Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

Nanostructured WSe_2/C composites as anode materials for sodium-ion batteries

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Experiment section

Synthesis of nanostructured WSe_2/C composites

Nanostructured WSe_2/C composites were synthesized by the following solid-state synthetic route. 1.2 g of selenium powder, 1.396 g of tungsten powder and 0.65 g Super P carbon black were thoroughly mixed, and milled together with 40 g of stainless steel balls at 400 rpm for 8 h under Ar atmosphere. And then the mixture were placed into a quartz tube and heated to 600 ^{o}C for 3 h under Ar atmosphere at a heating rate of 3 ^{o}C min^{-1}. After cooled automatically to room temperature, nanostructured WSe_2/C composites were obtained. For comparison, WSe_2 nanoplates were prepared through the same method in the absence of Super P carbon black.

Material characterization

Field emission scanning electron microscopy (SEM, Nova NanoSEM 230) and transmission electron microscopy (TEM, TecnaiG2 20ST) were applied to investigate the morphologies, particle sizes, and elemental compositions of the materials. Powder X-ray diffraction (XRD, Rigaku3014) using Cu Ka radiation was employed to identify the crystalline phase of the materials. Thermogravimetric analysis (TGA, SDTQ600) was conducted in determining the WSe_2 content in the nanostructured WSe_2/C composites.

Cell assembly and electrochemical characterizations

The electrode was prepared by mixing 80 wt% active material, 10 wt% acetylene black, and 10 wt% sodium alginate binder in deionized water solvent. The slurry was spread onto copper foil, and dried at 60 ^{o}C overnight, then the anodes were cut into pellets with a diameter of 1.0 cm and dried for 12 h in a vacuum oven at 60 ^{o}C. The typical mass loading of the active material was 1.0-1.2 mg cm^{-2}. All capacities in this study were calculated based on whole active material. 2025 type coin cells were fabricated in an Ar-filled glove box by assembling the electrode with a piece of sodium metal, separated by a Celgard 2400. The electrolyte used for sodium battery was a solution of 1 M $NaClO_4$ (Aldrich) in a 1:1 volume mixture of ethylene carbonate/dimethyl carbonate (EC/DMC) with 5 wt% fluoroethylene carbonate. Cyclic voltammetry (CV) was conducted using a PARSTAT 2273 electrochemical

measurement system at a scan rate of 0.2 mV s^{-1} in the voltage range of 0.01-3.0 V. Galvanostatic chargeedischarge tests were performed in the potential range of 0.01-3.0 V at 25 ^{o}C by using a LAND CT2001A battery-testing instrument.

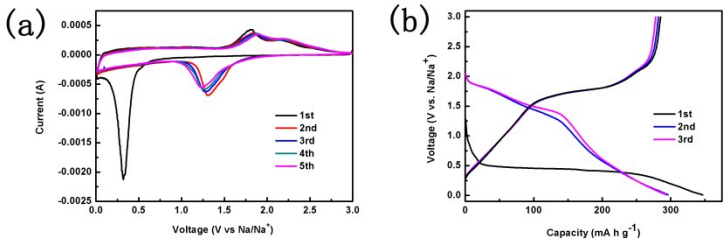

Fig. S1 The CV curves (a) and charge-discharge profiles (b) of WSe_2 nanoplates

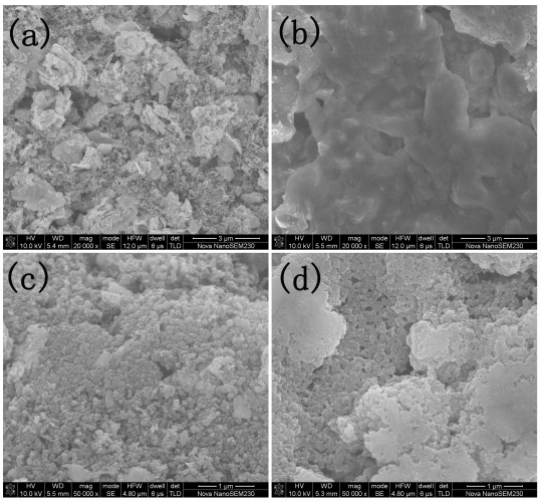

Fig. S2 SEM images of (a-b) WSe_2 nanoplates and (c-d) WSe_2/C nanomaterials before and after cycling.

Table 1 Component content of samples

	Selenium (g)	**Tungsten (g)**	**Super P carbon black (g)**	**Theoretical carbon amount (%)**
Sample 1	1.2	1.396	0.29	10
Sample 2	1.2	1.396	0.65	20
Sample 3	1.2	1.396	1.11	30

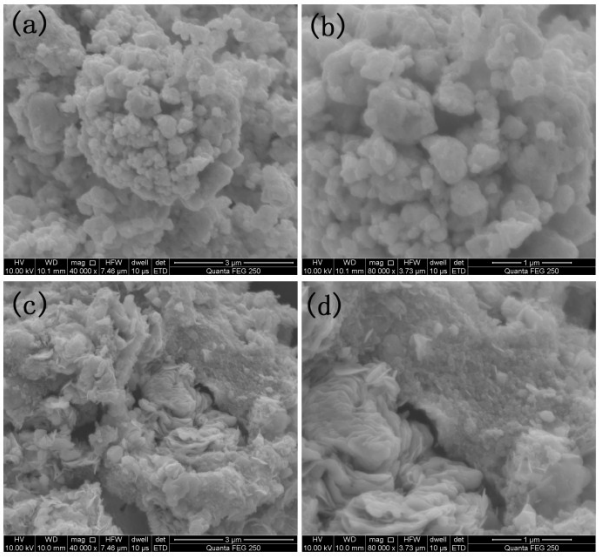

Fig. S3 SEM images of sample 1(a-b) and sample 2(c-d)

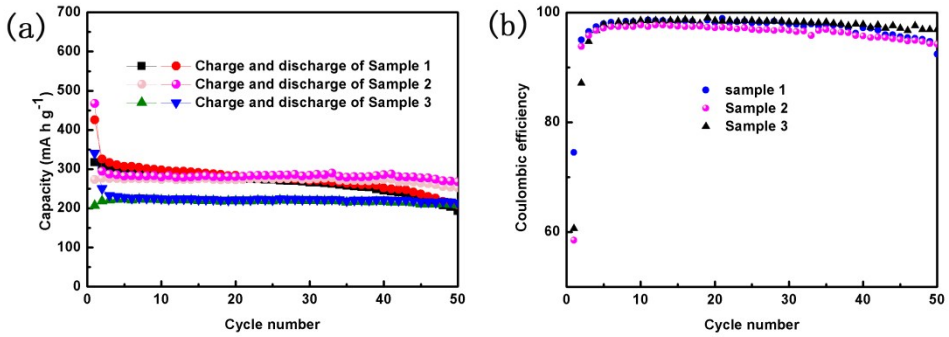

Fig. S4 Cycling performance (a) and Coulombic efficiency (b) of sample 1, sample 2 and sample 3 at current density of 200 mA g^{-1}.