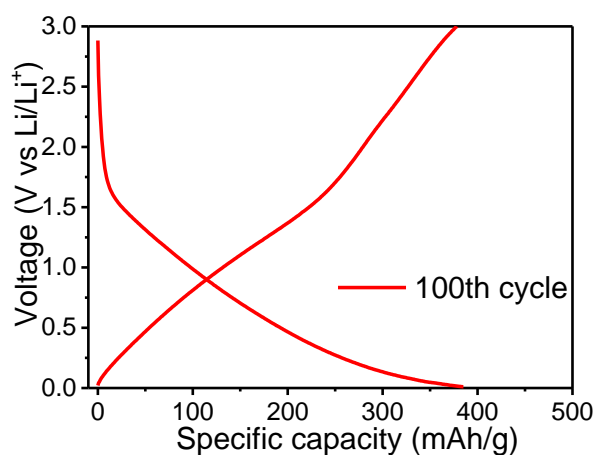


Fig. S7: the 100th charge/discharge curves of MnS@C treated by hydrochloric acid for 4 h at 90 °C at a current density of 50 mA g⁻¹.

The stable capacity of the carbon shell is ca. 380 mA h g⁻¹ after 100 cycles (Fig. S7). So the specific capacity from the carbon shell is ca. 156 mA h g⁻¹ (calculated by 380 x 41 %), while the capacity contribution of MnS in MnS@C-800 is ca. 344 mA h g⁻¹ (calculated by 500 - 156). Thus, the actual specific capacity of MnS in will deliver 583 mA h g⁻¹ (calculated by 344 ÷ 59 %).

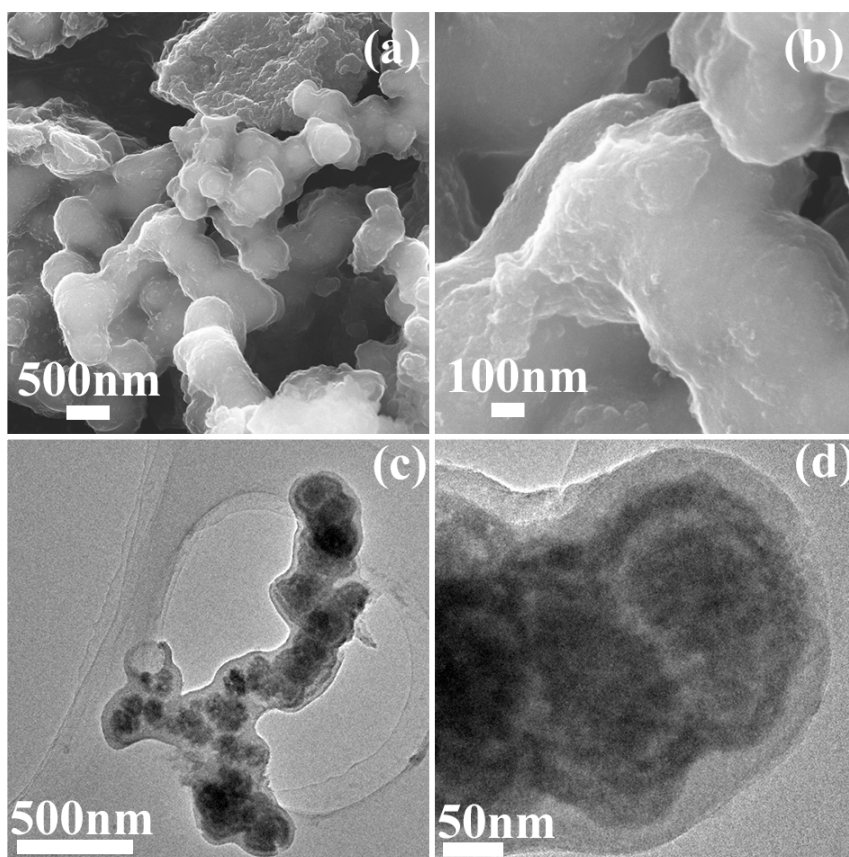


Fig. S8: (a, b) the SEM images and (c, d) TEM images of MnS@C-800 electrode plate after charge/discharge of 50 cycles at the current density of 50 mA/g.

Table 1. Fitting results of the EIS curves in Fig. 7d using the equivalent circuit.

Sample	R _e (Ω)	R _{sf} +R _{ct} (Ω)
MnS	1.02	60.91
MnS@C	0.80	29.45
MnS@C-800	1.37	16.44

Reference

- 1 K. M. Jeon, J. S. Cho and Y. C. Kang, *J. Power Sources* 2015, **295**, 9-15.