

Electronic Supplementary Information

Tracking the Confinement Effect of Highly Dispersive Carbon in a Tungsten Oxide/Carbon Nanocomposite: Conversion Anode Materials in Lithium Ion Batteries

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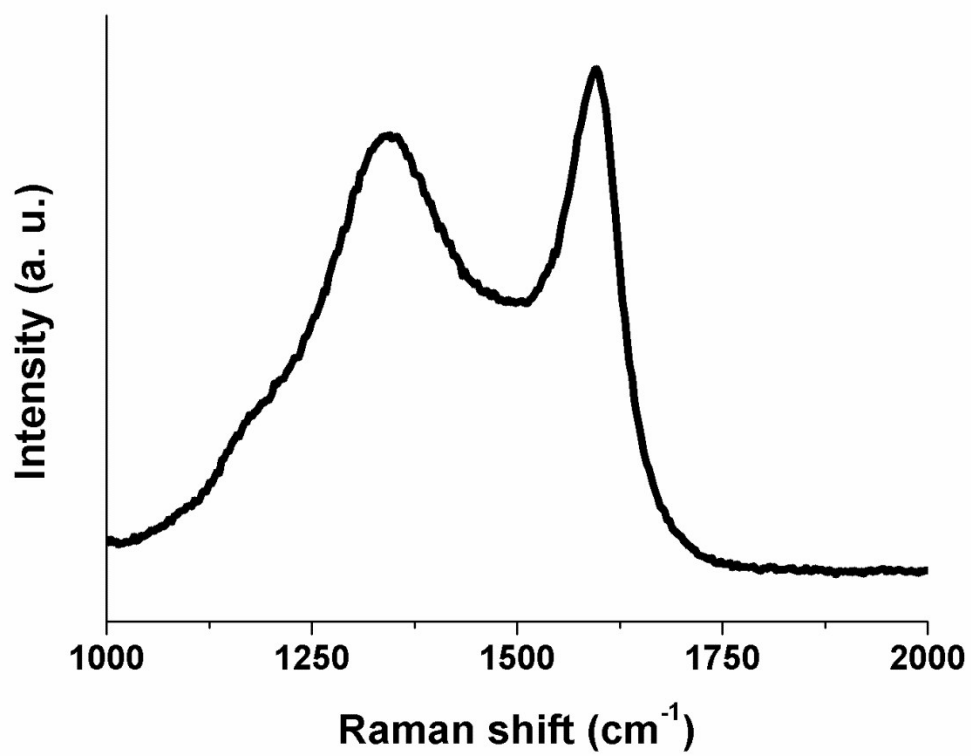


Figure S1. Raman spectra of m-WO_x/C.

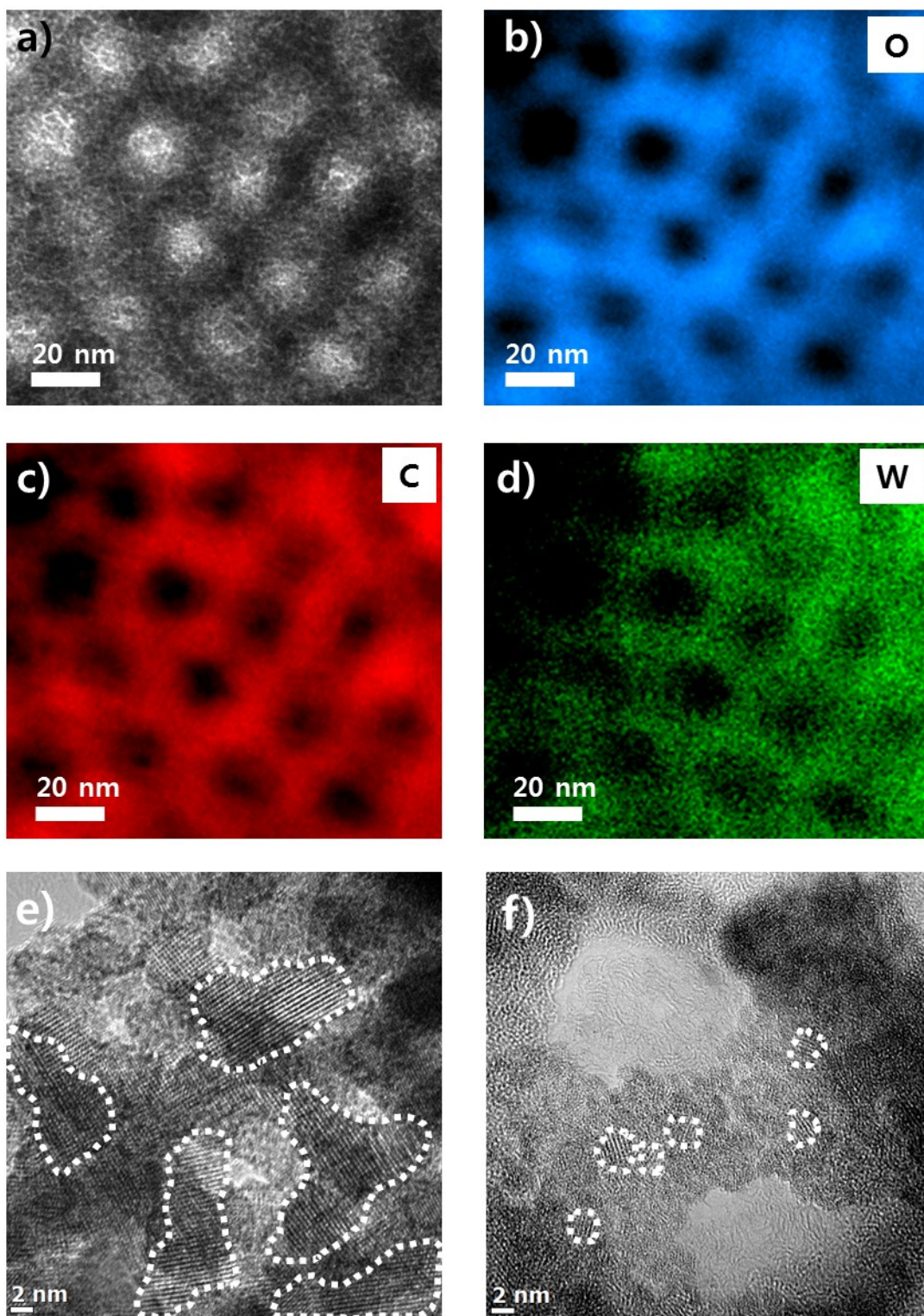


Figure S2. EELS mapping images of m-WO_x/C (a-d), oxygen (b), carbon (c), and tungsten (d). HR-TEM images of (e) m-WO₃ and (f) m-WO_x/C. White dotted line indicates the crystalline tungsten oxide phase in each sample.

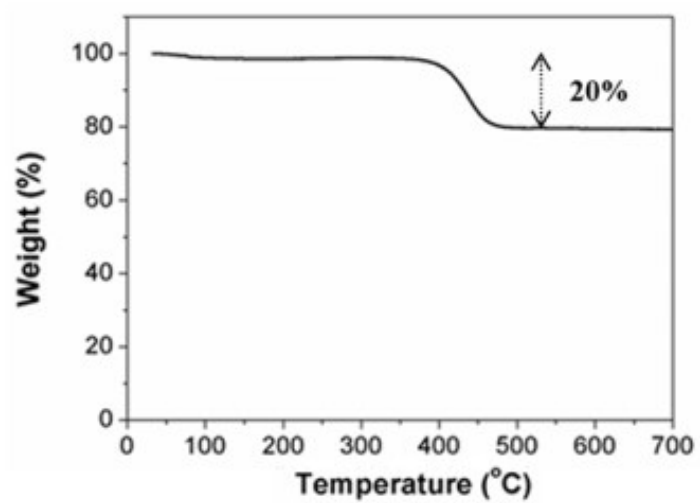


Figure S3. TGA data of m-WO_x/C.

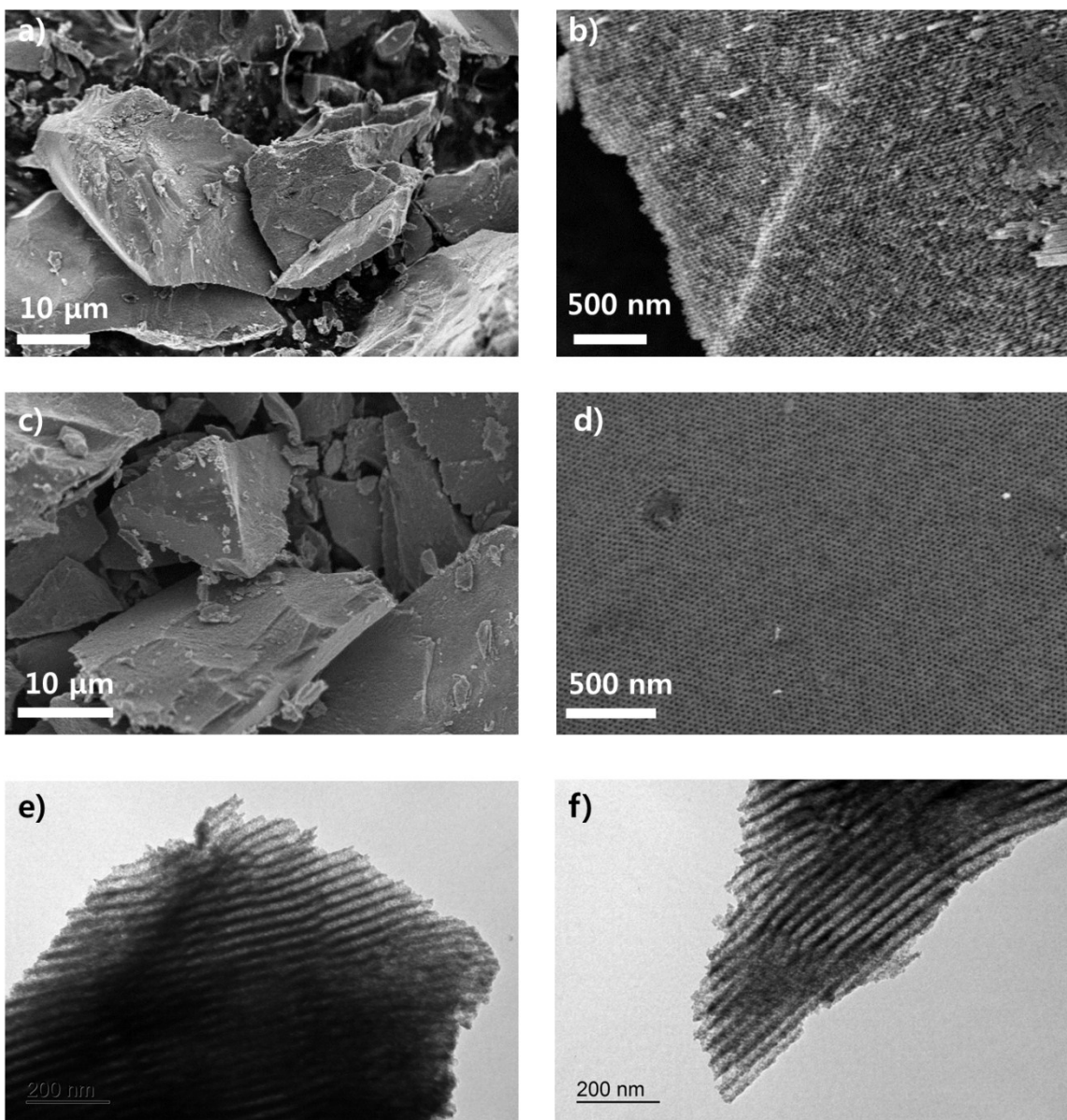


Figure S4. SEM images of (a, b) m-WO_x/C and (c, d) m-WO₃ with different magnification. TEM images of (a) m-WO_x/C and (b) m-WO₃.

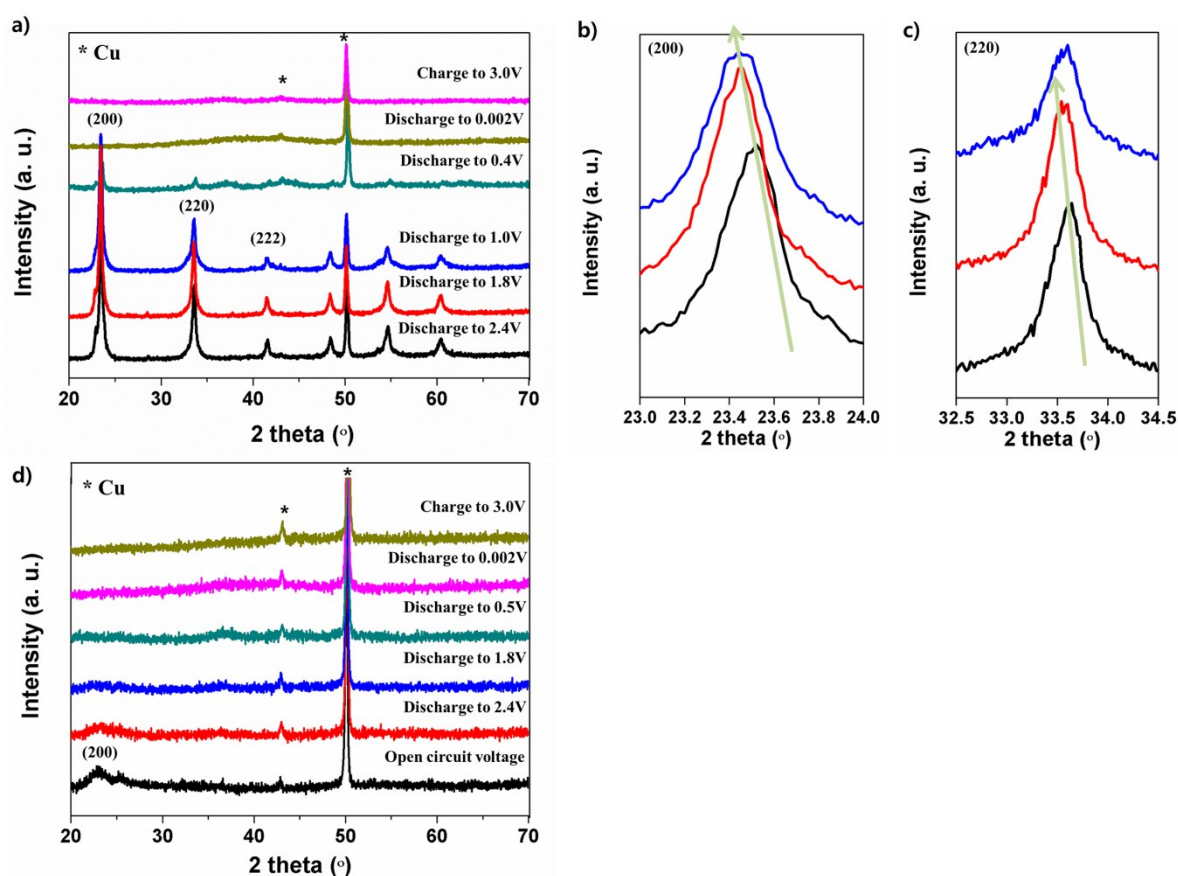


Figure S5. *ex-situ* XRD patterns of (a) m-WO₃, (b) (200) peaks (c) (220) peaks of m-WO₃, and (d) m-WO_x/C.

Analysis of *ex-situ* XRD was performed at several points considering the discharge/charge graph of m-WO₃. During discharge to 1.0 V, (200) and (220) peaks show similar intensities but shift to lower angle. It is due to expansion of WO₃ lattice by intercalation of Li⁺.¹ When discharged to 0.002 V, most of peaks are diminished and not recovered in spite of charging to 3.0 V. In relation to discharge/charge graph of m-WO₃ electrode, it was confirmed that conversion reaction of m-WO₃ occurs after plateau sloped region (0.9 to 0.002 V) and amorphous phase reacts reversibly with Li⁺ after the first cycle.

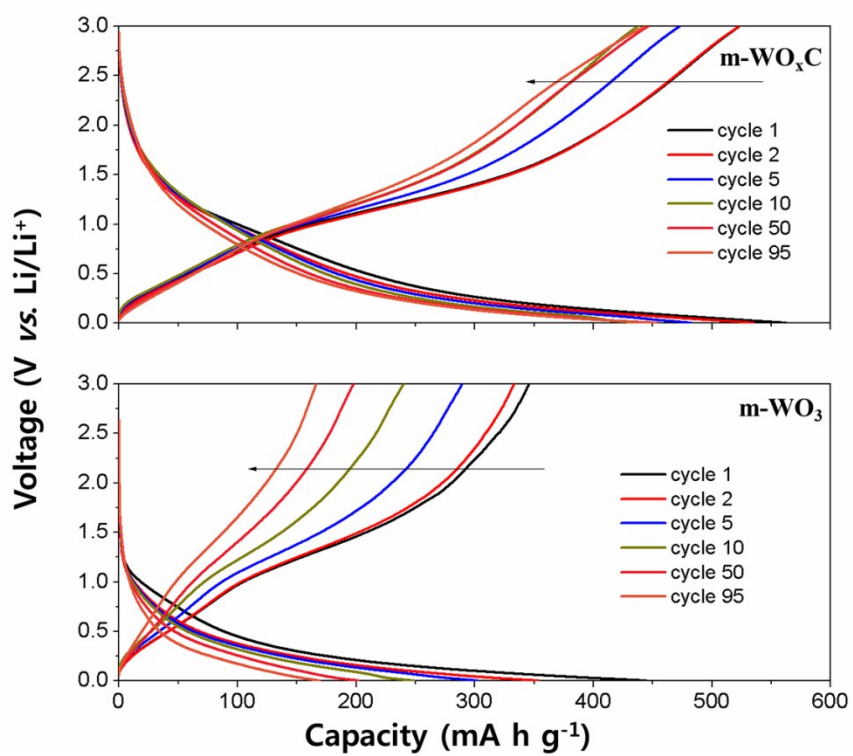


Figure S6. Voltage profiles of m-WO_x/C and m-WO₃ at 250 mA g⁻¹.

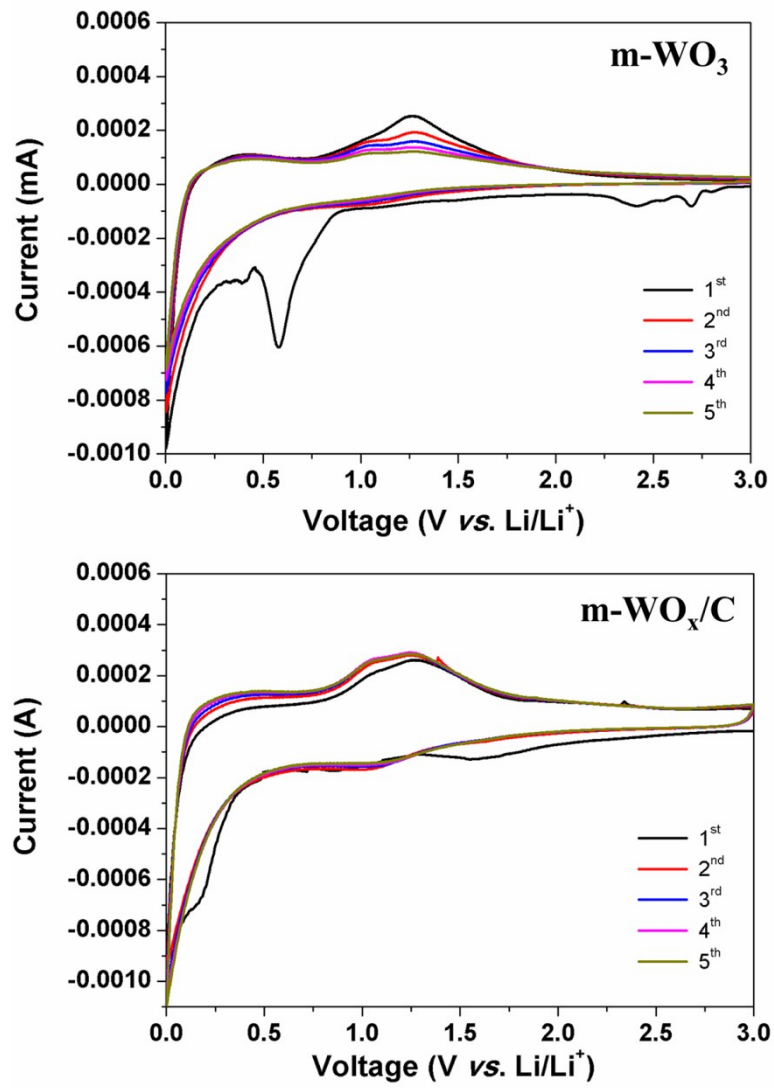


Figure S7. Cyclic voltammetry of (a) m-WO₃ and (b) m-WO_x/C.

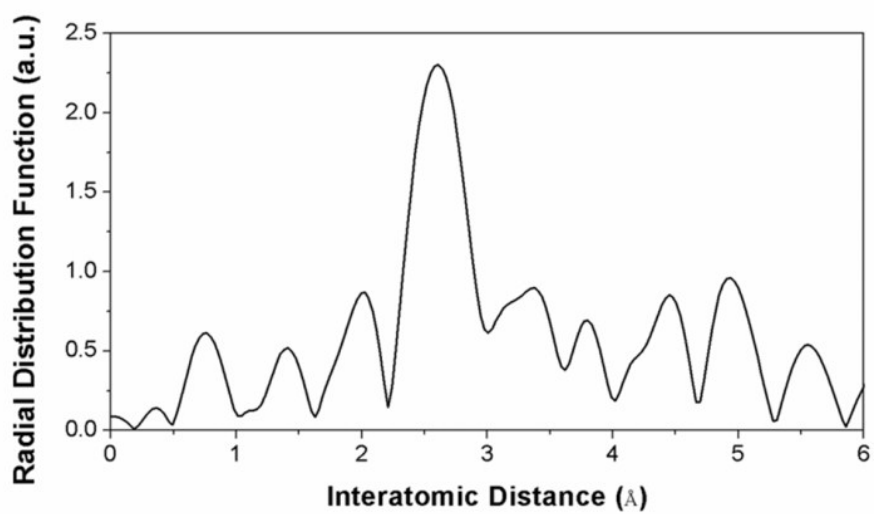


Figure S8. EXAFS spectra of tungsten metal.

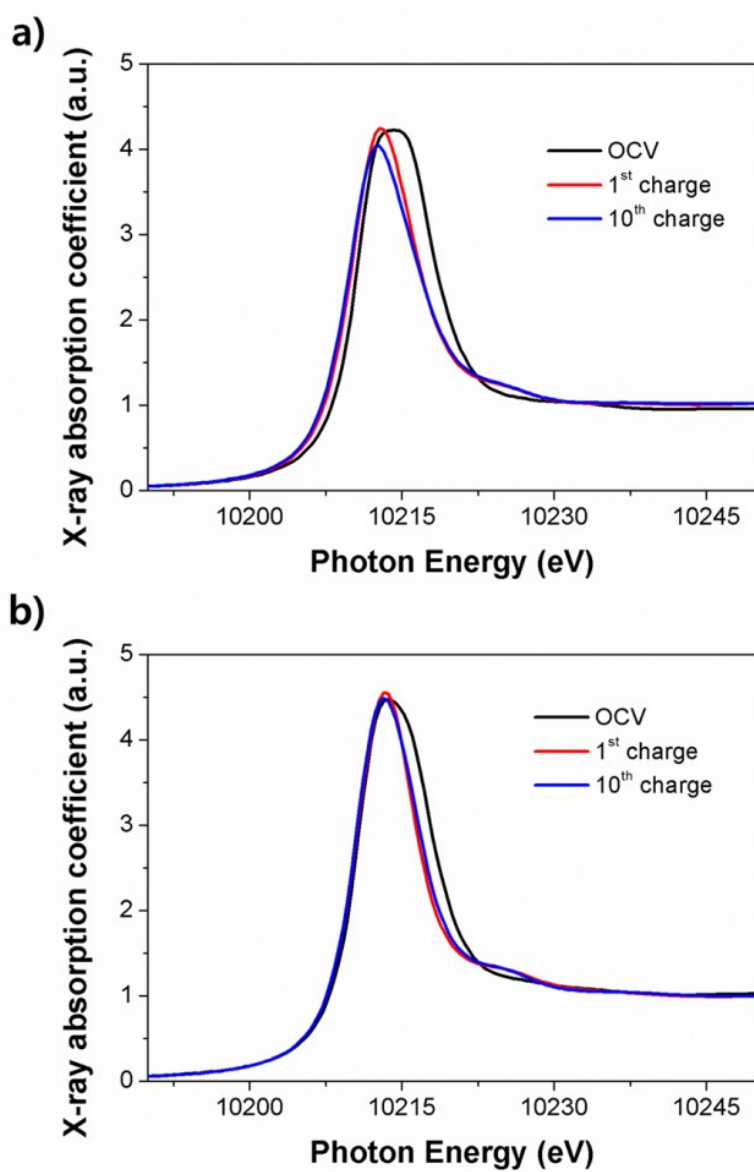


Figure S9. XANES spectra of (a) m-WO₃ and (b) m-WO_x/C.

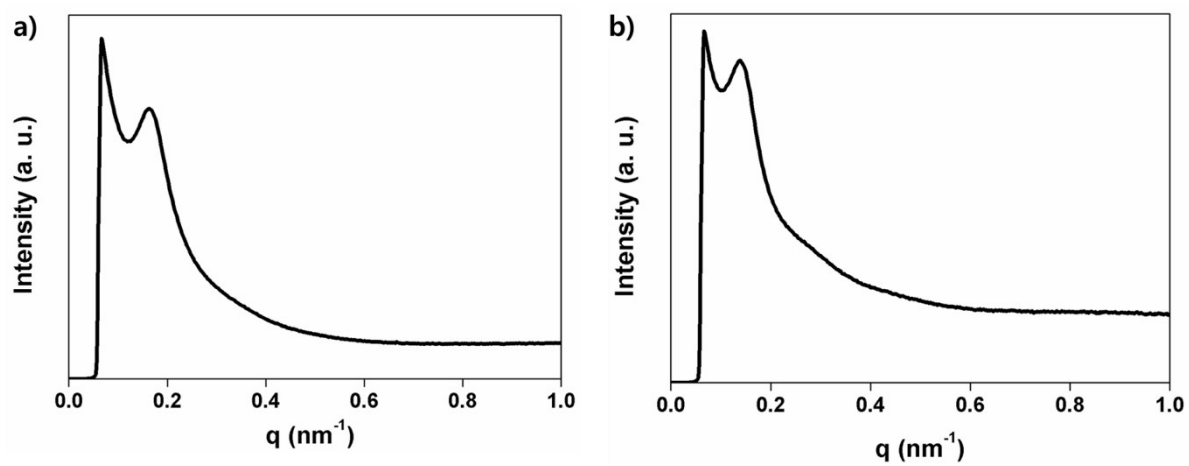


Figure S10. SAXS patterns of m-WO_x/C (a) before galvanostatic charge/discharge cycle and (b) after 10 cycles.

Reference

1. Kim, M. S.; Lim, E.; Kim, S.; Jo, C.; Chun, J.; Lee, J., *Adv. Funct. Mater.* 2017, **27**, 1603921.