Supporting Information:

N-doped yolk-shell carbon nanotube composite for enhanced electrochemical performance in supercapacitor

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Experimental Section

Synthesis of MC/CNT samples

The CNT is a commercial product.

The process of MC: Resorcinol (0.4) was added quickly into the solution EtOH (220 ml) and H_2O (110 ml), and 30 ml [C_{16}Mim]Br solution (110 mM, dissolved in a 2:1 mixture of H_2O and EtOH) was quickly added under vigorous stirring and then add the resorcinol stirring for 30 min. 2.15 ml TEOS was added to the reaction mixture and subsequently stirred at ambient temperature overnight. The as-synthesized suspension was centrifuged and dried at 70 ^{o}C overnight. For carbonization, the obtained product was heated at 800 ^{o}C for 3 h with a heating rate of 3 ^{o}C min^{-1} under N_2 atmosphere. Finally, the MC was obtained, after removing the silica with 10 wt% HF solution for 24 h.

The process of preparation of MC/CNT-0.1, MC/CNT-0.2 and MC/CNT-0.4 was similar with the MC with adding of CNT with the resorcinol of 1:0.1, 1:0.2 and 1:0.4 respectively before adding [C_{16}Mim]Br solution.

Characterizations

The morphology and structure of samples were investigated by transmission electron microscopy (TEM, JEOL JEM-2100). Nitrogen adsorption-desorption isotherms were carried out on a Micromeritics TriStar 3020 instrument at -196 °C. The Brunauer-Emmett-Teller (BET) method was employed to calculate the specific surface area, while the Barrett-Joyner-Halenda (BJH) method was applied to analyze the pore size distribution using the desorption branch of isotherm. The total pore volume was obtained from the amount of N_2 adsorbed at the relative pressure ($P/P_0 = 0.97$).

Electrochemical Measurements

The working electrode was prepared by coating the viscous slurry (samples, carbon black and polytetrafluoroethylene with the mass ratio of 8:1:1 in ethanol) onto Ni foam current collector. The mass of active material loaded on each working electrode was 4~5 mg after drying at 100 °C for 24 h. Electrochemical measurements were carried out in both three-electrode and two-electrode system using an electrochemical workstation (CHI 760E, Chenhua Instruments, China) with 6 M KOH solution as the electrolyte. For three-electrode system, a Pt wire and Hg/HgO was used as the counter and reference electrodes. For the fabrication of supercapacitor devices, two slices of electrode were immersed in 6 M KOH and were separated by a filtration paper, then tested by the current collector. Electrochemical performances were evaluated by cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and electrical impedance spectroscopy (EIS) analysis. For the two-electrode system, the specific capacitances (C, F g^{-1}), energy density (E, Wh kg^{-1}) and power density (P, W kg^{-1}) were calculated by the following equations: $C=4I\Delta t/\Delta Vm$, $E=0.5C(\Delta V)^2/4$ and $P=E/\Delta t$, where I (A), Δt (s), ΔV (V) and m (g) are GCD current, discharge time, voltage window, and mass of active material, respectively. In three-electrode system, the specific gravimetric capacitance according to the GCD measurements: $C=I\Delta t/\Delta Vm$.

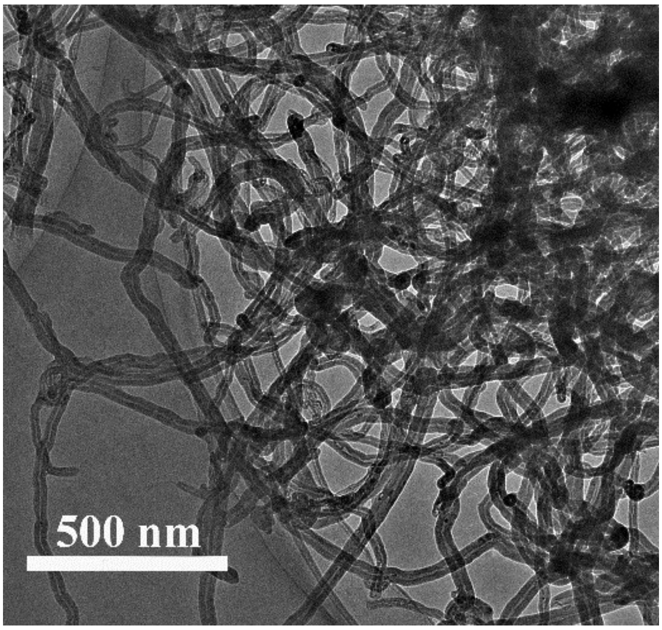

Fig. S1. TEM images of CNT.

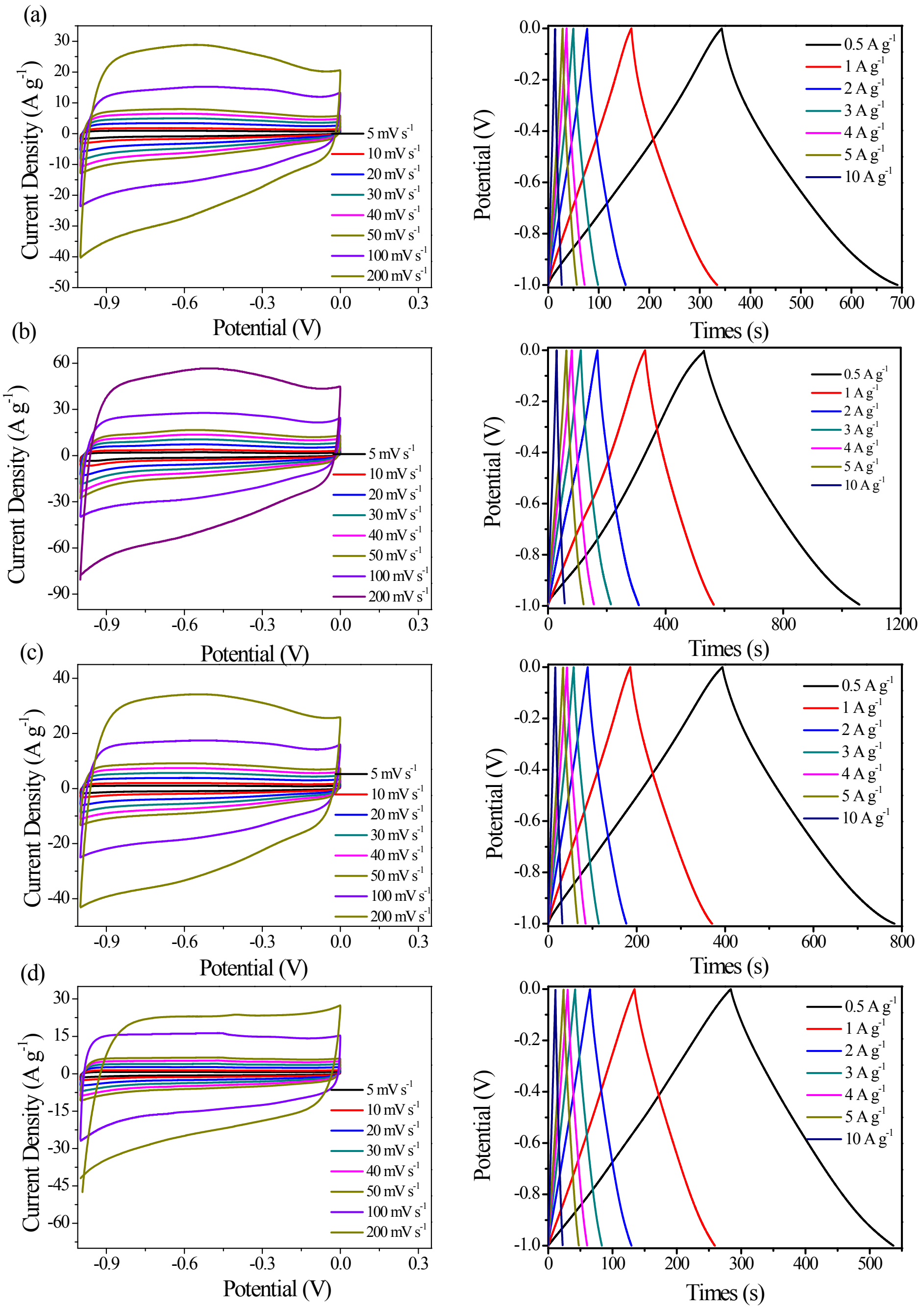

Fig. S2. CV curves at different scan rates and GCD curves at different current densities (b) of MC (a), MC/CNT-0.1 (b), MC/CNT-0.4 (c) and CNT (d) in three-electrode system with 6M KOH electrolyte.

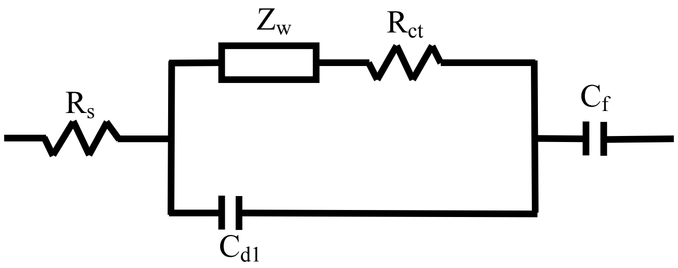

Fig. S3. The fitted equivalent circuits of the EIS.

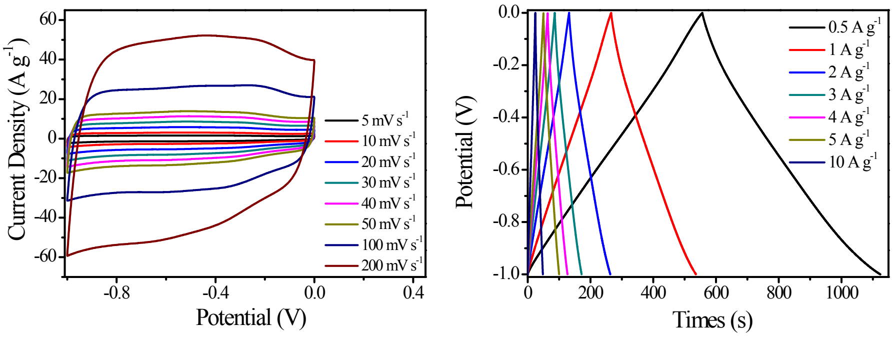

Fig. S4. CV curves at different scan rates (a), GCD curves at different current densities (b) of MC/CNT-0.2 in three-electrode system with 6M KOH electrolyte.

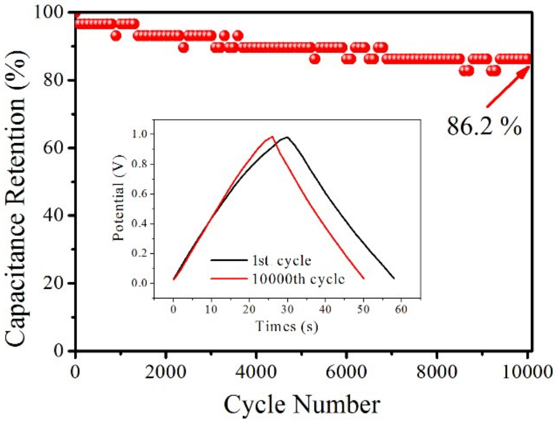

Fig. S5. Cycle ability of MC/CNT-0.2 at current density of 2 A g^{-1} and the GCD curves of 1th and 10000th cycle (inset) in two-electrode system.