Electronic Supplementary Material (ESI) for RSC Advances

Electronic Supplementary Information

Carbon nanofibers-templated mesoporous TiO_2 nanotubes as a high-capacity anode material for lithium-ion batteries

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Experimental section

Materials

Polyacrylonitrile (PAN) and N,N-dimethylformamide solution (DMF) were purchased from Aldrich Chemical Co. Tetrabutyl titanate (TBOT), ammonia water and the other chemicals were purchased from Aladdin Ltd. (Shanghai, China) and used as received without further purification. The water used throughout all experiments was purified through a Millipore system.

Synthesis of carbon nanofibers

In a typical synthesis process, PAN was used as a carbon precursor. The PAN was dissolved in DMF (10 wt%) at room temperature and stirred for 12 h. The clear solution was electrospun at 20 kV, and the fibers were collected on a aluminum foil. The resulting fibers were first annealed at 280 °C for 6 h in the air for stabilization, and then calcined at 800 °C for 1 h in N_2 ambient for obtaining the carbon nanofibers.

Synthesis of mesoporous TiO_2 nanotubes

Carbon nanofibers (2.4 mg) were dispersed in absolute ethanol (23 mL) and mixed with ammonia solution (0.053 mL, 28 wt%) under ultrasound for 15 min. Afterward, TBOT (0.16 mL) was added dropwise in 2 min and allowed to proceed at 45 °C under magnetic stirring for 6 h. The resultant product was centrifuged and washed with deionized water and ethanol for 3 times, respectively, followed by drying at 100 °C and calcination at 550 °C for 4 h in air.[1]

Characterizations

Scanning electron microscope (SEM) measurements were made on a XL30 ESEM FEG microscope. Transmission electron microscopy (TEM) measurements were made on a Hitachi H-8100 electron microscope (Hitachi, Tokyo, Japan). Powder X-ray diffraction (XRD) data were recorded on a RigakuD/MAX 2550 diffractometer.

The Brunauer–Emmett–Teller (BET) surface area and pore volume were measured on a Quantachrome NOVA 1000 system at liquid N_2 temperature.

Electrochemical Measurements

The electrodes were prepared by mixing active materials (80 wt%), acetylene black (10 wt%), and polyvinylidene fluoride (PVDF, 10 wt%) in N-methyl-2-pyrrolidone (NMP). The above slurries were then uniformly spread onto a copper foil and dried at 120 ^{o}C in vacuum (active material: 1.2 mg). Coin cells (CR2025) were assembled using lithium metal as the counter electrode, Celgard 2400 membrane as the separator and $LiPF_6$ (1 M) in ethylene carbonate/dimethyl carbonate/ethylmethyl carbonate (EC/DMC/EMC, 1:1:1 vol%) as the electrolyte. The galvanostatic charge-discharge tests were carried out on a Land Battery Measurement System (Land, China). The weight of active materials is based on the weight of the mesoporous TiO_2 nanotubes. Electrochemical impedance spectroscopy (EIS) measurements were also carried out in the frequency range of 100 kHz–0.01 Hz (CHI 660D).

Reference

1. W. Li, J. Yang, Z. Wu, J. Wang, B. Li, S. Feng, Y. Deng, F. Zhang, D. Zhao, *J. Am. Chem. Soc.*, 2012, **134**, 11864.

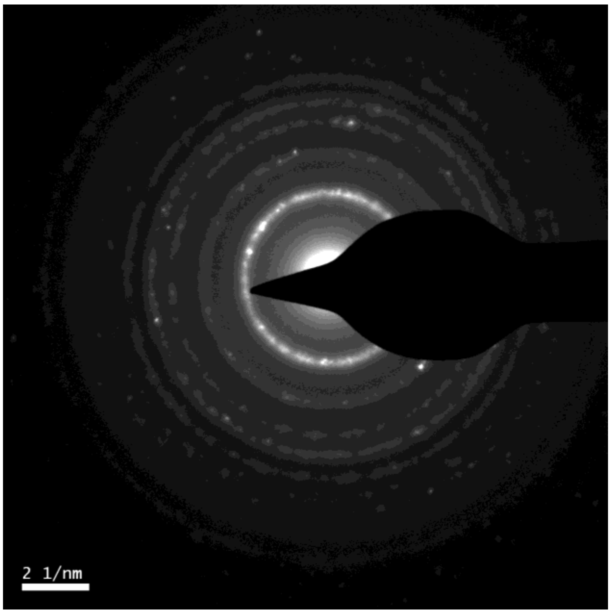

Fig. S1 The SAED pattern of the TiO_2 nanotubes.

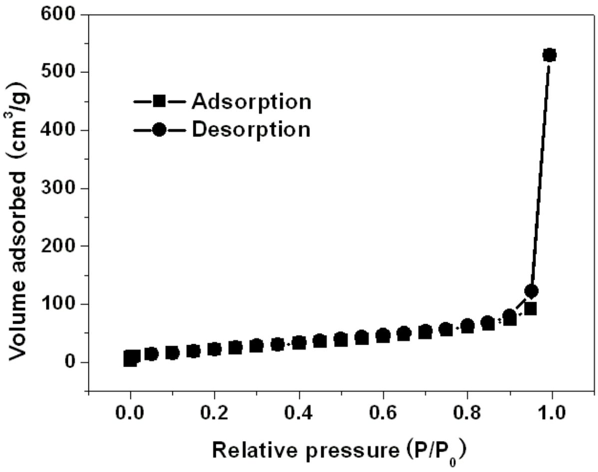

Fig. S2 N_2 adsorption–desorption isotherm of Degussa P-25 nanoparticles.

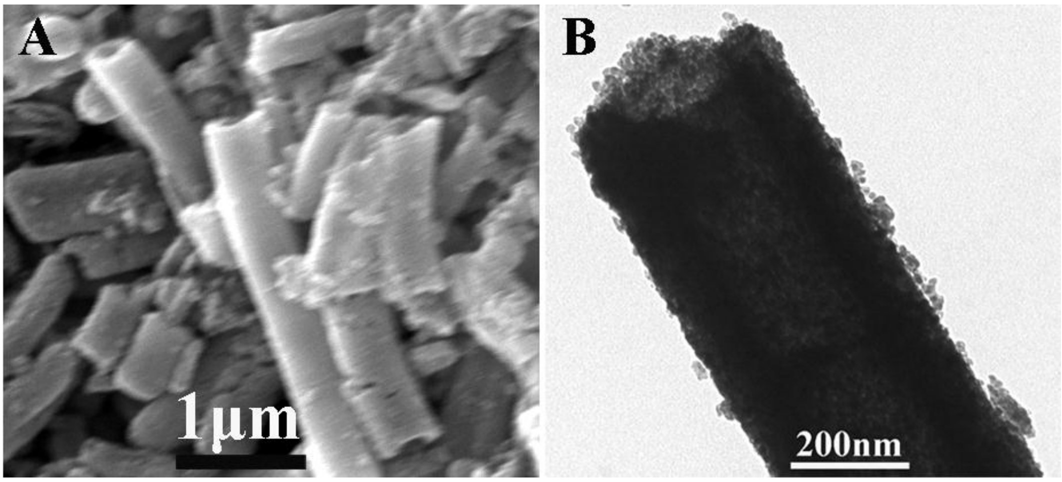

Fig. S3 The SEM and TEM images of TiO_2 nanotubes after cycling for 500 cycles.