

High Performance Electrochemical Supercapacitors Based on Polyaniline/Carbon Nanotubes Grown Directly on Carbon Cloth

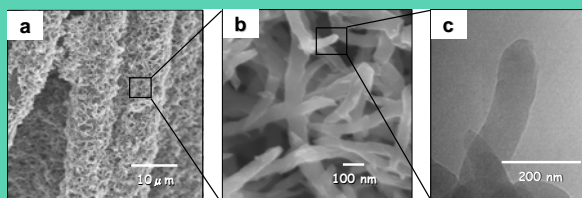
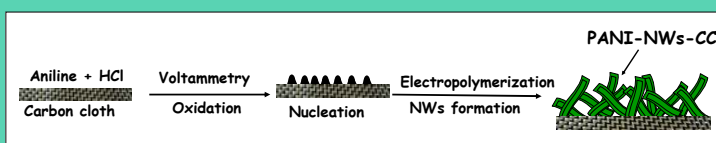
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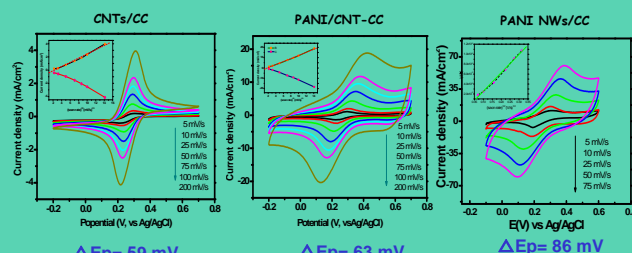
Characterization of supercapacitors of polyaniline /carbon nanotubes grown directly on carbon cloth (PANI/CNT-CC) and polyaniline nanowires grown on carbon cloth (PANI-NWs/CC) nanocomposite electrodes were investigated in this study. Multi-wall carbon nanotubes (CNTs) directly grown on carbon cloth were coated with protonated polyaniline (PANI) in situ during the polymerization of aniline. PANI-NWs/CC was prepared by cyclic voltametric method followed by constant current deposition. The surface morphology of these electrodes was measured by scanning electron microscopy. The structure of the PANI/CNT-CC composites, illustrating a coaxial and uniform coating of CNT with PANI, was identified by scanning electron microscope. The diameter of PANI/CNT-CC composites is much larger than that of CNT/CC, about 20 nm for CNT and 60-80 nm for PANI/CNT composites were observed, respectively.

The capacitance properties of PANI/CNT-CC were carried out by cyclic voltammetry, galvanostatic charge and discharge method. It is revealed that the specific capacitance of 860 F/g for PANI/CNT-CC is obtained at charge-discharge current density of 5mA/cm². Even at a relatively high scan rate of 400 mV/s, the observed specific capacitance of PANI/CNT-CC up to 500 F/g can be achieved. The specific power and specific energy of PANI/MWNT-CC electrode measured at discharge current 5 mA/cm² is equal to 7.5 kW /kg and 120 Wh/kg, respectively. As can be seen from the results, the charge/discharge rate and power density of PANI/CNT-CC is threefold higher than PANI NWS /CC. It can be ascertained that the presence of carbon nanotubes improves the charge transfer rate that enables a higher charge/discharge rate and power density. Due to the flexible properties of both carbon cloth and polyaniline, the PANINWs/CC and PANI-CNT/CC nanocomposite electrodes can be potentially used in flexible power devices for versatile application from cameras to cars, e-papers, smart cards and plastic electronic devices in the near future.

Schematic Diagram of the Preparation of PANI-NWs/CC Electrode



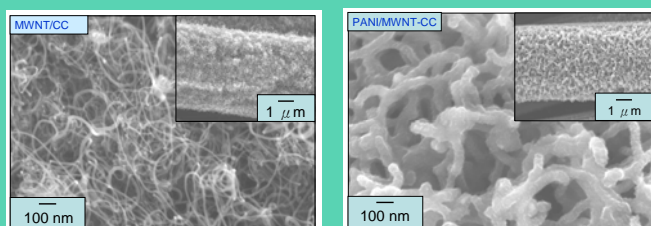
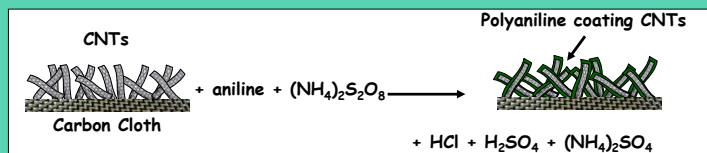
Effect of CNTs addition



Electrochemical Nerstian Behavior scan rates=10 mV/s
5mM K₃[Fe(CN)₆]/ 1M KCl as a probe

- ΔEp : CNT/CC < PANI/CNT-CC < PANI NWS/CC.
- Electron transfer rate: CNT/CC > PANI/MWNT-CC > PANI-NWS/CC.

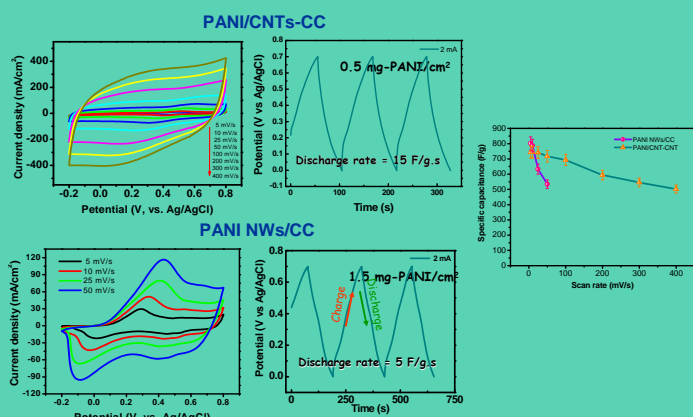
Schematic Diagram of the Preparation of PANI-CNT/CC Electrode



Performance

	PANI-NWs/CC	PANI/CNTs-CC
Scan rate	5-50 mV/s	5-400 mV/s
Specific Capacitance (5 mV/s)	801 F/g	744 F/g
Specific Capacitance (400 mV/s)	-	500 F/g 😊
Discharge rate (discharge current= 5 mA/cm ²)	5 F/g.s	15 F/g.s 😊
Specific Capacitance	1050 F/g	865 F/g
Specific Energy	145.0 W-hr/kg	117.2 W-hr/kg
Specific Power	2.4 kW/kg	7.5 kW/kg 😊
Cost	😊	
Preparation	😊	

Cyclic Voltammograms & Charge/Discharge Analyses



Conclusions

- The PANI/CNT-CC nanocomposite electrode can be synthesized successfully and provide a high-performance supercapacitor.
- The specific power and specific energy of PANI/CNT-CC electrode measured at discharge current 5 mA/cm² is equal to 7.5 kW /kg and 120 Wh/kg, respectively.
- The power density of PANI/CNT-CC is threefold higher than PANI NWS /CC because CNTs enhance faster electron transfer for charge storage and delivery.
- Due to the flexible properties of both carbon cloth and polyaniline, the PANINWs/CC and PANI-CNT/CC nanocomposite electrodes can be potentially used in flexible power devices for versatile application from cameras to cars, e-papers, smart cards and plastic electronic devices in the near future.