Electronic Supplementary Material (ESI) for ChemComm.
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Facile fabrication of freestanding three-dimensional composites for supercapacitors

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Electronic Supplementary Information

Experimental Section

Acid treated-MCNTs were prepared by mixing with sulfuric (98 wt %) and nitric (68 wt %) acids in a ratio of 3:1 by volume and treated in an ultrasonic bath at 50 °C for 4 h. Carbon nanofibers were prepared by electrospinning of PAN followed by carbonization process. Homogeneous solutions of DMF with PAN (5 wt%) containing acid treated-MCNTs (0.5 wt%), zinc acetate (3 wt%) and PTA (4 wt%) were prepared with magnetic stirring at 60 °C. The feeding rate of precursor while electrospinning was 1.0 mL/h, the applied positive voltage was 14 kV and the distance between the needle tip and the collector was 15 cm. Then as-electrospun dense fabrics were stabilized in a controlled atmosphere furnace by heating at 280 °C for 2 h (heating rate was 1 °C/min) and then carbonized at 800 °C at a heating rate of 2 °C/min for 2 h under N_2 atmosphere. The as-prepared carbon nanofibers (designated as ZTP-CNFs) were immersed into an aqueous solution of hexamethylenetetramine ($C_6H_{12}N_4$, 12 mM) and zinc nitrate ($Zn(NO_3)_2 \cdot 6H_2O$, 12 mM) followed by ultrasonication for 30 min, and then the ZnO nanorods with different morphologies were grown at 95°C for 3 or 5 hours. The final nanocomposite electrodes were denoted as ZTP-CNFs/ZnO-1 and ZTP-CNFs/ZnO-2 as the ZnO nanorods were grown on ZTP-CNFs at 95°C for 3 and 5 h, respectively. The sample without any zinc acetate loading (denoted as TP-CNFs) was also prepared as a control sample, and the ZnO nanorods grown on TP-CNFs at 95°C for 5 h were denoted as TP-CNFs/ZnO for comparison.

All samples used as the working electrodes were cut into pieces of web (the total area≈1.0×2.0 cm^2, the total weight≈10.0 mg) and used directly for the electrode without adding a polymer binder. Electrochemical evaluations of the nanocomposite electrodes were carried out on electrochemical workstation (CHI 760D, Shanghai Chen Hua instrument co., LTD, China) using a three electrode testing system with a Pt plate as counter-electrode and saturated calomel electrode (SCE) as reference electrode in 1.0 M Na_2SO_4 aqueous electrolyte solution.

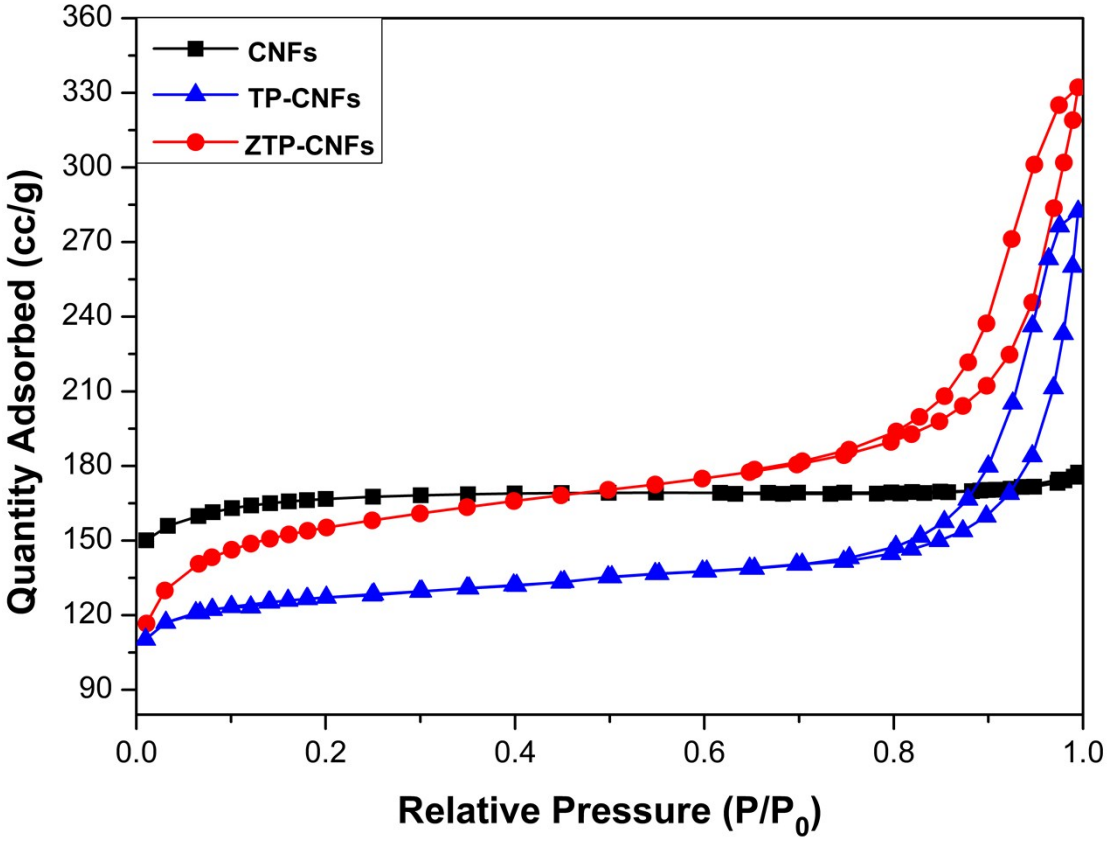

Fig. S1. Nitrogen adsorption-desorption isotherms of the as-prepared nanofibers.