Electronic Supplementary Information for

Facile synthesis of hierarchical conducting polypyrrole nanostructures via a reactive template of MnO_2 and their application in supercapacitors

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Experimental details

1. Synthesis of MnO_2 nanostructures

α-MnO_2 nanotubes: 0.658 g of $KMnO_4$ was firstly dissolved into 75 ml of deionized water. Then 1.5 ml of concentrated HCl (36%) was added to the above solution under stirring for 15 min to form a homogeneous mixture. Subsequently, the mixture was transferred into a Teflon-lined (PTFE) stainless steel autoclave with a capacity of 100 ml, sealed and maintained in an oven at 150 °C for 10 h. When the autoclave was naturally cooled to room temperature, the resulting brown precipitates were filtered and washed with distilled water until excess reagents were removed. The thus prepared MnO_2 was dried at 80 °C for 12 h in air.

α-MnO_2 nanorods-assembled urchin-shape microspheres: the synthesis conditions are similar to those of α-MnO_2 nanotubes except the use of HNO_3 as the reagent instead of HCl.

δ-MnO_2 nanosheets-assembled flower-like microspheres: the synthesis conditions are similar to those of α-MnO_2 nanotubes except the hydrothermal time. The dwelling time at 150 °C was reduced to 1 h.

2. Synthesis of polypyrrole (PPy) nanostructures

In a typical procedure, 100 mg of MnO_2 powders was dispersed in 20 ml of 0.1 M HCl solution by using ultrasonication. Then 71 μL of pyrrole monomers were added to the above suspension at room temperature under vigorous magnetic stirring. The reaction initiated rapidly as the brownish MnO_2 suspension changed its color to black within minutes. After a stirring of 15 min, the polymerization of PPy proceeded statically for another 1 h. Finally, the resultant black PPy products were filtered and washed with ethanol and deionized water for several times. For comparison, PPy granules were prepared by using $FeCl_3$ as oxidant.

3. Materials characterization

The morphologies of the products were observed on field emission scanning electron microscopy (FESEM, LEO-1530) and transmission electron microscopy (TEM, JEOL 2010). The chemical structure of PPy was characterized by X-ray powder diffraction (XRD, Rigaku D/Max 2500PC, Japan), Fourier transformation infrared (FTIR) spectroscopy (Nicolet 6700) and Energy-disperse X-ray spectroscope (EDX). The electrical conductivity of the compressed PPy nanostructures was measured at room temperature by using SX1934 (SZ-82) digital four-probe instrument. The electrochemical properties of PPy nanostructures were measured using cyclic voltammetry and galvanostatic charge/discharge techniques, which carried out on CHI 660B electrochemical station by employing a three-electrode configuration and 2 M KCl as electrolyte.

Supplementary Images

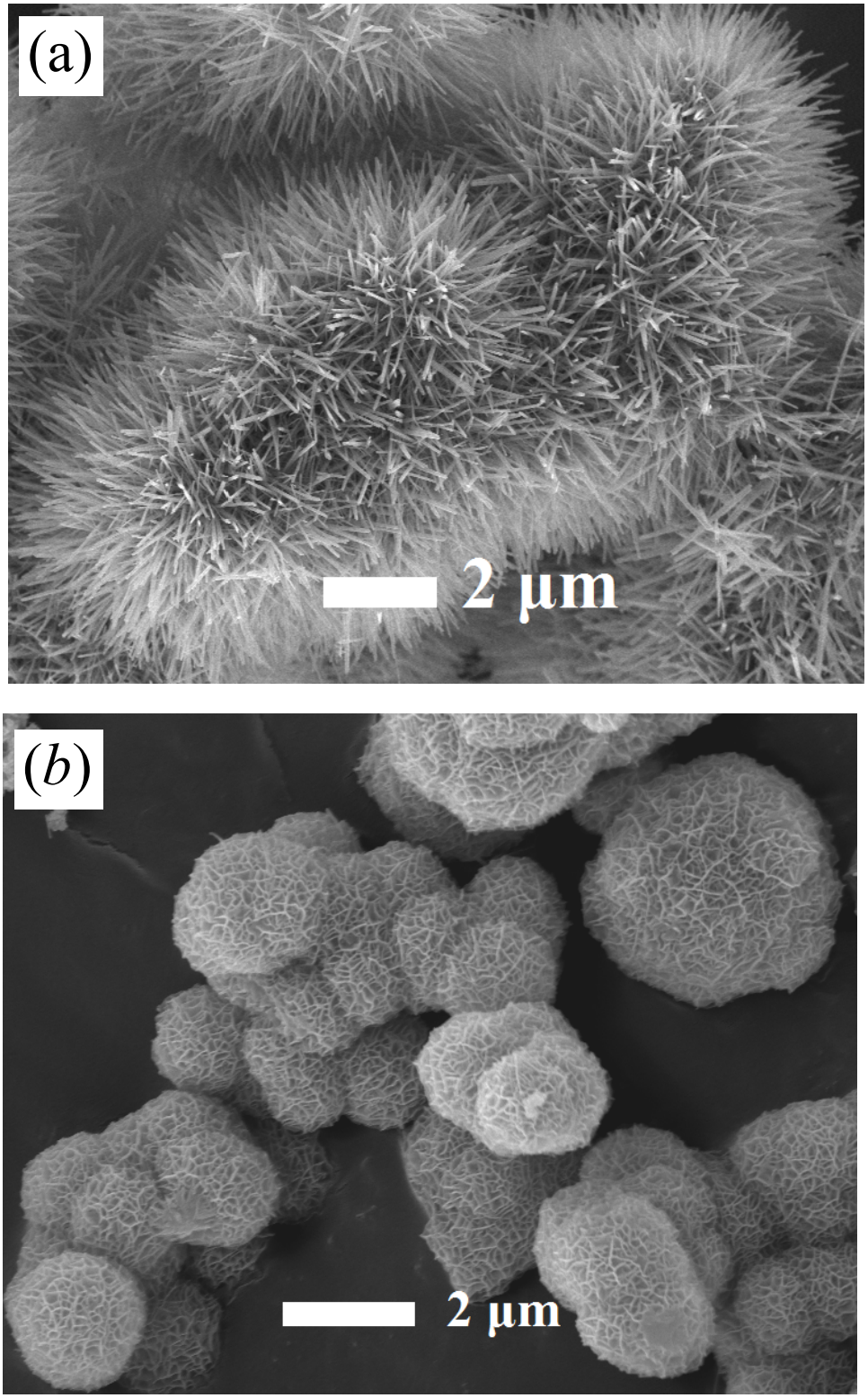

Fig. S1. SEM images of (a) α-MnO_2 nanorods-assembled urchin-shape microspheres and (b) δ-MnO_2 nanosheets-assembled flower-like microspheres.

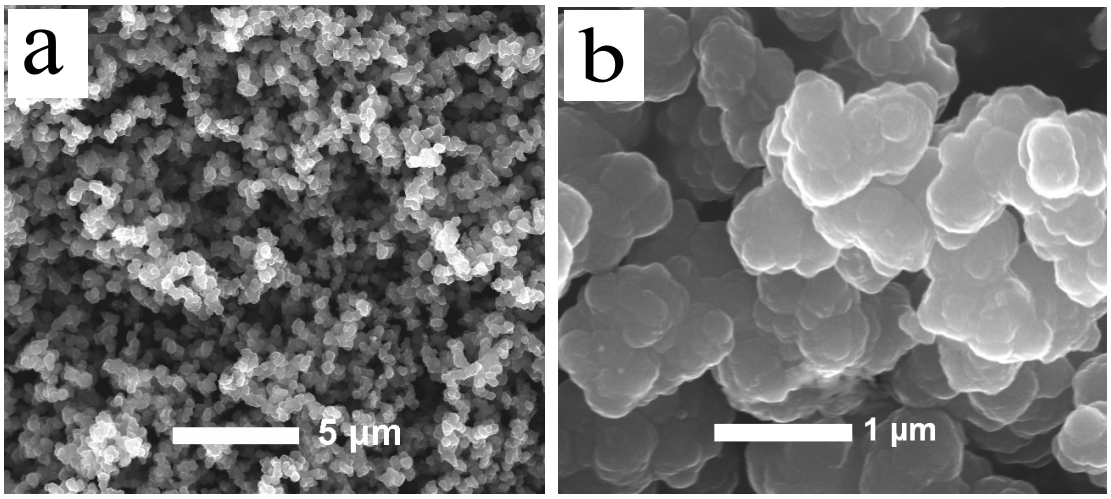

Fig. S2. (a) and (b) SEM images of PPy granules;

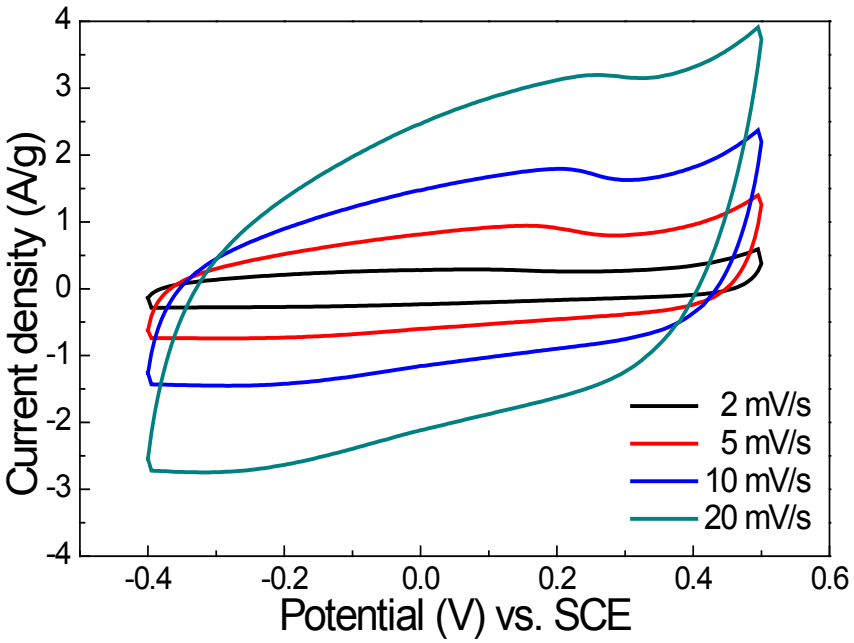

Fig. S3. CV curves of PPy granules.