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Electronic Supplementary Information (ESI) *for*

Highly active Fe_3BO_6 as an anode material for sodium-ion batteries

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Experimental details

Preparation of Fe_3BO_6

The Fe_3BO_6 nanoparticles were synthesized via a facile solid state method. All reagents were purchased from Sinopharm Chemical Reagent Co., Ltd (Shanghai) without further treatment. In a typical experiment, $FeC_2O_4{\cdot}2H_2O$ and H_3BO_3 were mixed by ball milling in a molar ratio of 3:1.2 with a proper amount of deionized water as a dispersant. After the grinding and mixing, the obtained rheological phase was transferred into an autoclave and kept at 80 °C for 12 h. The precursor was then calcined at 800 °C for 5 h with a heating rate of 3 °C /min in air. After cooling down to ambient temperature, the product was washed 3 times using boiling water to remove the unreacted boron oxide. In addition, the Fe_3BO_6@C sample was prepared by mixing Fe_3BO_6 with oleic acid and then heating it at 500 °C in N_2.

Characterization of the materials

The crystal structure of the samples was characterized by an X-ray diffractometer (XRD, Rigaku RINT 2200). XRD data were gained with Cu Kα_1 radiation (λ = 0.15406 nm) in the 2θ range of 20–80° with a step size of 0.02° and a scan rate of 2° per minute. The morphologies and structure of the Fe_3BO_6 nanoparticles were investigated by scanning electron microscopy (SEM, Hitachi S-3500N) and transmission electron microscopy (TEM, JEM-2100F, JEOL, Japan). X-ray photoelectron spectroscopy (XPS) tests were carried out on a Kratos Axis UltraDLD spectrometer (Kratos Analytical - A Shimadzu Group company) with monochromatic Al Kα radiation (hv = 1486.6 eV).

Electrochemical measurements

The Fe_3BO_6 powders were mixed with sodium carboxymethyl cellulose (CMC, WALOCEL™ CRT 2000 PPA 12, Dow Wolff Cellulosic) and acetylene black to form a slurry with a weight ratio of 80:10:10. The working electrode was manufactured by casting the slurry on copper foil substrate, which was dried at 80°C overnight. Disks with an area of 1.54 cm^2 were punched out of the foil, and the average mass loading of active material on each disk was about 1.0 mg. In CR2016 coin cells, the Fe_3BO_6 samples and metallic sodium were using as working electrode and counter electrode, respectively. 1 M $NaClO_4$ (98% Sigma Aldrich) in ethylene carbonate (EC) and diethyl carbonate (DEC) (1:1 by volume) was used as the electrolyte. The cells were assembled in an argon-filled glove box (Mikrouna-China Super 1220/750). The electrochemical properties of the cells were tested using a battery tester (LAND CT2001A Wuhan, China) in the voltage range of 0.01-3.0 V under different current densities. The cyclic voltammetry (CV) tests were carried out on an electrochemical workstation (Autolab PGSTAT 302N) at a scan rate of 0.01mV s^{-1} in the voltage range of 0.01-3.0 V. The electrochemical impedance spectroscopy (EIS) analysis was conducted on an Autolab PGSTAT 302N electrochemical workstation from 100 kHz to 0.1 Hz with potentiostatic signal amplitude of 5 mV in the fully charged state. The working potential for EIS tests is stable at open circuit potential (about 1.7 V) after charging to 3.0 V (vs. Na^+/Na) and resting for 6 h.

Fig. S1

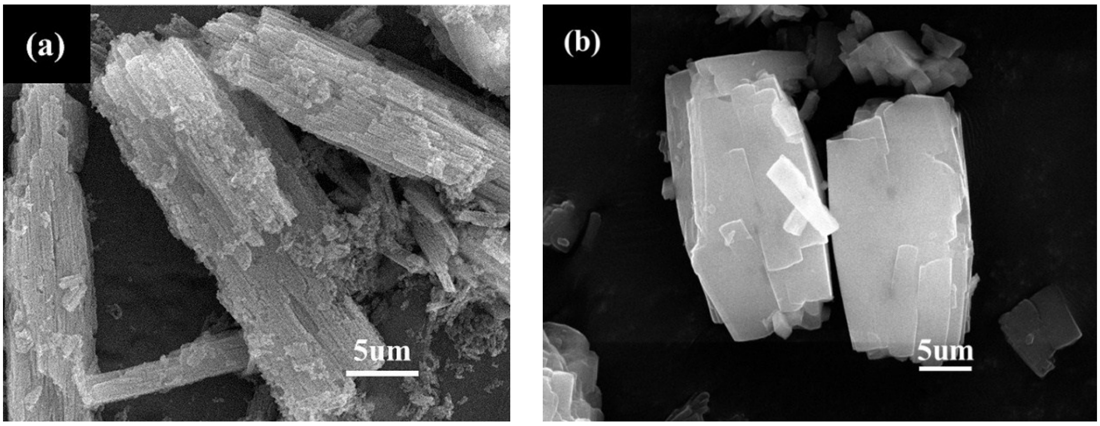

Fig. S1 (a) Low-magnification SEM image of as-prepared Fe_3BO_6; (b) SEM image of the $FeC_2O_4 \cdot 2H_2O$ precursor.

Fig. S2

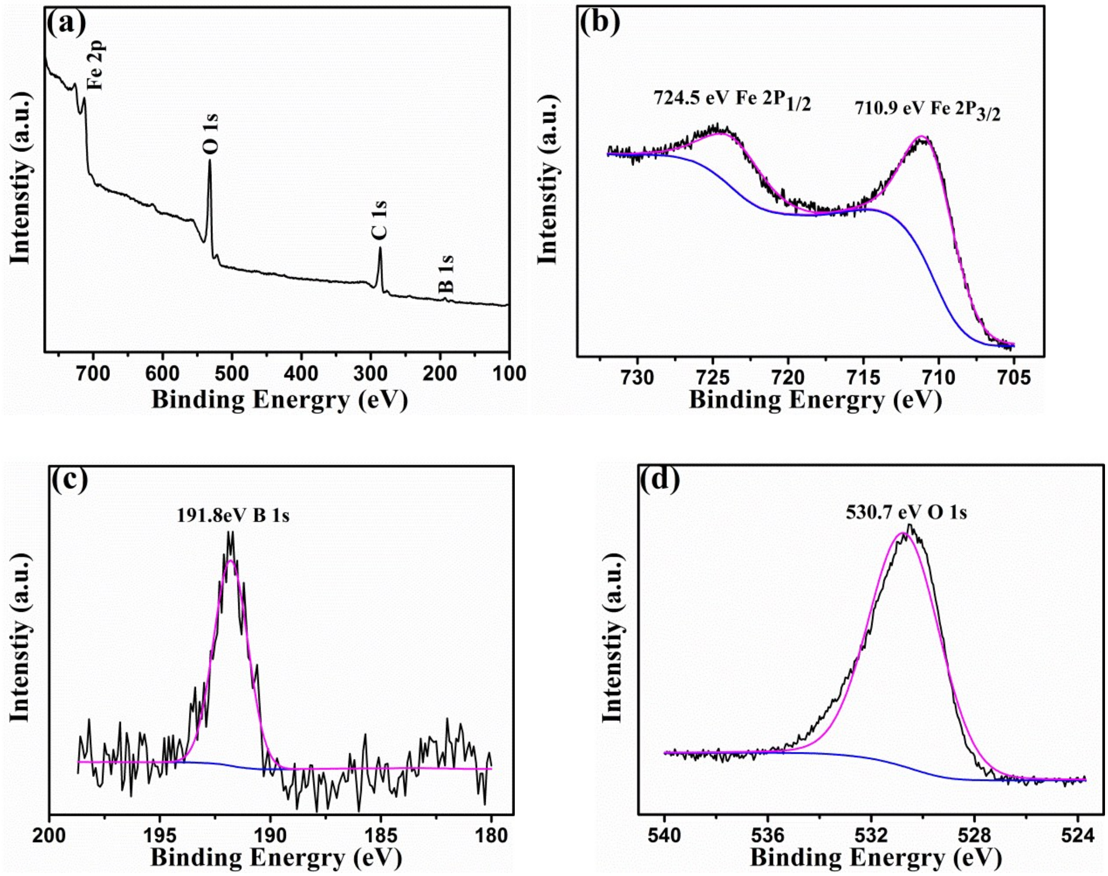

Fig. S2 XPS spectra of the Fe_3BO_6 sample: (a) survey spectrum, (b) Fe 2p, (c) B 1s, and (d) O 1s.

Fig. S3

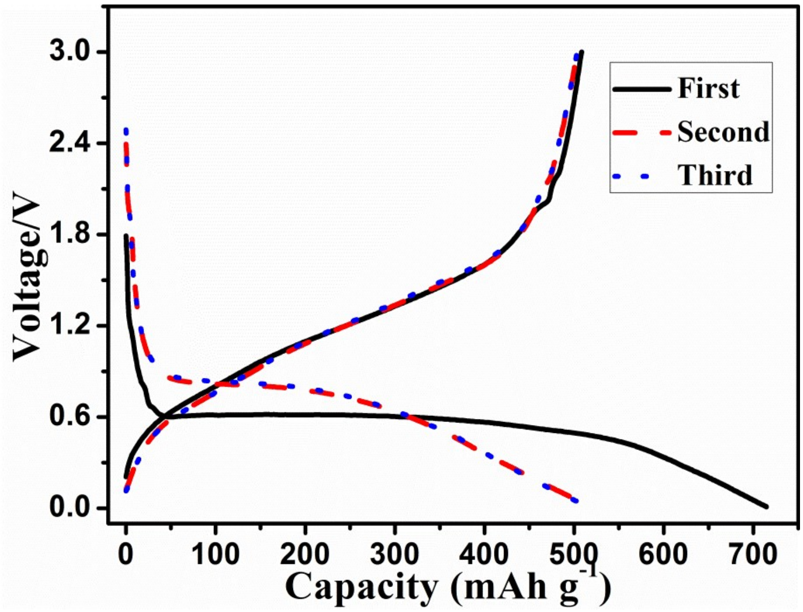

Fig. S3 Initial three charge-discharge curves of Fe_3BO_6 electrode at 100 mA g^{-1}.

Table S1

Table S1: Solution resistance (R_s), charge transfer resistance (R_{ct}), and constant phase angle element (*CPE*) derived from the equivalent circuit model of EIS curves.

Cycles	R_s/Ω	R_{ct}/Ω	*CPE*	
			$Y_o/\mu F$	N
1^{st}	1.98	100	225	0.60
2^{nd}	2.41	94.4	213	0.63
30^{th}	2.67	102	192	0.63
80^{th}	3.24	125	190	0.61