Supporting information

Mesoporous carbon matrix confinement synthesis of ultrasmall $\text{WO}_3$ 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/\text{WO}_3 (OMC-WO_3) composites obtained after pyrolysis at 550 °C in N\textsubscript{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 WO₃ nanocrystals from the ordered mesoporous carbon/WO₃ (OMC-WO₃) 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.