Electronic Supplementary Material (ESI) for RSC Applied Polymers.

Supporting Information

Fabrication of PANI/MWCNT supercapacitors based on chitosan binder and aqueous electrolyte for enhanced energy storage

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Table S1. Areal specific capacitance results of different composites at various scan rate.

Sample	Scan rate (mV s^{-1})	Areal specific capacitance (mF cm^{-1})
PANI/MWCNT 5-1	5	416
PANI/MWCNT 5-1	20	262.8
PANI/MWCNT 5-1	50	136
PANI/MWCNT 5-1	100	66.6
PANI/MWCNT 10-1	5	160.4
PANI/MWCNT 10-1	20	83.3
PANI/MWCNT 10-1	50	65.6
PANI/MWCNT 10-1	100	35
PANI/MWCNT 30-1	5	64.5
PANI/MWCNT 30-1	20	33
PANI/MWCNT 30-1	50	14
PANI/MWCNT 30-1	100	12.4

Table S1 shows a summary of the areal specific capacitance values for PANI/MWCNT (5:1), PANI/MWCNT (10:1), and PANI/MWCNT (30:1) electrodes at various scan rates, namely 5 mV $^{-1}$, 20 mV $^{-1}$, 50 mV $^{-1}$, and 100 mV $^{-1}$. The values are calculated by using the cyclic voltammograms of electrodes from three electrode measurements (values were calculated from Figure 9 in the main text). The highest areal capacitance value belongs to PANI/MWCNT (5:1) composite at all scan rates. This might be explained by the higher surface area of PANI/MWCNT (5:1) and higher electrical powder conductivity. Likewise, the mass dependent capacitance values, the PANI/MWCNT (30:1) electrode has the lowest areal specific capacitance. This could be due to the lower surface area and electrical conductivity of PANI/MWCNT (30:1). However, it is not feasible to compare mass capacitance and areal capacitance directly due to the fact that their units are different.

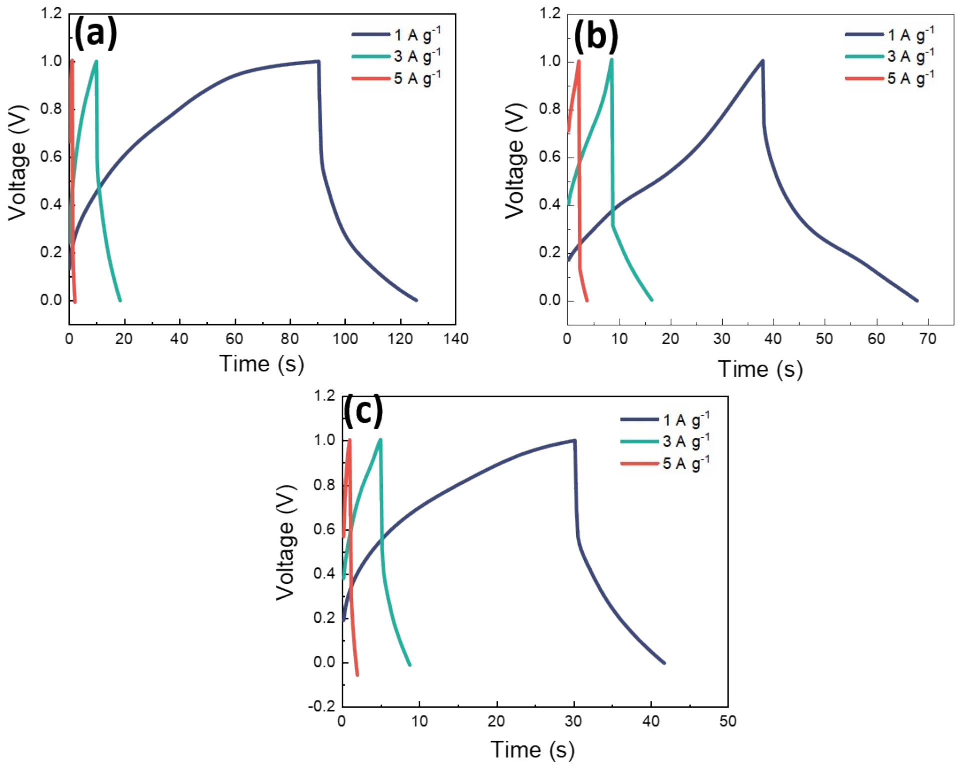

Figure S1. GCD curves of (a) PANI/MWCNT (5:1), (b) PANI/MWCNT (10:1), PANI/MWCNT (30:1) at different current densities.

Figure S1 shows GCD curves of PANI/MWCNT (5:1), (b) PANI/MWCNT (10:1), PANI/MWCNT (30:1) at a current density of 1 A g^{-1}, 3 A g^{-1} and 5 A g^{-1}, respectively. The specific capacitance values mentioned in the text were derived via the analysis of discharge curves by using slope of the curves.

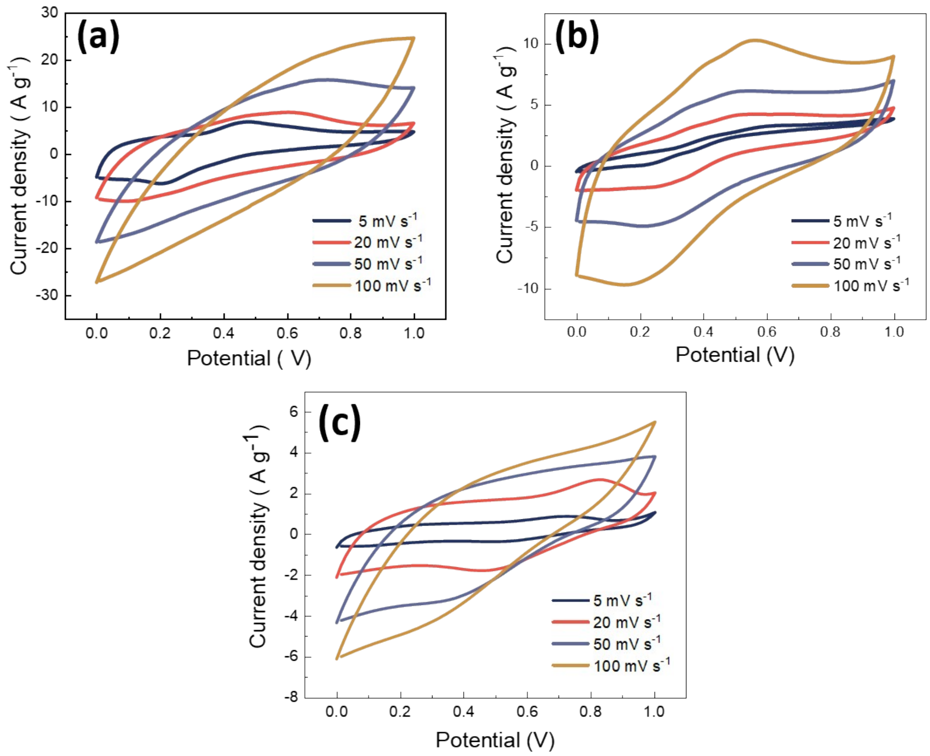

Figure S2. Cyclic voltammograms of PANI /MWCNT symmetrical supercapacitor at different scan rates a) PANI/MWCNT (5:1), b) PANI/MWCNT (10:1) and c) PANI/MWCNT (30:1), respectively.

Figure S2 displays the cyclic voltammograms of a symmetrical supercapacitor composed of PANI/MWCNT (5:1), PANI/MWCNT (10:1), and PANI/MWCNT (30:1) at various scan rates. The measurement was conducted using two electrode measurement setups, similar to those employed in GCD measurements. Similarly, to the observations reported from three-electrode measurements, symmetrical supercapacitors also exhibit faradic redox peaks at varying scan rates. In order to enhance the accuracy of specific capacitance calculation for symmetrical supercapacitors, GCD curves were employed.

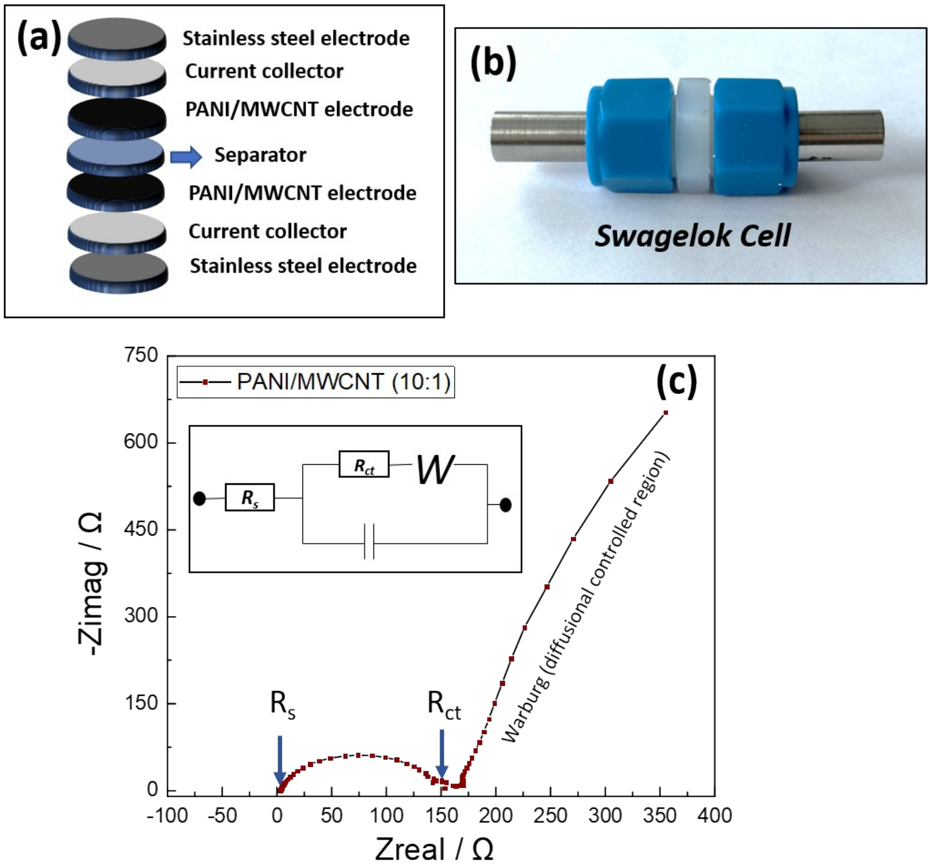

Figure S3. Schematic design and (a) picture of a 10 mm diameter Swagelok-type electrochemical cell (b) EIS curve of PANI/MWCNT (10:1) electrode with inset showing Randles equivalent circuit model (c).

Electrochemical impedance spectroscopy (EIS) is also used to characterize the composite electrode by using Gamry's Interface 1010T Potentiostat. Symmetrical two electrode configuration was prepared by using a Teflon Swagelok cell with two stainless steel (SS) disks (**Figure 3a**). PANI/MWCNT electrodes was coated on the circular current collectors. The coated current collectors were fitted into SS circular disks and separated by using separator and 0.5 M Na_2SO_4 electrolyte. The picture of a 10 mm diameter Swagelok-type electrochemical cell is shown in **Figure 3b.**

Figure 3c shows the Nyquist plots of the PANI/MWCNT (10:1) composite films measured in the frequency range from 0.001 Hz to 100 kHz at open circuit potential by using Na_2SO_4 electrolyte. The symmetrical PANI/MWCNT supercapacitor consists of a semi-circle and a straight line in the Nyquist plot, which may match the Randles circuit model[1-3], which is shown in the inset of **Figure 3c**. R_s (~2.9 Ω) in the higher frequency represent electrolyte resistance. The diameter of the semicircle in the Nyquist plots correspond to the charge transfer resistances or sum of the electrolyte solution and electrode resistance which is R_{ct} (~149 Ohm). Furthermore, the straight line in the lower frequency region represents the Warburg resistance that results from a diffusion process occurring at the interface between the electrode and electrolyte.[4] Similar behaviour has been observed for other PANI electrodes in the literature.[2,5]

References

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