Electronic Supplementary Material (ESI) for RSC Advances.

High-performance flexible supercapacitors based on mesoporous carbon nanofibers/Co_3O_4/MnO_2 hybrid electrodes

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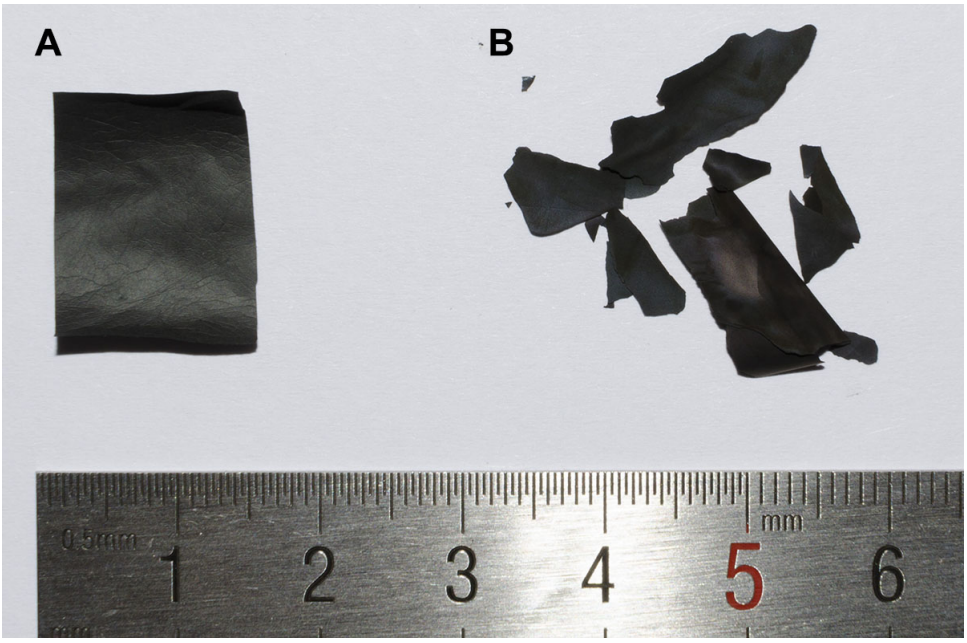

Figure S1. Digital photographs of CNFs/Co_3O_4 membranes derived from (A) 1 wt % $Co(Ac)_2$ and (B) 3 wt % $Co(Ac)_2$.

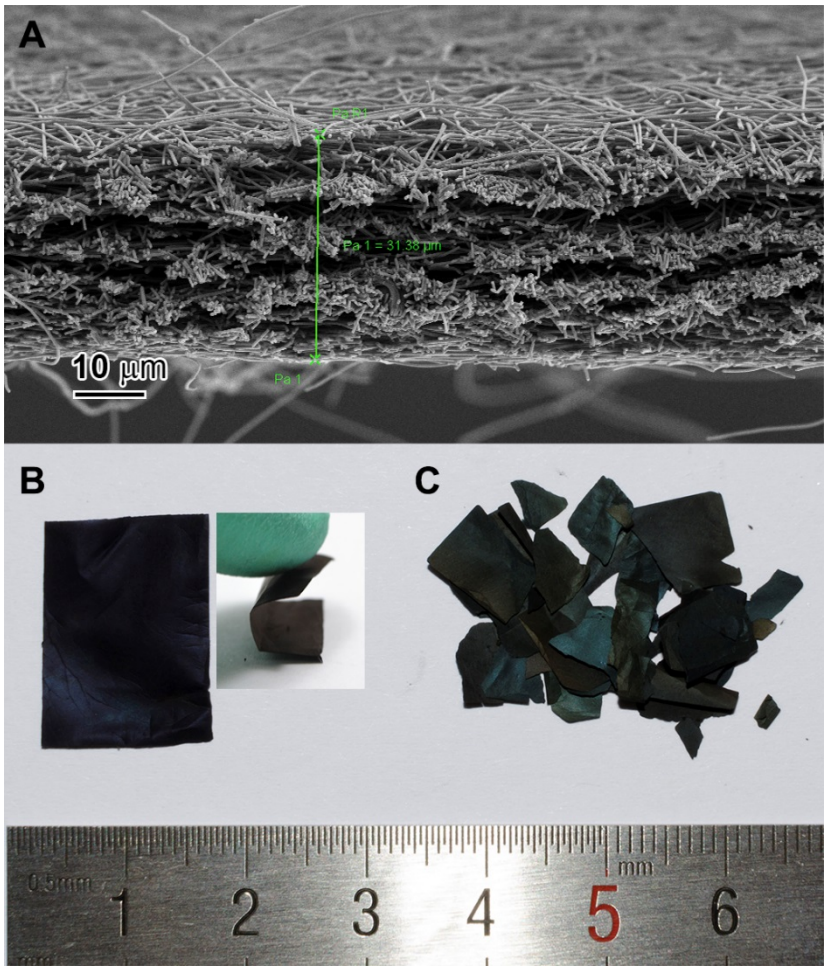

Figure S2. (A) Cross-sectional image of CNFs/Co_3O_4 membranes derived from 1 wt % $Co(Ac)_2$, (B) CCM-10 membrane and (C) CCM-20 membrane.

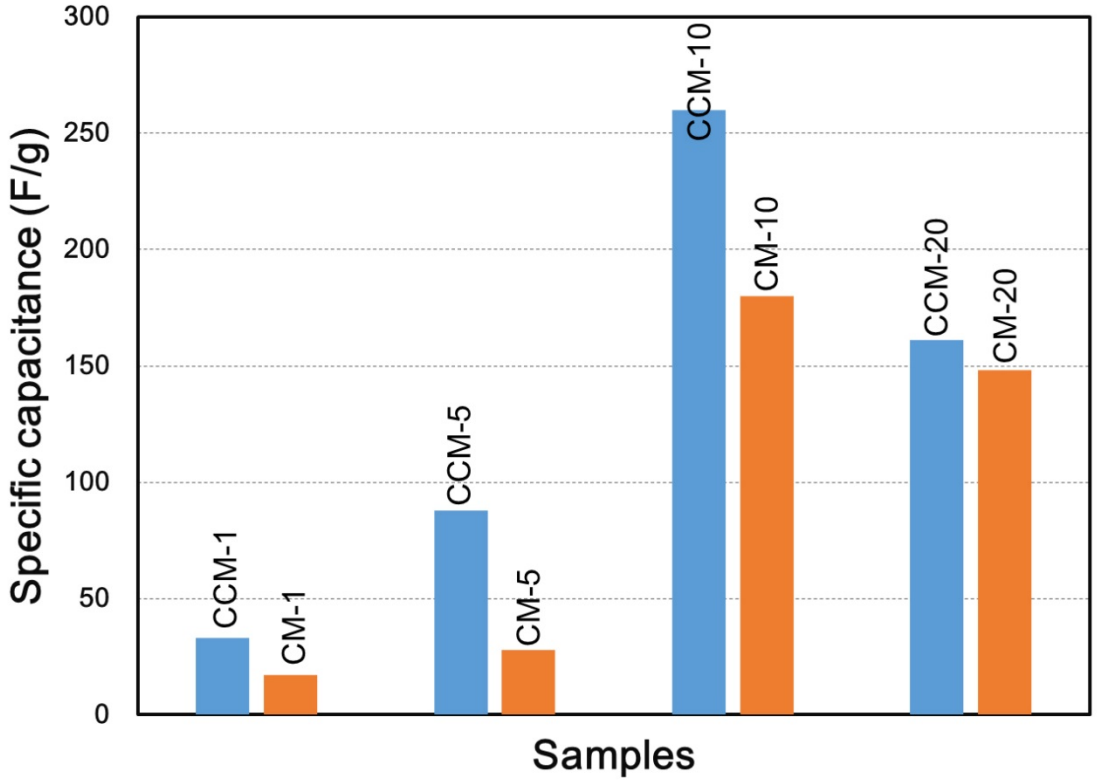

Figure S3. Comparison of the total capacitance between CCMs and CMs.

Calculation of MnO_2 loading content from TGA data:

In the CNFs/Co_3O_4/MnO_2 composite, we set MnO_2 weight as M, carbon weight as C, and percentage of residue as n (%), respectively.

Then, the weight of consumed carbon can be expressed as $\frac{36 \times M}{347.6}$ according to Eq. (1), and thus Co_3O_4 mass in all composites can be given by $\left(\frac{36 \times M}{347.6} + C\right) \times 0.082$, and mass of residual Mn_2O_3 is $\frac{157.8 \times M}{173.8}$. Then, the following equation can be derived from the TGA curves:

$$\left(\left(\frac{36 \times M}{347.6} + C\right) \times 0.082 + C + M\right) \times n = \left(\frac{36 \times M}{347.6} + C\right) \times 0.082 + \frac{157.8 \times M}{173.8}$$

Thus, the loading percentage of MnO_2 is $\frac{M}{\left(\frac{36 \times M}{347.6} + C\right) \times 0.082 + C + M}$. All results are listed in Table S1:

Table S1. Mass loading of MnO_2 for all the samples.

Sample	Residue mass (%)	Calculated MnO_2 content (%)
CCM-1	13.91	7.54
CCM-5	29.78	26.42
CCM-10	43.71	43.00
CCM-20	60.80	63.33
CNFs/Co_3O_4	Co_3O_4 content: 8.21%	

Specific capacitance calculation:

The specific capacitance of the composite electrode based on the mass of MnO_2 is calculated according to the following equation:[1]

$$C_{MnO_2} = \frac{m_{fiber}}{m_{MnO2}}\left\{C_{comp}\left(1 + \frac{m_{MnO2}}{m_{fiber}}\right) - C_{fiber}\right\}$$

where C_{MnO2} is the specific capacitance from the MnO_2 layer alone, C_{comp} is total capacitance of all the components in the composite, C_{fiber} is the capacitance from the CNFs/Co_3O_4 fiber only. m_{fiber} and m_{MnO2} are the mass of CNFs/Co_3O_4 hybrid fiber and deposited MnO_2 in the composite obtained from TGA curves.

C_{comp} and C_{fiber} can be calculated from CV according to the following equation:

$$C = \frac{\int id\Delta u}{\nu \Delta u m}$$

where i is the discharging current (A), Δu is the discharge voltage range (V), v is scan rate (mV s^{-1}), and m is the mass of electrode materials.

Reference:

1 A. Ghosh, E. J. Ra, M. H. Jin, H. Jeong, T. H. Kim, C. Biswas and Y. H. Lee, *Adv. Funct. Mater.*, 2011, **21**, 2541-2547.