<Supporting information>

**One-Step Transformation of MnO$_2$ into MnO$_{2-x}$@Carbon Nanostructures for High-Performance Supercapacitors using Structure-Guided Combustion Waves**

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Calculation of specific capacitance from scan rate or current density

A specific capacitance was calculated from the CV curve by the subtraction of the capacitance between bare MWCNT electrode and MnO$_x$/MWCNT electrode using the following equation:

$$C = \frac{\int_{V_1}^{V_2} \{I_v(MnO_x/MWCNT) - I_v(MWCNT)\}dV}{\Delta V \times v \times m (MnO_x)}$$

where $C$ is the specific capacitance (F/g), $I_v$ is the current at a specific scan rate during charge and discharge cycling (A), $\Delta V$ is the applying voltage (V), $v$ is the scan rate (V/s), and $m$ is the mass of deposited MnO$_x$ (g).

A Specific capacitance was also obtained from the charge–discharge cycle (current density) using the following equation:

$$C = \frac{I \times \Delta t}{\Delta V \times m (MnO_x)}$$

where $C$ is the specific capacitance (F/g), $I$ is the current during charge and discharge cycling (A), $\Delta t$ is the discharge time (s), $\Delta V$ is the potential window (V), and $m$ is the mass of deposited MnO$_x$ (g).
Cyclic voltammetry (CV) curves for Mn$_2$O$_3$/Mn$_3$O$_4$/MnO@C, MnO@C and MnO$_2$ electrodes.

All electrodes, fabricated by filtrating manganese oxide nanoparticles and nanostructures on MWCNT current collector film were investigated through cyclic voltammetry (CV) (Figure S1). CV curves were measured in 0.8 V potential window, at scan rates of 10, 25, 50, 100, 250 and 500 mV/s within Na$_2$SO$_4$ 1 M electrolyte.

Galvanostatic charge-discharge curves were measured at various current densities of 0.5, 1, 2, 5 and 10 A/g with the potential window between 0 and 0.8 V for Mn$_2$O$_3$/Mn$_3$O$_4$/MnO@C (Figure S2a) and MnO@C (Figure S2b). Those charge-discharge curves showed good bilateral symmetry and linear energy quantity slopes at both charging and discharging periods. The highest specific capacitance based on the current density rate was 415.6 F/g at 0.5 A/g of current density. The larger current density resulted in the smaller specific capacitance for all electrodes (Figure S2c).
**Figure S1.** Cyclic voltammetry (CV) curves for (a) Mn$_2$O$_3$/Mn$_3$O$_4$/MnO@C, (b) MnO@C and (c) MnO$_2$ electrodes.

**Figure S2.** Galvanostatic charge–discharge performances of (a) Mn$_2$O$_3$/Mn$_3$O$_4$/MnO@C-based electrode and (b) MnO@C-based electrode at different current densities. (c) Specific capacitances of Mn$_2$O$_3$/Mn$_3$O$_4$/MnO@C-based electrode and MnO@C-based electrode at different current densities.
**Figure S3.** Scanning electron microscope (SEM) image for Mn$_2$O$_3$/Mn$_3$O$_4$/MnO@C, MnO@C electrodes supercapacitors after 5000 times charge-discharge cycling. SEM images of (a) Mn$_2$O$_3$/Mn$_3$O$_4$/MnO@C and (b) MnO@C electrodes after 5000 times charge-discharge cycling. There are no change of morphology in nanostructure of MnO$_x$@C.

**Figure S4.** Pore size distribution of MnO$_x$@C, analyzed by ImageJ.