Supporting information for

**Controlled growth of porous δ-MnO₂ nanosheets on carbon fibers as a bi-functional catalyst for rechargeable lithium-oxygen batteries**

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**Figure S1** SEM image of $\delta$-MnO$_2$/CCFs-K80 sample showing a typical core-shell structure.

**Figure S2** SEM images of pure $\delta$-MnO$_2$ sample at high (a, b) and low (c) magnification.
Figure S3 SEM images of the acid-treated CFs before loading the MnO$_2$ (a) and the SEM images of δ-MnO$_2$/CCFs-K40 (b), δ-MnO$_2$/CCFs-K80 (c) and δ-MnO$_2$/CCFs-K120 (d) after etching the MnO$_2$ phase.

Figure S4 Line-scanning (marked by the red line in the insert image) elemental profiles of C, Mn and O elements.
**Figure S5** Nitrogen adsorption-desorption isotherms and the pore size distribution (insert) of CFs (a), δ-MnO$_2$/CCFs-K80 (b) and δ-MnO$_2$/CCFs-K120 (c) samples.

**Figure S6** Charge/discharge curves during of the cycled Li-O$_2$ battery based on the δ-MnO$_2$/CCFs-K80-XC-72 electrode with a limited capacity of 500 mAh g$^{-1}$.

**Figure S7** SEM images of the δ-MnO$_2$/CCFs-K80-XC-72 (a, b, c) and XC-72 (d, e, f) electrodes at before discharge, fully discharged and charged state.
Figure S8 SEM images of the fully discharged electrode with $\delta$-MnO$_2$/CCFs-K80 catalyst at high (a) and low (b) magnifications.

Figure S9 Raman spectra of $\delta$-MnO$_2$/CCFs-K80 electrode after discharge at the 3rd cycle.

Figure S10 Nitrogen adsorption-desorption isotherms of XC-72 carbon (a) and the FITR spectrum of XC-72 carbon (b).
Figure S11 SEM images of the discharge products of the electrode with $\delta$-MnO$_2$/CCFs-K80 catalyst after discharged at 350 mAh g$^{-1}$. 