

Supporting Information for

Ptrotein-Inspired Synthesis of SnO₂ Nanocrystals with Controlled Carbon Nanocoating as Anode Materials for Lithium-Ion Battery

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1. Materials and Characterization

Cu foil, electrolyte, 2032 coin cell cases were purchased from Land Electronic., Ltd, Wuhan, China.

The other reagents used in this work were purchased from Aldrich Sigma or Alfa Aesar.

SEM was measured on a Quanta 400 FEG field-emission scanning electron microscope. TEM was measured on a Tecnai G2 F20 S-Twin field-emission transmission electron microscope. XRD was collected on a Bruke D8. FTIR spectroscopy measurement was performed using a Thermo FTIR spectrometer. UV-Vis spectroscopy was measured on a PE lambda 25. TGA measurement was performed using a TG/DTA 6200. Raman spectroscopy was measured on a LabRam HR800.

2. Experimental Section

(1) *Preparation of carbon-coated SnO₂ NCs.* 0.75 g SnCl₄·5H₂O and 1 g BSA were dissolved in 1000 ml Milli-Q water under continuous magnetic stirring. The solution was then refluxed for 5 hours to produce BSA-capped SnO₂ NCs. The as-prepared solution was finally cooled down to room temperature and precipitates was collected through centrifugation at 10000 rpm and dried at 60 °C. To adjust the amount of BSA encapsulated with SnO₂ NCs, a certain amount of ammonia was passed slowly into the as-prepared BSA-capped SnO₂ NCs solution to adjust the pH value of the solution.

Then, the precipitates in the respective solutions were collected and treated with the same procedure described above. For carbonization, the precipitates after dried were calcined at 450 °C for 4 hours under Ar₂ gas.

(2) *Preparation of hollow carbon shell.* Carbon-coated SnO₂ NCs were treated by a sodium hydroxide solution (concentration more than 10 M) at 90 °C for 24 hours in order to dissolve SnO₂ NCs. After this, the sample was collected by centrifugation at 6000 rpm for 10 min.

Electrochemical Measurement: Working electrodes were prepared by casting slurry containing active materials, carbon black and sodium alginate binder in a weight ratio of 80:10:10, respectively, and then coating it onto a Cu foil current collector using doctor-blade method. The electrodes were calendared and degassed in vacuum at 80 °C for at least 12 hours. The mass of active materials was accurately determined using a microbalance (Sartorius, 0.001mg resolution). The final slurry mass loading is ~3 mg in each working electrode. To test its battery performance, 2032 type coin cells were made using the dried working electrode, Celgard 2250 separator, and Li metal foil as a counter electrode. The electrolyte consisted of 1 M LiPF₆ in a 1:1 (volume) mixture of ethylene carbonate (EC), and diethyl carbonate (DEC). The coin cells were assembled inside an Ar₂ filled glove box. Electrochemical measurements were carried out using Land battery analyzers. The working electrodes were cycled between 2 V and 0.01 V vs Li⁺/Li.

3. Raman spectrum of carbon-coated SnO₂ NCs

Raman spectrum of carbon-coated SnO₂ NCs (the sample was obtained at pH value of 1.4). As shown in Fig. S1, the peaks at 1322 cm⁻¹ and 1613 cm⁻¹ correspond to D and G bands of amorphous carbon, respectively.

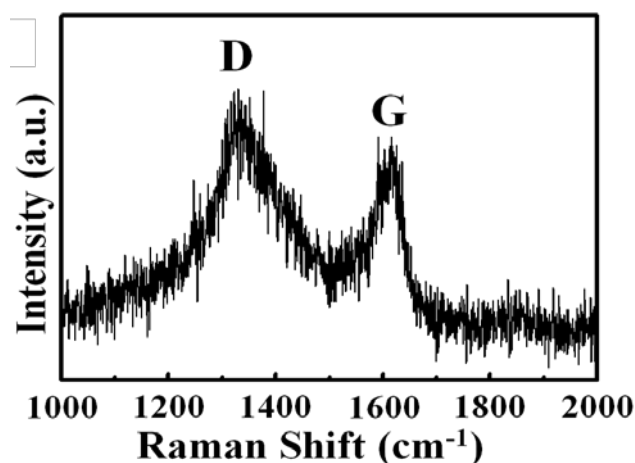


Fig. S1. Raman spectrum of carbon-coated SnO₂ NCs.

4. Charge/discharge curves at current rate of 50 mA/g of carbon-coated SnO₂ NCs with different carbon contents

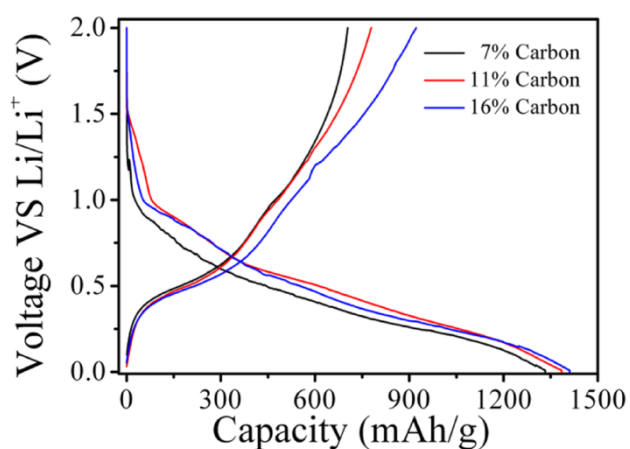


Fig. S2. Charge/discharge curves of carbon-coated SnO₂ NCs at current rate of 50 mA/g.

Fig. S2 shows the charge-discharge voltage profiles of the three carbon-coated SnO₂ NCs samples (carbon content of 7 wt%, 11 wt%, and 16 wt%, respectively) at a constant current density of 50 mA/g. It is clear that the SnO₂ NCs with carbon content of 16 wt% shows the highest charge capacity of 1420 mAh/g and the highest discharge capacity of 921 mAh/g among the three samples and gives an irreversible loss of 35.7 %. With the decrease of carbon content, the charge capacity is fading and the irreversible capacity loss increases correspondingly. When the carbon content is 7 %, the lowest

charge capacity with irreversible loss up to 47.2 % is shown (charge capacity is 1332 mAh/g and discharge capacity is 704 mAh/g).

5. Charge/discharge and Coulombic efficiency curves of carbon-coated SnO₂ NCs

Fig. S3 and S4 show the detail charge/discharge curves and coulombic efficiency curves of carbon-5 coated SnO₂ NCs in different carbon content and at different current rates.

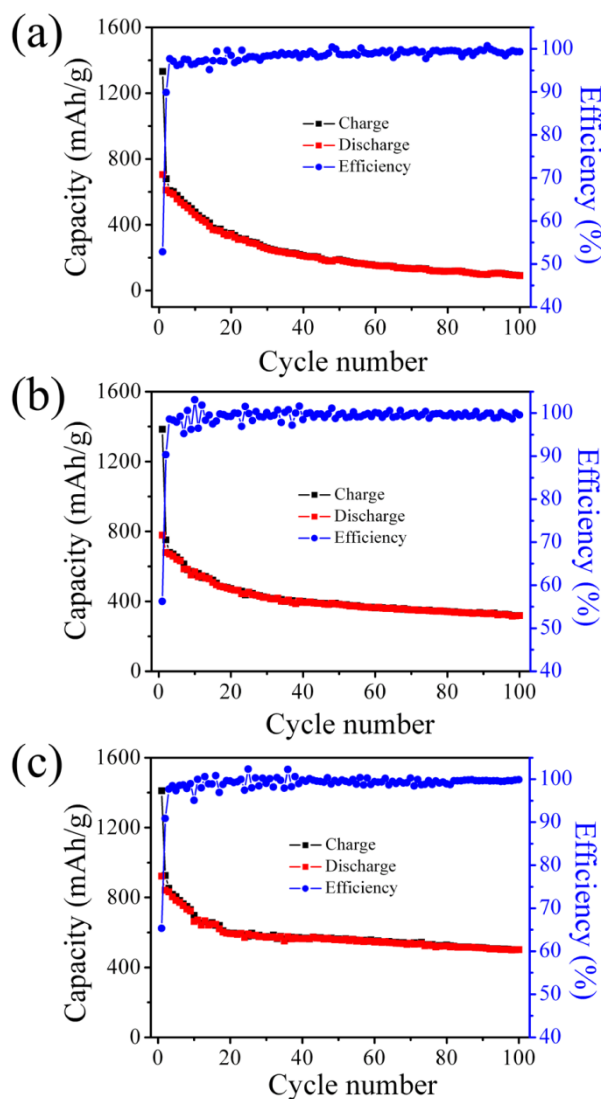


Fig. S3. Charge/discharge curves and Coulombic efficiency curves of carbon coated SnO₂ NCs with different carbon content (a, 7 wt%; b, 11 wt%; and c, 16 wt%) at a current rate of 100 mA/g. (The first charge/discharge was carried out at a current rate of 50 mA/g).

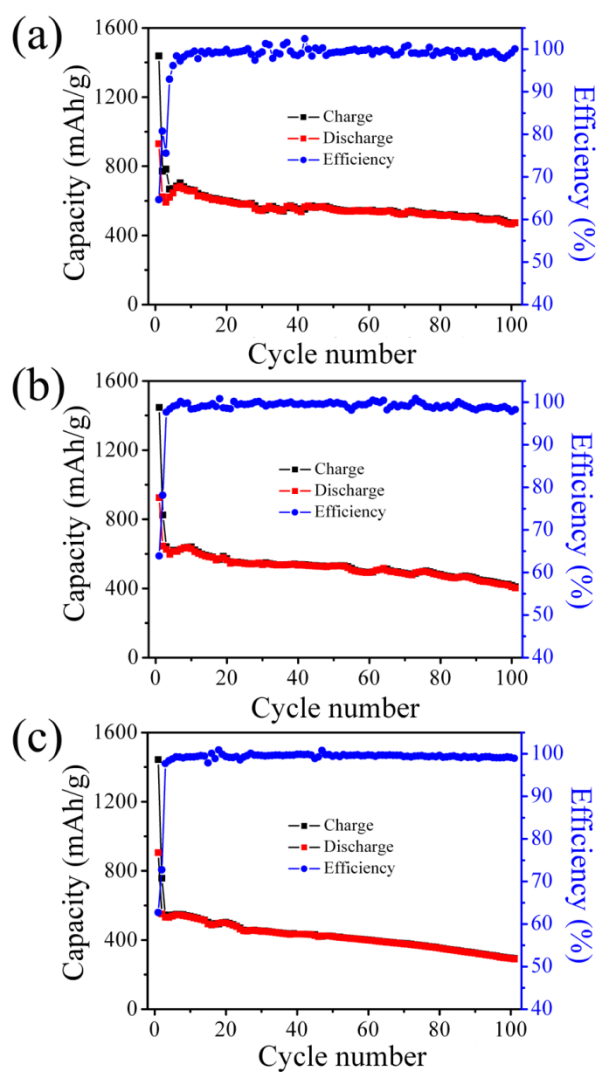


Fig. S4. Charge/discharge curves and Coulombic efficiency curves of 16 wt% carbon-coated SnO_2 NCs at current rate of 250 mA/g (a), 500 mA/g (b), and 1000 mA/g (c). (The first charge/discharge was carried out at a current rate of 50 mA/g).

6. Optical images of carbon-coated SnO₂ NCs in different carbon content

To clearly see the color change of carbon-coated SnO₂ NCs in different carbon content, optical images of the samples were taken as shown in Fig. S5. The as-prepared BSA-capped SnO₂ NCs is light-yellow. With the increase of carbon content, the color of carbon-coated SnO₂ NCs changed from 5 brown to dark black.

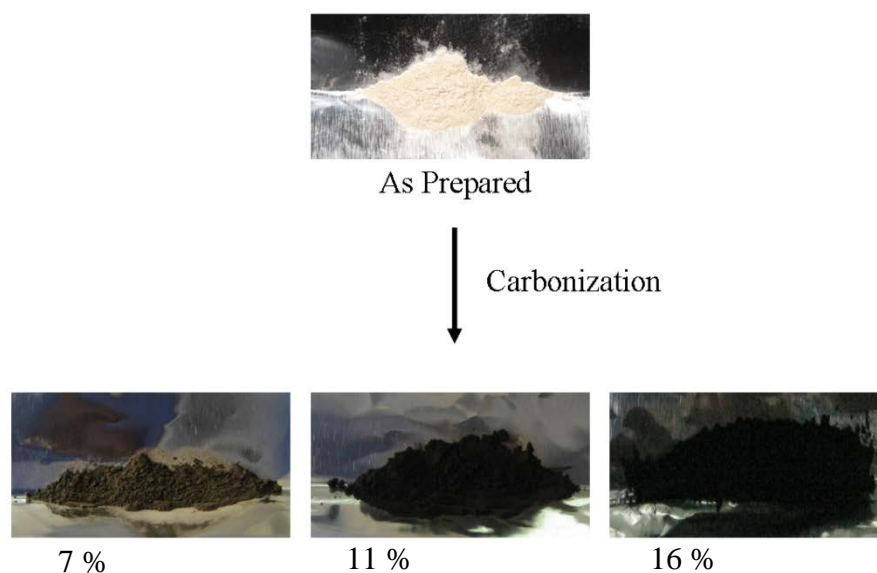


Fig. S5. Optical images of as-prepared BSA-capped SnO₂ NCs and carbon-coated SnO₂ NCs.

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