Supporting information

Mesoporous carbon matrix confinement synthesis of ultrasmall WO_3 nanocrystals for lithium ion batteries

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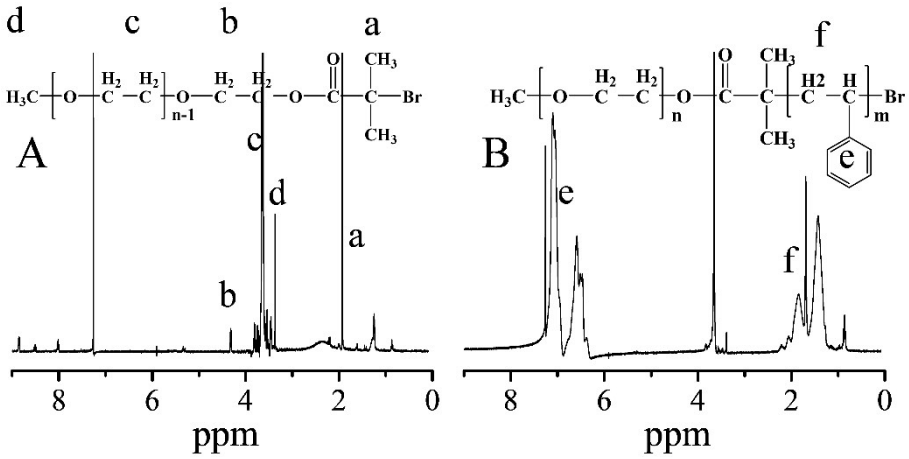

Figure S1. ^{1}H NMR spectra of (A) PEO-Br; (B) the synthesized diblock copolymer poly(ethylene oxide)-*block*-polystyrene (PEO_{117}-*b*-PS_{156}).

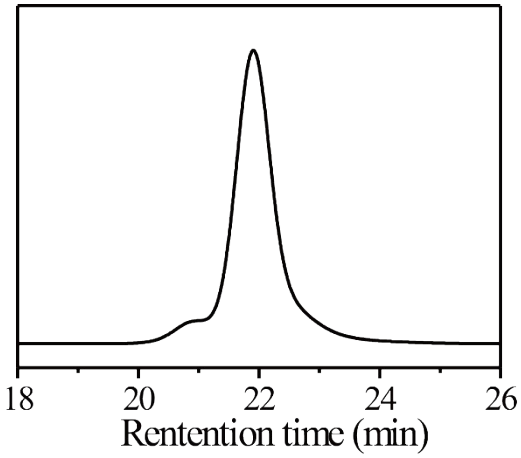

Figure S2. The gel permeation chromatograph (GPC) trace of the synthesized diblock copolymer poly(ethylene oxide)-*block*-polystyrene (PEO_{117}-*b*-PS_{156}).

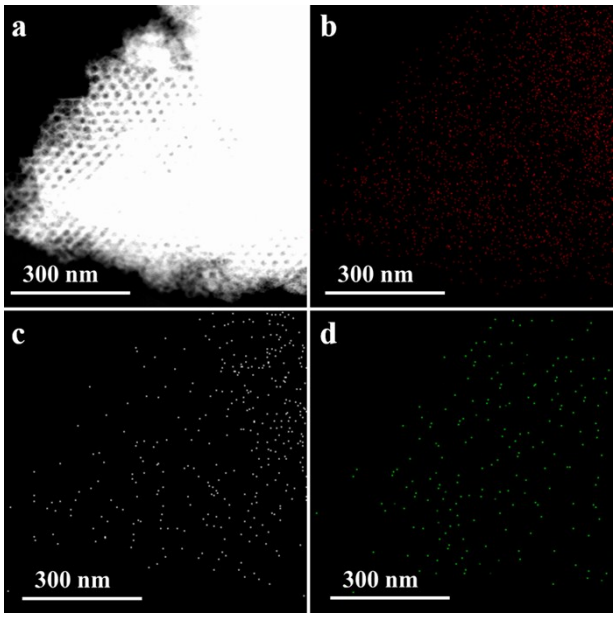

Figure S3. Scanning transmission microscopy (STEM) image (a) and EDX mapping images of W (b), O (c), C (d) elements of the ordered mesoporous carbon/WO_3 (OMC-WO_3) composites obtained after pyrolysis at 550 °C in N_2.

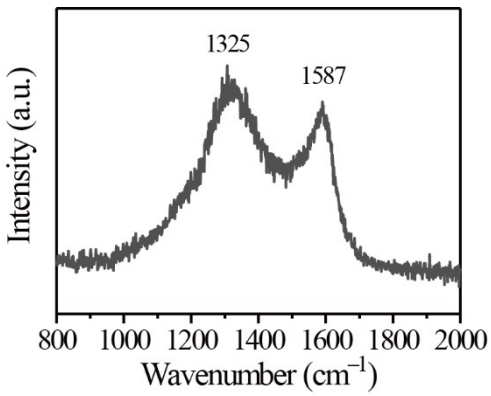

Figure S4. The Raman spectrum of the ordered mesoporous carbon/WO_3 (OMC-WO_3) composites obtained after pyrolysis at 550 °C in N_2. Peaks at 1325 and 1587 cm^{-1} can be attributed to the D and G bands of sp^3 and sp^2 carbon, respectively.

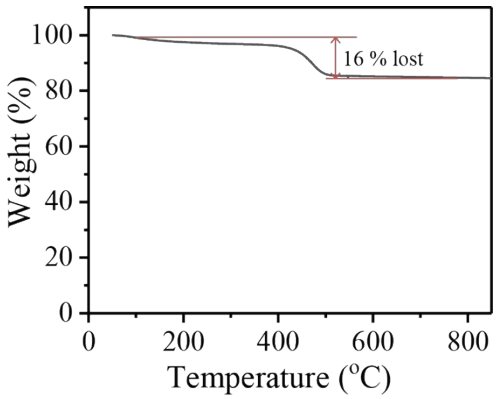

Figure S5. The TGA curve of the ordered mesoporous carbon/WO_3 (OMC-WO_3) composites obtained after pyrolysis at 550 °C in N_2 with a heating rate of 5 °C/min from 50 to 900 °C in air atmosphere. Approximately 16% weight loss is observed between 100 and 600 °C, which is attributed to the decomposition of carbon species in the OMC-WO_3 composites.

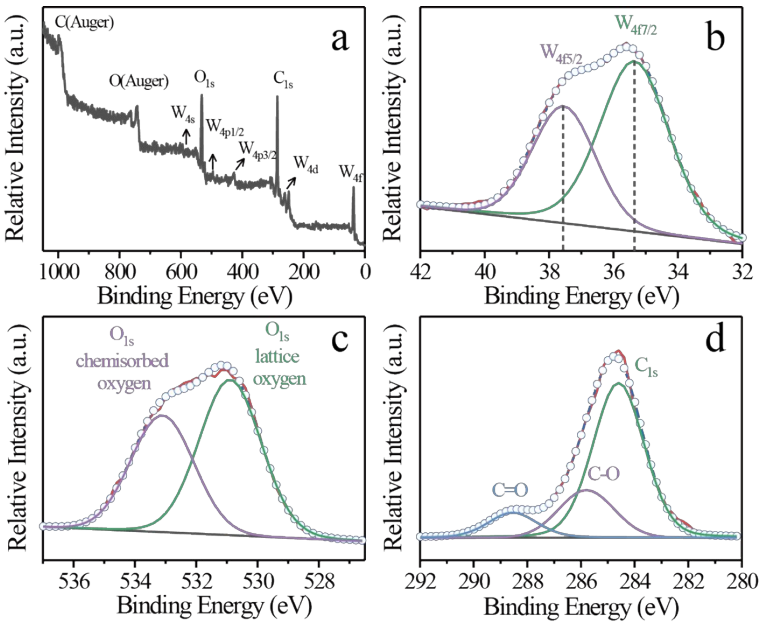

Figure S6. The XPS survey spectra (a) and high-resolution W_{4f} (b), O_{1s} (c), and C_{1s} (d) spectra of the ordered mesoporous carbon/WO_3 (OMC-WO_3) composites obtained after pyrolysis at 550 °C in N_2.

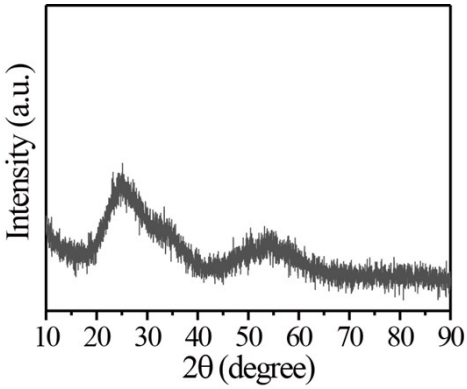

Figure S7. The XRD pattern of the ordered mesoporous carbon (OMC) obtained after removal WO_3 nanocrystals from the ordered mesoporous carbon/WO_3 (OMC-WO_3) composites by HF etching.

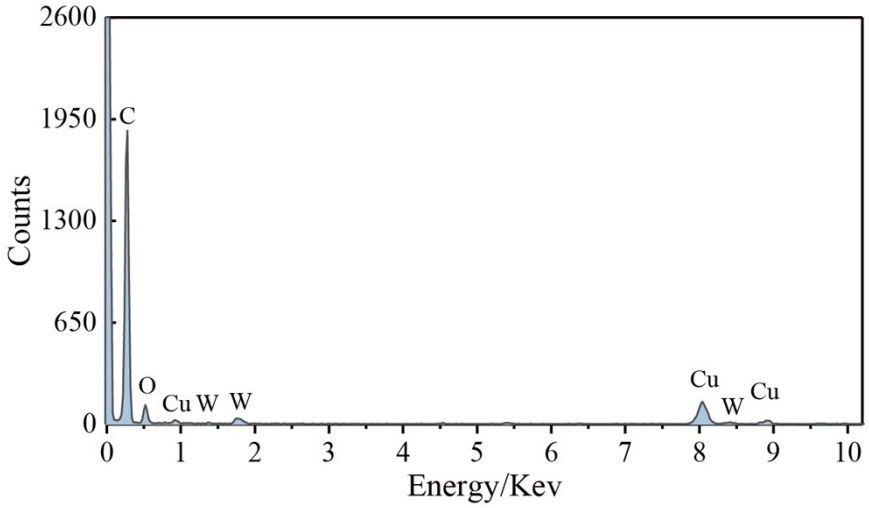

Figure S8. The EDX spectrum of the ordered mesoporous carbon (OMC) obtained after removal WO_3 nanocrystals from the ordered mesoporous carbon/WO_3 (OMC-WO_3) composites by HF etching.

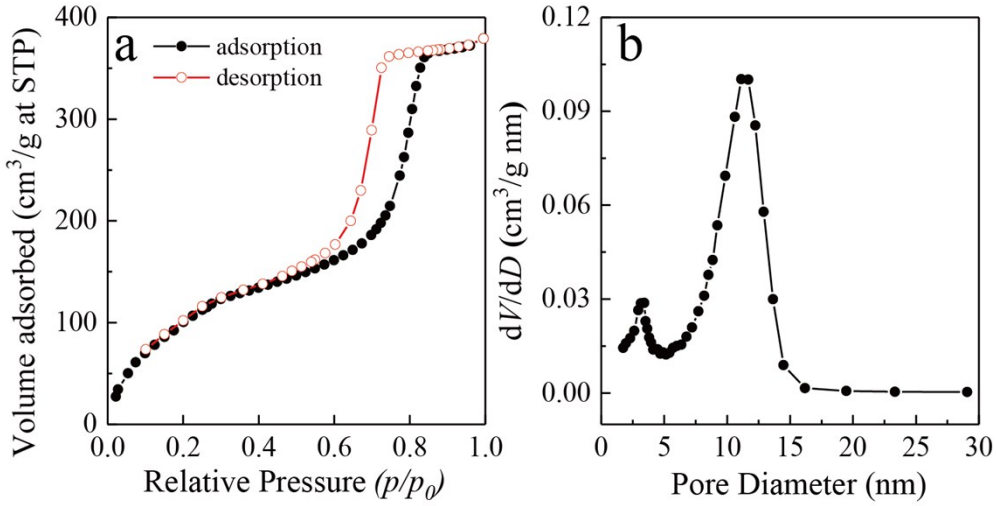

Figure S9. (a) Nitrogen-sorption isotherms and (b) pore-size distribution curve of the ordered mesoporous carbon (OMC) obtained after removal WO_3 nanocrystals from the ordered mesoporous carbon/WO_3 (OMC-WO_3) composites by HF etching.

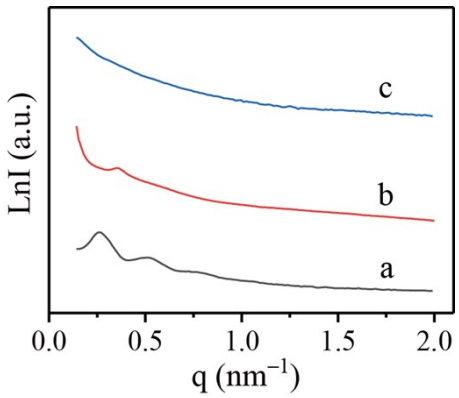

Figure S10. The SAXS patterns of the amorphous ordered mesoporous carbon/WO_3 (AOMC-WO_3, a), mesoporous carbon/WO_3 (MC-WO_3, b) and WO_3-nanowire/carbon (WO_3-NW-C, c) composites obtained after pyrolysis at 500, 600 and 650 °C in N_2, respectively.

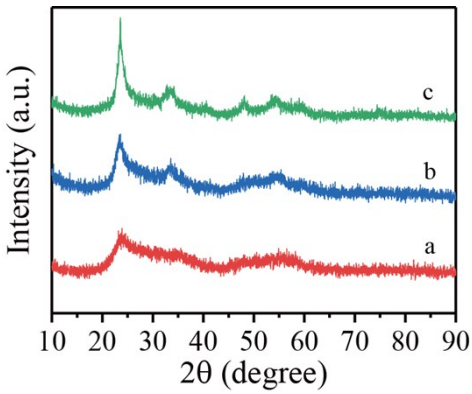

Figure S11. The XRD patterns of the amorphous ordered mesoporous carbon/WO_3 (AOMC-WO_3, a), mesoporous carbon/WO_3 (MC-WO_3, b) and WO_3-nanowire/carbon (WO_3-NW-C, c) composites obtained after pyrolysis at 500, 600 and 650 °C in N_2, respectively.

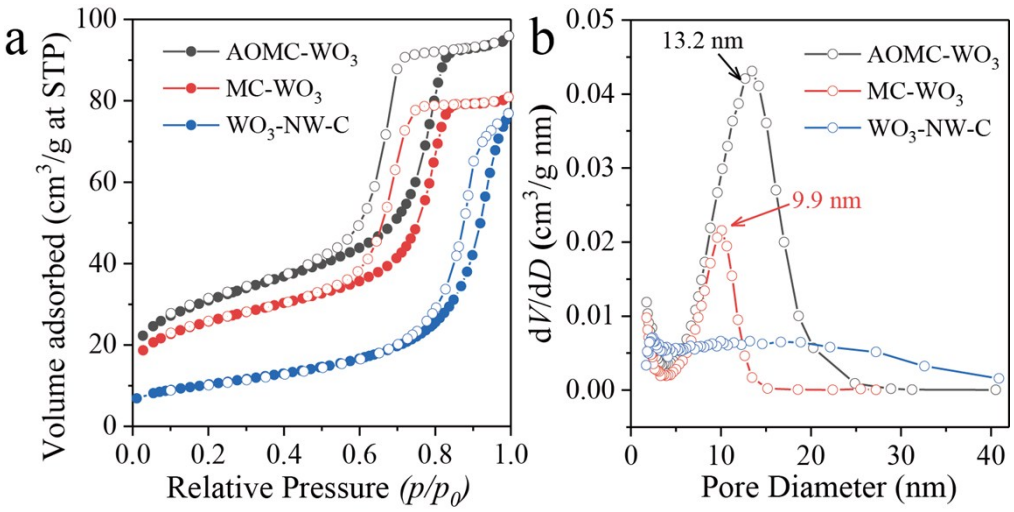

Figure S12. (a) Nitrogen-sorption isotherms and (b) pore-size distribution curve of the amorphous ordered mesoporous carbon/WO_3 (AOMC-WO_3), mesoporous carbon/WO_3 (MC-WO_3) and WO_3-nanowire/carbon (WO_3-NW-C) composites obtained after pyrolysis at 500, 600 and 650 °C in N_2, respectively.

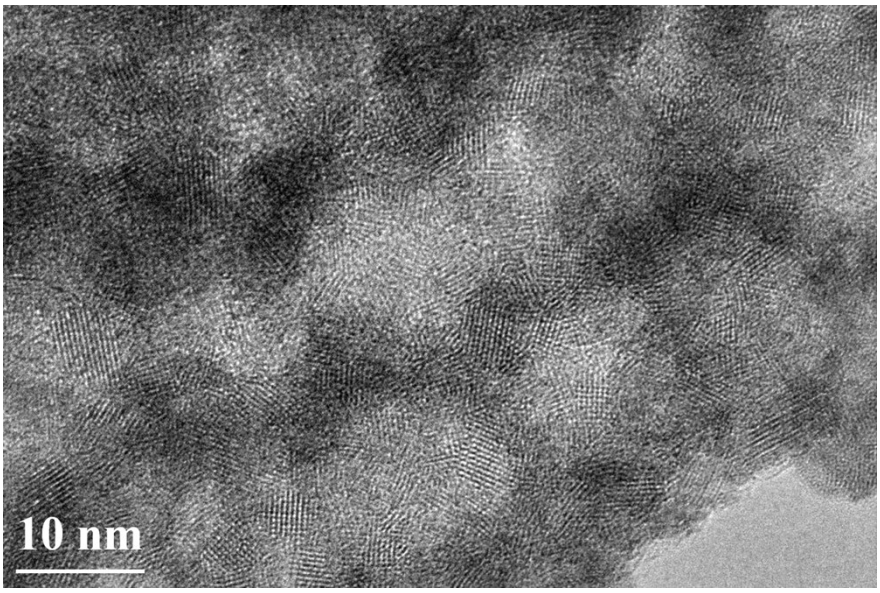

Figure S13.TEM image of the mesoporous WO_3 obtained after pyrolysis at 550 °C without addition of resols.

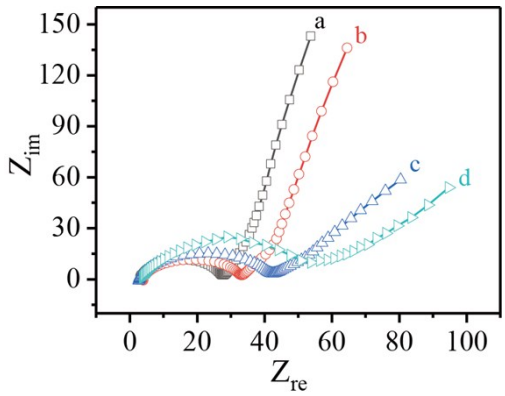

Figure S14. Nyquist plots of the ordered mesoporous carbon/WO_3 (OMC-WO_3, a), mesoporous carbon/WO_3 (MC-WO_3, b), WO_3-nanowire/carbon (WO_3-NW-C, c) composites and ordered mesoporous WO_3 (OM-WO_3, d) at room temperature.