Electronic Supplementary Material (ESI) for Journal of Materials Chemistry

Electronic Supporting Information (ESI) for

Significant Electrochemical Stability of Manganese Dioxide/Polyaniline Coaxial Nanowires by Self-Terminated Double Surfactant Polymerization for Pseudocapacitor Electrode

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Fig. S1. TEM image of MnO_2/Pani coaxial NW synthesized at (a) lower HCl concentration (0.01 M); (b) lower monomer concentration (0.004 ml); (c) lesser 0.1 M HCl (10 ml); (d) higher MnO_2 NW (100 mg).

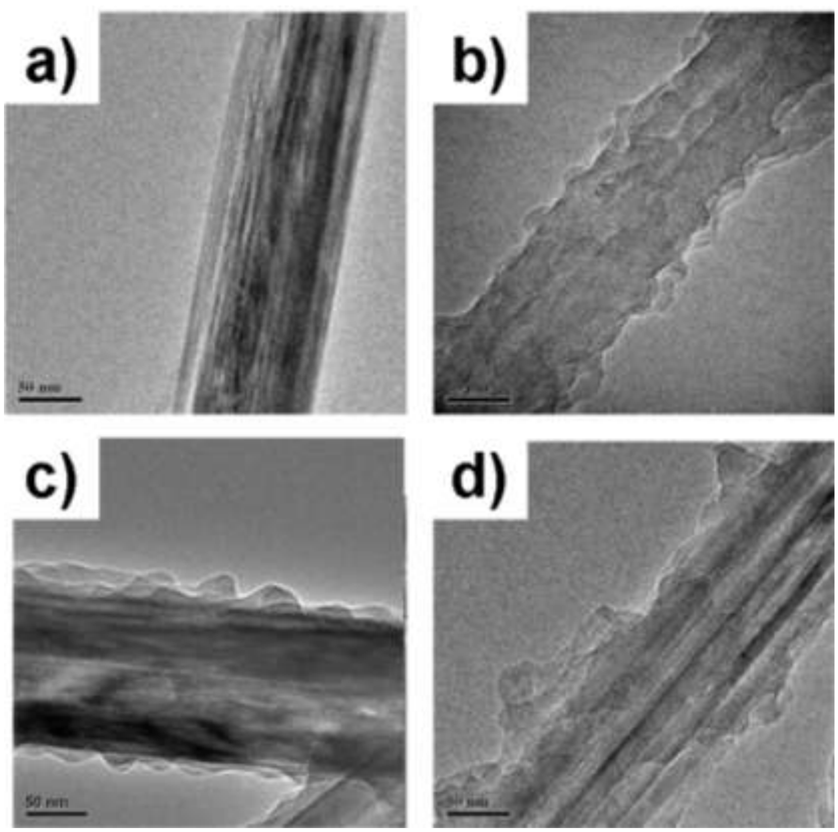
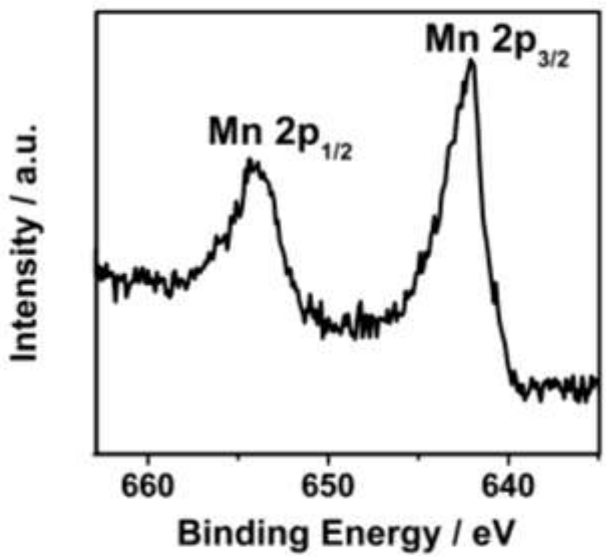


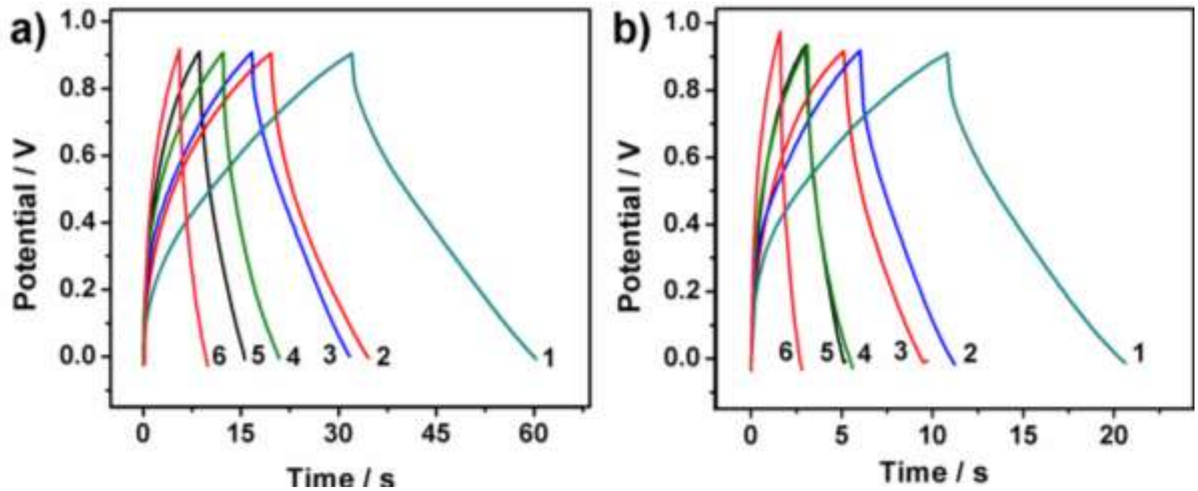
Fig. S1a shows the image of MnO_2/Pani coaxial NW sample synthesized by using 0.01 M HCl while keeping the other synthesis parameter constant. No Pani coating was seen on the MnO_2 nanowires due to the low concentration of H^+ during the polymerization process. Fig. S1b shows thinner coating of Pani with less protrusion morphology resulted from polymerization process with 0.004 mL aniline monomer. The thickness of Pani coating on MnO_2 nanowires can be conveniently adjusted by varying the aniline monomer concentration. Fig. S1c shows TEM image of the sample at slightly smaller amount of 0.1 M of HCl (10 mL, instead of 15 mL) which shows the presence of MnO_2 NW in the sample. The corresponding TEM image Fig. S1d shows very little amount of Pani attached on the MnO_2 NW when the double the amount of MnO_2 is added during Pani polymerization.

Fig. S2. Mn 2p XPS core level spectra of Pani/MnO_2 coaxial NW



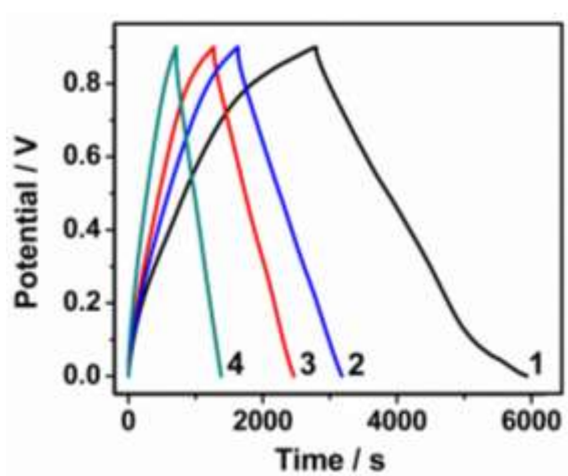
The presence of MnO_2 in MnO_2/Pani coaxial NW is confirmed by XPS characterization. The peaks of Mn $2p_{3/2}$ and Mn $2p_{1/2}$, which are centered at 642 and 653.9 eV, respectively, are in good agreement with reported data of Mn $2p_{3/2}$ and Mn $2p_{1/2}$ in MnO_2 NW (Fig. 3a in the main text).

Fig. S3. (a) Charge and discharge curve of MnO_2/Pani coaxial NW at 10 A g^{-1}(1) and 15 A g^{-1}(3); MnO_2 NW at 10 A g^{-1}(2) and 15 A g^{-1}(5); Pani at 10 A g^{-1}(4) and 15 A g^{-1}(6). (b) Charge and discharge curve of MnO_2/Pani coaxial NW at 20 A g^{-1}(1) and 30 A g^{-1}(2); MnO_2 NW at 20 A g^{-1}(3) and 30 A g^{-1}(5) Pani at 20 A g^{-1}(4) and 30 A g^{-1}(6).



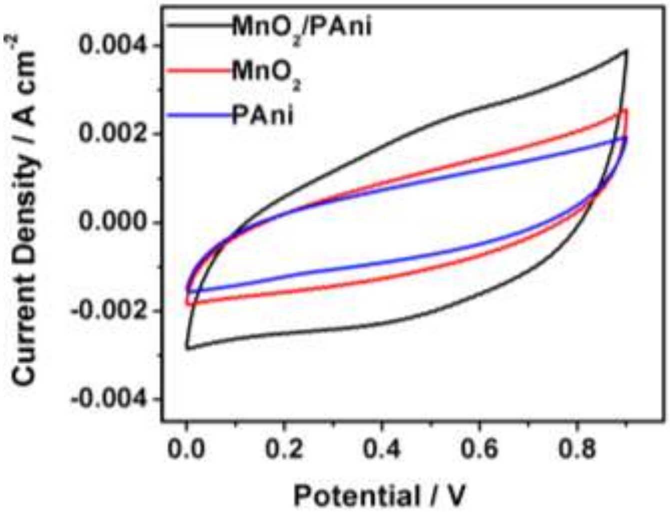
The charge/discharge time of MnO_2 NW samples improve significantly after coating a layer of Pani especially at high applied current. This concludes that the specific capacitance of the MnO_2/Pani is increased based on the calculation method in S14.

Fig. S4. Charge and discharge curve of MnO_2/Pani coaxial NW at 0.25 A g^{-1} (1); 0.5 A g^{-1} (2); 1 A g^{-1} (3); and 2 A g^{-1} (4)



The charge discharge curve of MnO2/Pani coaxial NW at lower applied current: 0.25, 0.5, 1 and 2 A g^{-1} are shown in Fig. S4. The resultant C_{sp} are much higher than references listed in Table S1 (Page 4): 873, 663, 574 and 498 F g^{-1}.

Fig. S5. Cyclic voltammograms of MnO_2 NW, MnO_2/Pani coaxial NW and Pani at 50 mV s^{-1}.



From this figure we can see that MnO_2/Pani coaxial NW shows better capacitive performance at every scan rate, especially at high scan rate (50 mV s^{-1}). The cyclic voltammogram of MnO_2/Pani is able to maintain the rectangular shape at high scan rate, which suggest the capacitive property is well maintained as compared to other two samples.

Table S1. Literature data on Pani/MnO_2 based electrodes for supercapacitor application

Material	Synthesis Method	Structure	C_{sp} (Fg^{-1})	Cycling Performance (% degradation, no of cycle)	Reference
MnO/Poly(aniline-co-o-anisidine)	Chemical/Solution method	Nanostructure	262	10 %. 1000 cycles	[1]
Pani/MnO_2/CNT	Chemical/Solution method	Ternary coaxial structure	330	23 %, 1000 cycles	[2]
Pani/MnO	Chemical/Solution	Pani intercalated	330	6 %, 1000 cycles	[3]

	method	MnO			
Pani-PEDOT-PSS/MnO_2	Chemical and Electrodeposition	Nanostructure	372	32 %, 500 cycles	4
Pani/MnO_2/CNT	Chemical/Solution method	Ternary Coaxial structure	384	20 %, 1000 cycles	5
Pani/MnO_2/AC	Coelectrodeposition	Fibers	408	18 %, 1500 cycles	6
Pani/MnO	Coelectrodeposition	Nanoparticle	415	15 %, 1000 cycles	7
Pani/MnO	Chemical/Solution method	Film on porous carbon	500	40 %, 5000 cycles	8
Pani/MnO_2	Chemical/Solution method	MnO_2 nanoparticles on Pani support	510	-	9
Pani/MnO_2	Coelectrodeposition	Fibrous structure	532	24 %, 1200 cycles	10
Pani/MnO_2	Coelectrodepositin	Fibers	588	10 %, 1200 cycles	11
Pani/MnO_2	2 steps electrodeposition	Cornlike nanostructure	715	3.5 %, 5000 cycles	12
Pani/MnO	Chemical/Solution method	Nanotube	626	33 %, 1000 cycles	13
Current work Pani/MnO_2	Chemical/Solution	Coaxial nanowires electrostatically bonded	498 at 2 Ag^{-1}, 873 at 0.25 Ag^{-1}	5 %, 5000 cycles	

S6. Calculations

For supercapacitor application, the specific capacitance of active materials can be calculated from charge discharge and cyclic voltammetry test. The discharge specific capacitance is calculated according to this calculation:

$C_{sp} = (I \times \Delta t)/(m \times \Delta V)$.

I is the applied current, Δt is the discharge time, m is the active mass of the electrode, and ΔV is the voltage window of the test

The specific capacitance according the cyclic voltammogram is calculated according to the following equation:

$C_{sp} = Q/(m \times \Delta V)$

Q is the charge which is calculated from the area under the discharge curve over the scan rate.

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