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Supporting Information

Polyaniline/Carbon Nanotube Nanocomposite Electrode with Biomimetic Hierarchical Structure for Supercapacitor

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The MWNT is excellent homogeneous phase dispersed in the polymer matrix and it's a coherent argument of MWNT loading content shown as follow figure, this kind of special nanostructure supposed the benefit not only enlarges the liquid–solid interfacial area and gives more opportunity for ions insertion-extraction but also improve the mechanical strength and resistant consequent breakage of the films.

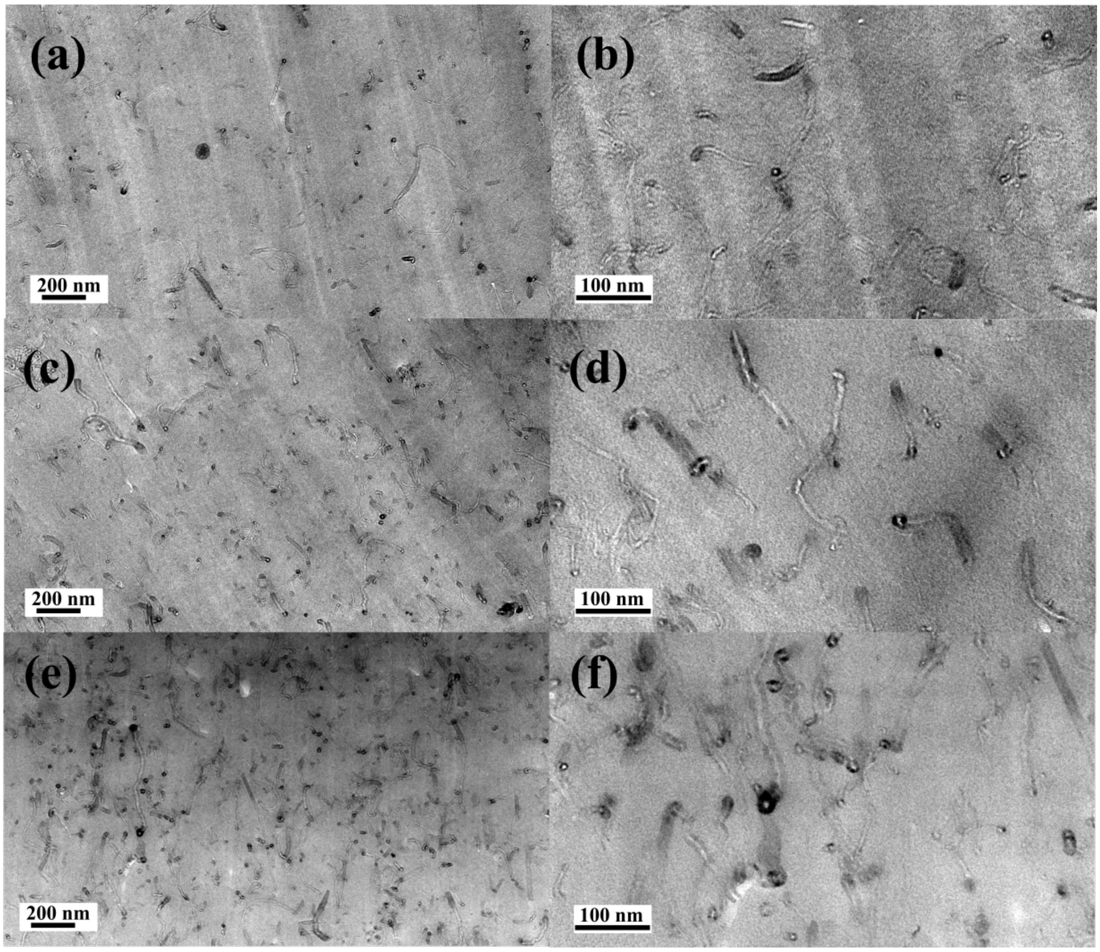

Figure S-1 The TEM images of MWNT dispersed in PANI polymer matrix with different loading weight (a) (b) 1wt%, (c)(d) 3wt% and (e)(f) 5wt%

It's obviously indicated that the CV curve areas of the PANI-3D electrode is larger than the sample of PANI-plane one, comparison of the PANI-3D-MWNT electrode, it exhibits the most largest CV curve area. To calculate electrochemical capacitance on the basis of CV curves area, specific capacitance Cs values are calculated from the CV curves by using equation (1)

$$C_s\,(F/g) = \frac{(2 \int I\,dV)}{(\Delta V \times m \times S)} \qquad (1)$$

Where Cs (F/g) is the specific capacitance, $\int IdV$ is the integrated area of the CV curve, m is the mass of the active materials of one electrode (g), $\triangle$V is the voltage window, and S is the scan rate (mV/s). After the pretreatment with 1M H_2SO_4 aqueous solution, the average capacitance for electrode PANI-plane, PANI-3D and PANI-3D-MWNT is 235 F/g, 410 F/g and 560 F/g, respectively. The specific capacitance of the PANI-3D and PANI-3D-MWNT electrode larger than PANI-plane electrode is improved by 174% and 238% recorded at a scan rate of 5 mV/s, respectively. The relationship of specific capacitance and scan rate is shown in Figure S-1. As the scan rate increased, the specific capacitance of the resulting composites with various PANI electrodes proportional decreased. The CV curve areas of the PANI-3D film is almost one order of magnitude higher than that of PANI-plane film even in high scan rate condition. The capacitive performance of the multiscale structure mainly influence the morphology of electrode. The surface of roughness increases the electrode/electrolyte contact area is increase and shortens the path lengths for electronic or electrolyte ion transport. Both characteristics might enhance the electrochemical activity of polymer layer. For the nanocomposites with multiscale structures, whereas MWCNT dispersed in the composites reduced the resistance of the electrode. Therefore, the tendency for the specific capacitance of PANI nanocomposite to decrease with the increasing of the scan rate was observed resulting the nanocomposite have higher capacitance than pure PANI electrode even in high scan rate.

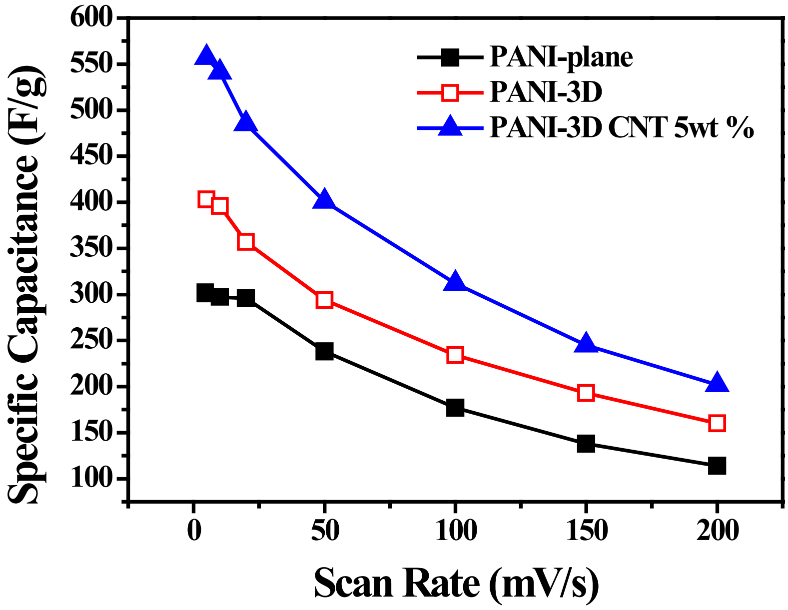

Figure S-2. Cyclic voltammograms (CV) of PANI nanocomposite electrode recorded using different preparation methods at various scan rate between 5 to 200 mV/s in 1.0 mol/L H_2SO_4 electrolyte.