Electronic Supplementary Information (ESI) for

Multidimensional MnO_2 Nanohair-Decorated Hybrid Multichannel Carbon Nanofiber as an Electrode Material for High-Performance Supercapacitors †

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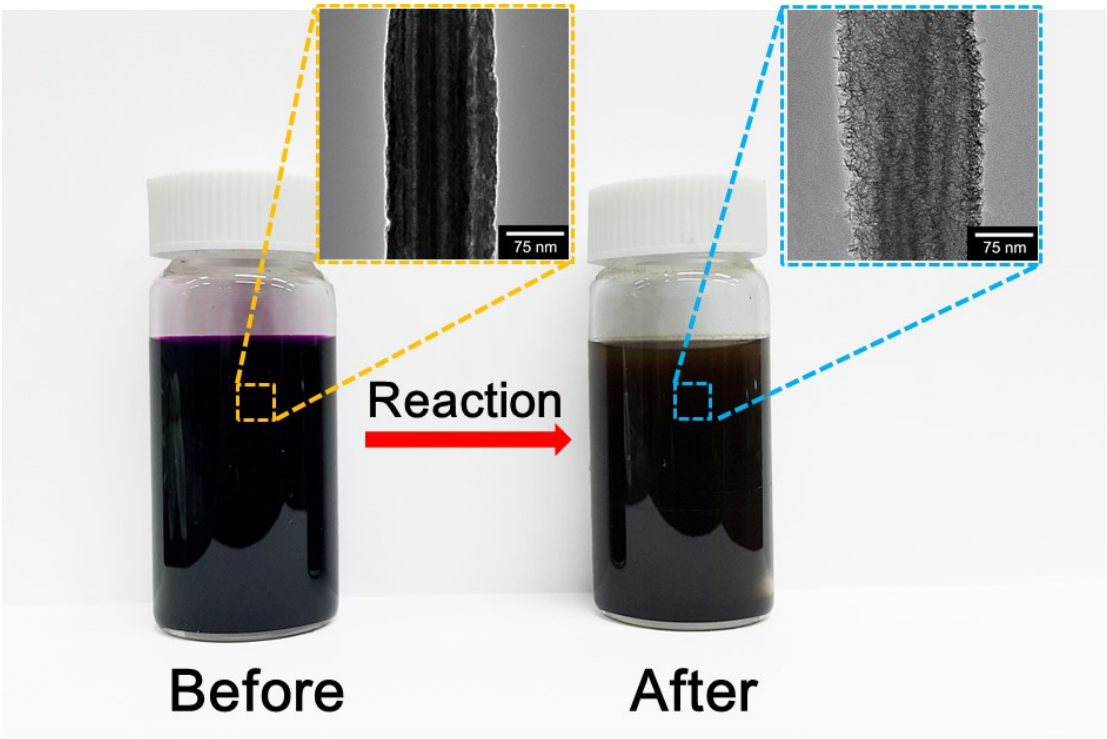

Figure S1. Optical images of the multichannel carbon nanofiber (MCNF) contained in a $KMnO_4$ aqueous solution before (left) and after (right) the redox reaction (yellow inset: MCNF; green inset: MnO_2 nanohair-decorated MCNF (Mn_MCNF).

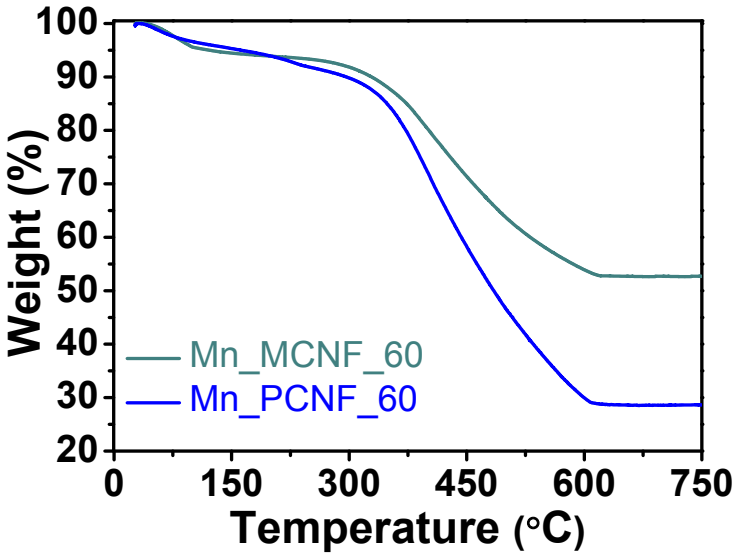

Figure S2. TGA analyses of MnO_2 decorated CNFs with and without inner channel (blue: Mn_P CNF_60 ; green: Mn_MCNF_60).

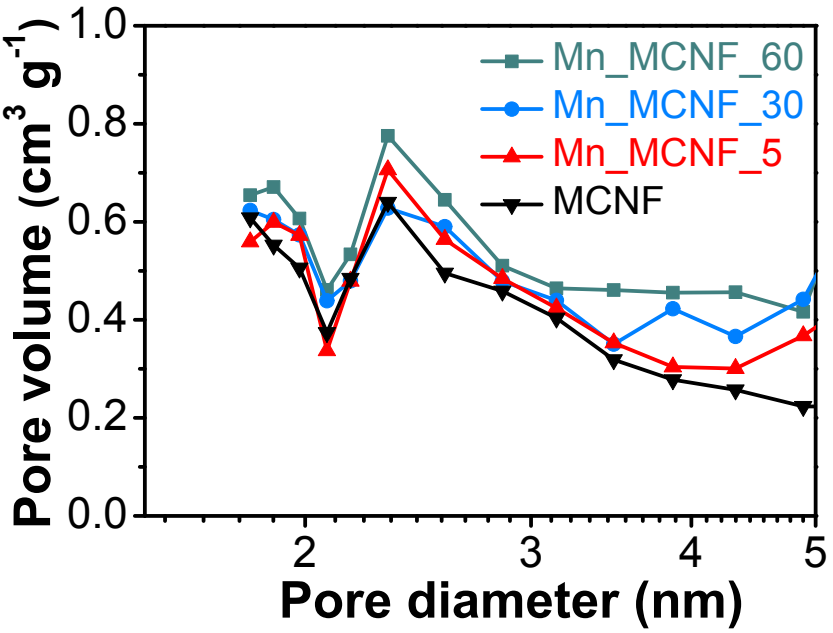

Figure S3. Magnified curves of the pore size distribution curves (black: MCNF; red: Mn_MCNF_5; blue: Mn_MCNF_5; green: Mn_MCNF_60).

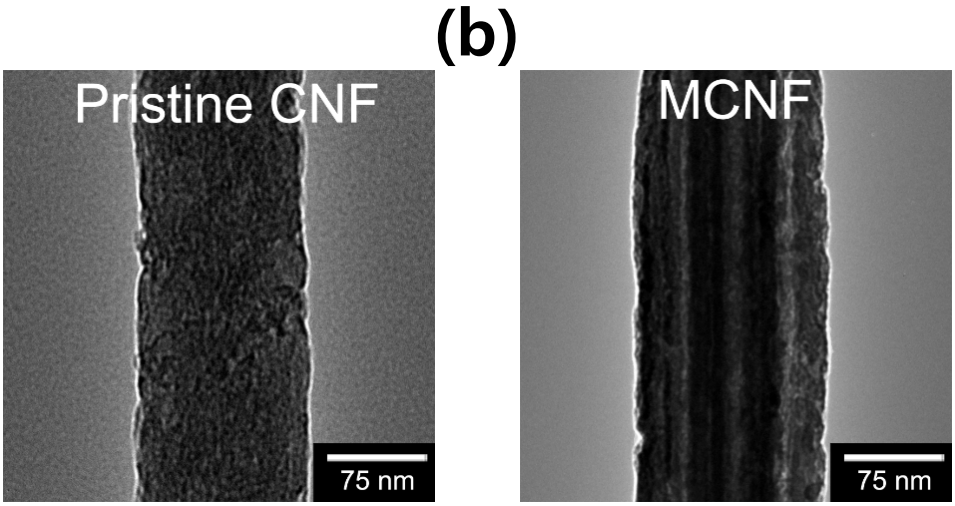

Figure S4. Transmission electron microscopy (TEM) image of (a) a carbon nanofiber (CNF) and (b) multichannel carbon nanofiber (MCNF).

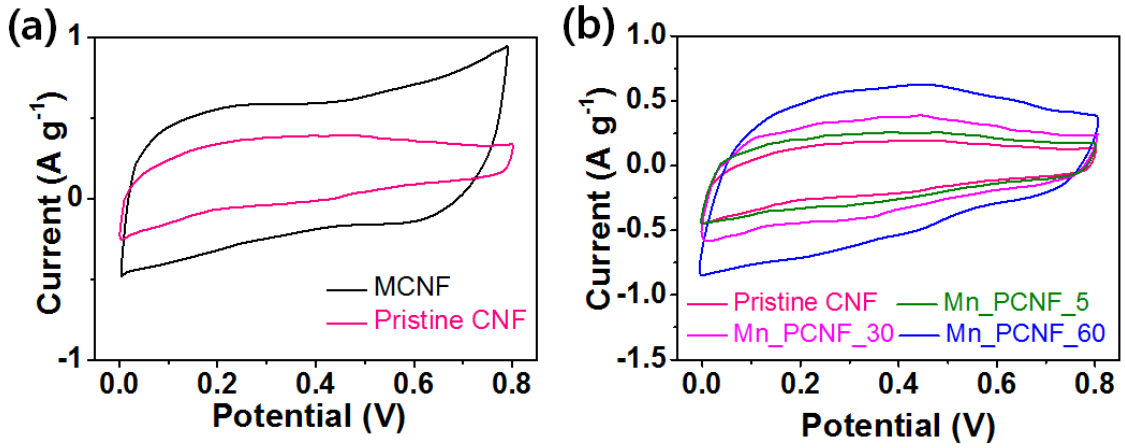

Figure S5. Cyclic Voltammetry (CV) curves (scan rate : 10 mV s^{-1})of (a)different carbon nanofibers (black: MCNF; pink: pristine CNF) and (b)pristine CNF and Mn_PCNF samples .

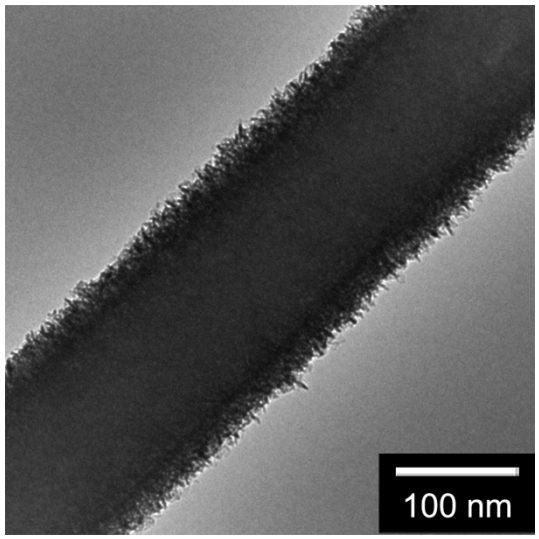

Figure S6. TEM image of Mn_PCNF_60.

Control experiments were conducted using pristine carbon nanofibers (PCNF) and pristine CNFs with MnO_2. PCNF were placed in a teflon container custom-designed for use during the redox reaction. Then 10 mM of a $KMnO_4$ aqueous solution was introduced and sonicated for 20 min. The mixture solution was then stirred vigorously for different time (5, 30 and 60 min) at 80°C. The final products were dried in a vacuum oven for 12 h at 60°C. The electrochemcial properties of the PCNF with MnO_2 (Mn_PCNF_5, Mn_PCNF_30 and Mn_PCNF_60, corresponding to a reaction time of 5, 30, and 60 min) were studied for a three-electrode sysetem. The Cyclic Voltammetry (CV) curves of the

Mn_PCNFs exhbited a relatively large area compared to PCNF without MnO_2 due to the combination of the faradaic reaction from MnO_2(**Figure S5**). Additionally, the area under the CV curve increased with reaction time duration. We confirmed that MnO_2 well-decorated on the surface of PCNF using TEM (**Figure S6**). However, the CV curves of the Mn_PCNF-60 displayed small area compared to Mn_MCNF_60. These results means that inner pores take a role of ion pathway.

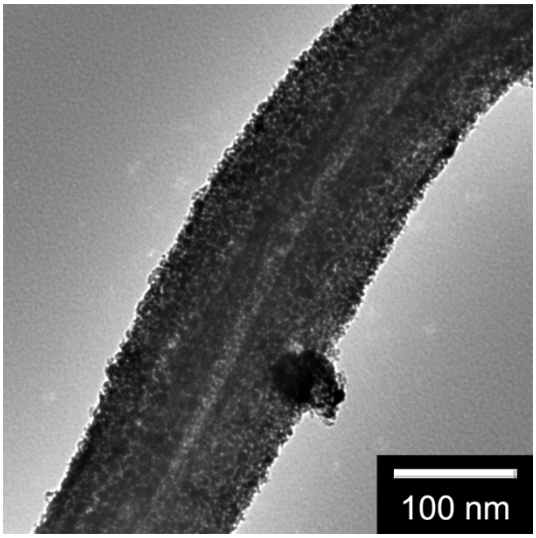

Figure S7. TEM image of Mn_MCNF_60 after cycling test..

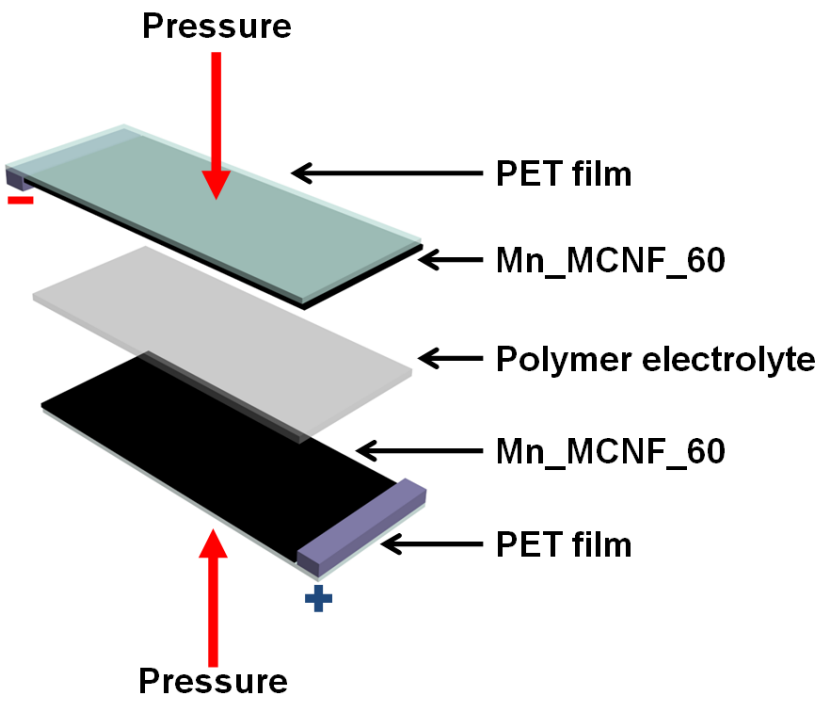

Figure S8. The structure of flexible supercapaticor device was made up of two symmetrical Mn_MCNF_60 electrodes.

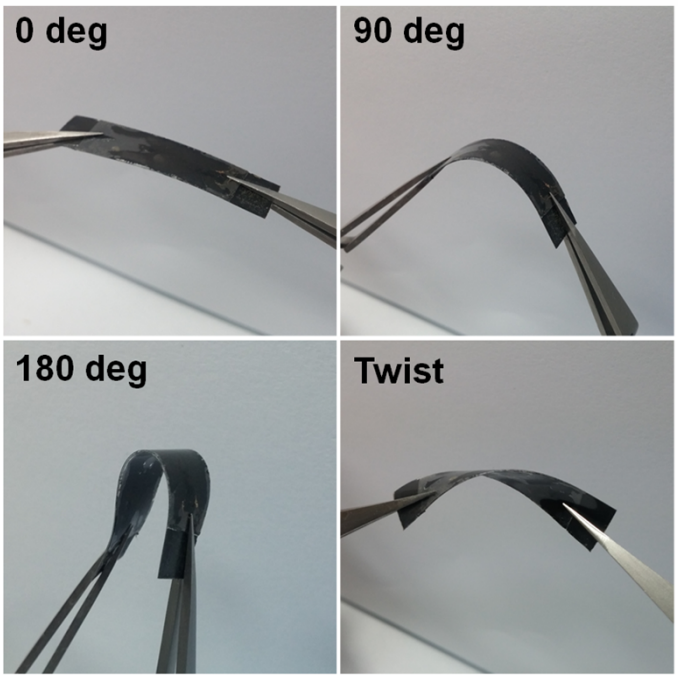

Figure S9. Digital photographs of Mn_MPCNF_60 based two electrodes supercapacitor with various deformation

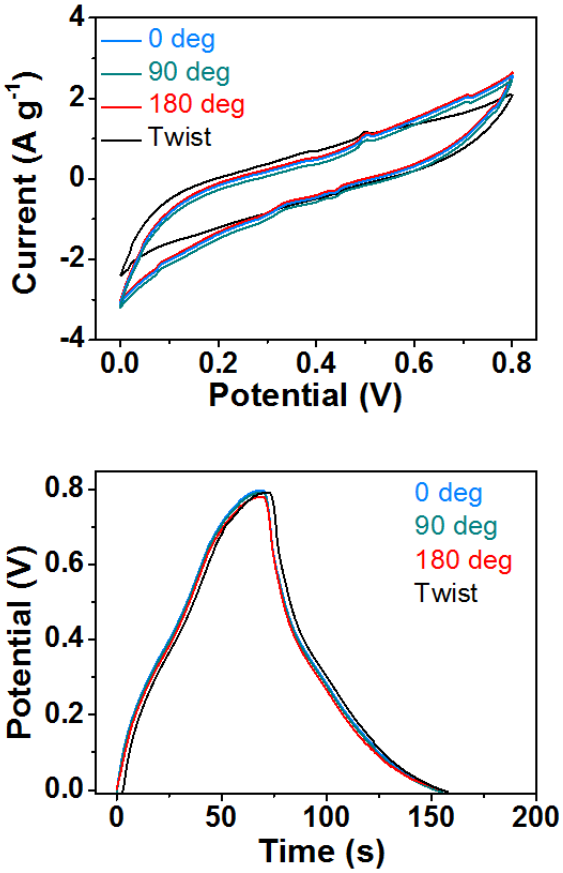

Figure S10. (a) CV curves (scan rate : 10 mV s^{-1}) and (b) galvanostatic charge-discharge curves (current density : 2 A g^{-1}) with various deformation (cobalt blue : plat; green : bending

We fabricated symmetrical two electrode flexible supercapacitor device, to measure the performance of the Mn_MCNF_60. Firstly, the Mixture of Mn_MCNF_60 paste was uniformly coated onto a polyethylene terephthalate (PET) film (1 x 5 cm) surface. To apply the flexible supercapacitor device, a polyvinyl alcohol (PVA)-gel electrolyte was prepared by mixing PVA with 1M sodium sulfate (Na_2SO_4) in D.I. water at 80 ℃ with vigorously stirring. Then, PVA-gel electrolyte was coated onto the identical electrodes surface using spin coater. These two identical electrodes were stacked at a pressure of 10 MPA for 10min using a sheet presser. The flexible supercapacitor device displays the stability with various bending and twisting angles (**Figure S9**). The electrochemical properties of supercapacitor device demonstrated that the flexibility of the device. The CV curves with various deformations exhibited similar rectangular shape at a scanrate of 10 mV s^{-1} (**Figure S10**). Additionally, GCD curves

at a specific current of 2 A g^{-1} also displayed symmetrical linear form. The specific capacitance calculated from galvanostatic charge-discharge curves at a 2.0 A g^{-1} current denstiy was 207 F g^{-1}

Table S1. Physiochemical properties of the multichannel carbon nanofiber (MCNF) and MnO_2 nanohair-decorated MCNFs (Mn_MCNFs).

	Specific surface area (m^2 g^{-1})	Total pore volume (cm^3 g^{-1})
MCNF	983	0.85
Mn_MCNF_5	1012	0.87
Mn_MCNF_30	1083	0.95
Mn_MCNF_60	1207	1.04