Supporting Information

Carbon coated $K_{0.8}Ti_{1.73}Li_{0.27}O_4$: A novel anode material for sodium-ion batteries with long cycle life

Kong-yao Chen, Wu-xing Zhang*, Yang Liu, Hua-ping Zhu, Jian Duan, Xing-hua Xiang, Li-hong Xue, Yun-hui Huang*

State Key Laboratory of Material Processing and Die & Mould Technology, School of Materials Science and Engineering, Huazhong University of Science and Technology, Wuhan, 430074, P. R. China. Email: zhangwx@mail.hust.edu.cn, huangyh@mail.hust.edu.cn

Experimental

1. Synthesis

Stoichiometric K_2CO_3, TiO_2 and Li_2CO_3 (10% excess) were mixed and grounded for 20 min, then K_2MoO_4 as fluxing agent was added in the above mixture with a mole ratio of KTLO/K_2MoO_4 equal to 3/7. The mixture was grounded and heated at 1100 °C for 5 h in air. After the heat treatment, the sample was washed with boiling water for several times to remove K_2MoO_4, and then dried at 120 °C for 10 h. The as-prepared KTLO was ball milled at 180 rpm for 10 h to obtain BM-KTLO. The BM-KTLO was then heated at 600 °C for 2 h in Ar/C_2H_2 to prepare C@BM-KTLO.

2. Characterization

The crystalline structure was characterized by X-ray diffraction (XRD, PANalytical B.V., Holland). The morphology was observed with scanning electron microscopy (SEM, SIRION200) and transmission electron microscopy (TEM, JEOL 2100). X-ray photoelectron spectroscopy (XPS) was measured on a VG MultiLab 2000 system with a monochromatic Al Kα X-ray source (ThermoVG Scientific). The thermo gravimetric analysis and differential thermal analysis (TG/DTA) was performed with a Netzsch STA 449F3 analyzer in air from 50 to 800 °C at a heating rate of 10 °C min^{-1}. CR 2032 coin cell was assembled in Ar-filled glove box to test the electrochemical performance. Typically, the working electrode was prepared by casting a slurry of 70 wt% active material, 20 wt% Super-P (SP) and 10% poly(vinyl difluoride) (PVDF) mixed in N-methyl pyrrolidinone (NMP) onto a Cu foil. After dried at 80 °C for 10 h, the foil was roll pressed and cut into round disks with a diameter of 8 mm. The active material load of each disk is about 1 mg cm^{-2}. The counter electrode was sodium foil and the separator was glass fibers. 1 M $NaClO_4$ dissolved in propylene carbonate/ethyl carbonate (1:1 v/v ratio) was used as electrolyte solution. The coin cells were galvanostatically discharged/charged at different current densities between 0.001 and 2 V by using a battery testing system (Neware, China) at room temperature.

Cyclic voltammetric measurements were carried out at a scan rate of 0.1 mV S^{-1} using a CHI 660d electrochemical workstation (ChenHua Instruments Co., Shanghai, China).

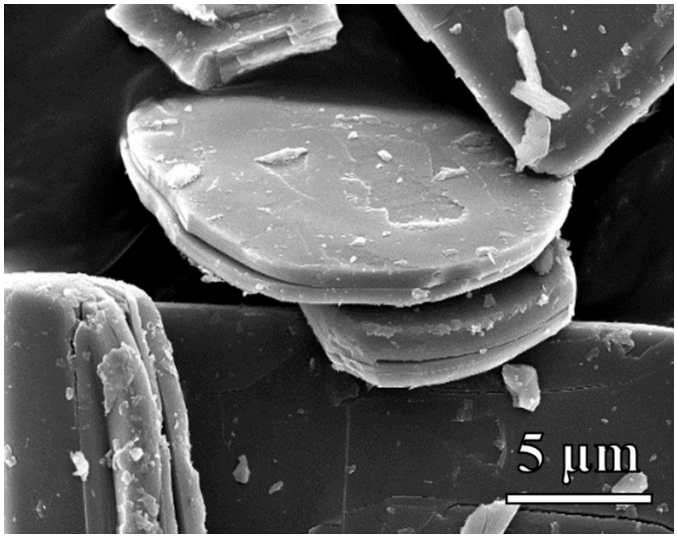


Fig. S1 SEM image of as-prepared KTLO.

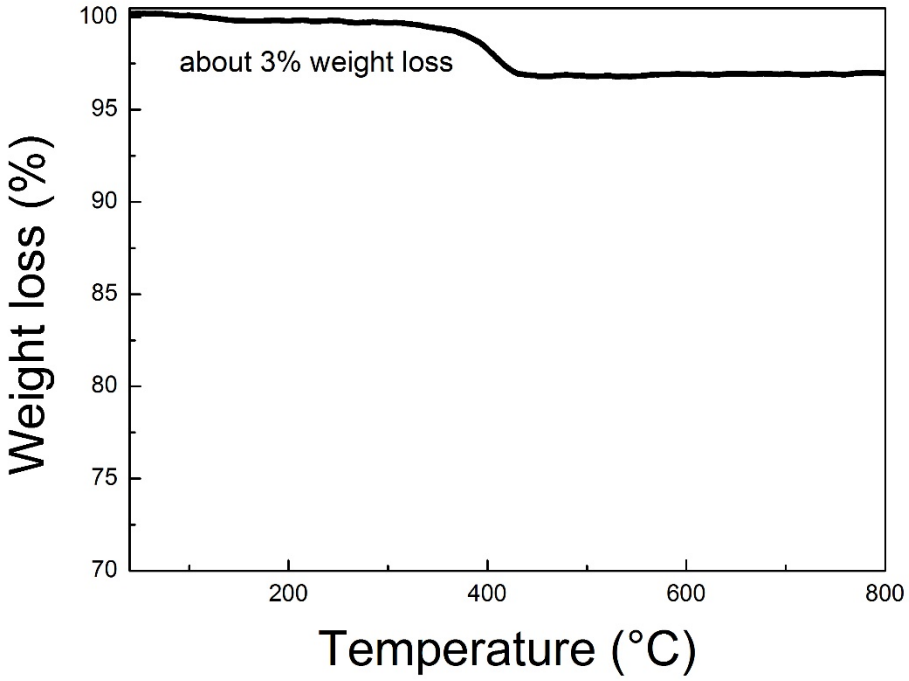


Fig. S2 TG analysis of C@BM-KTLO in air.

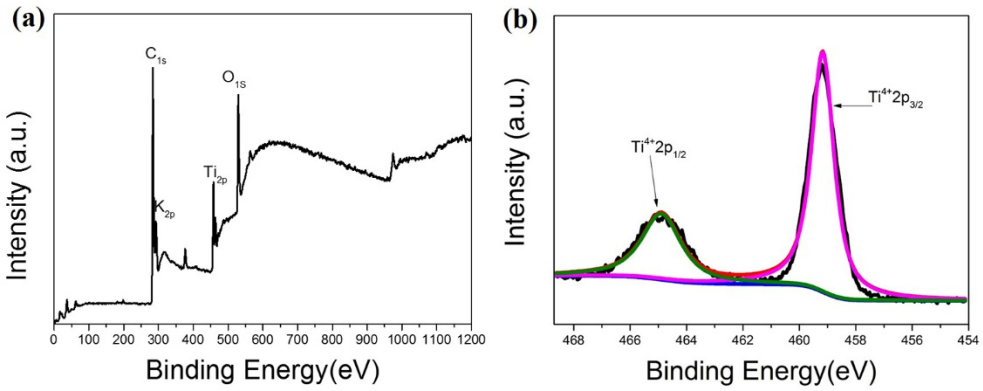
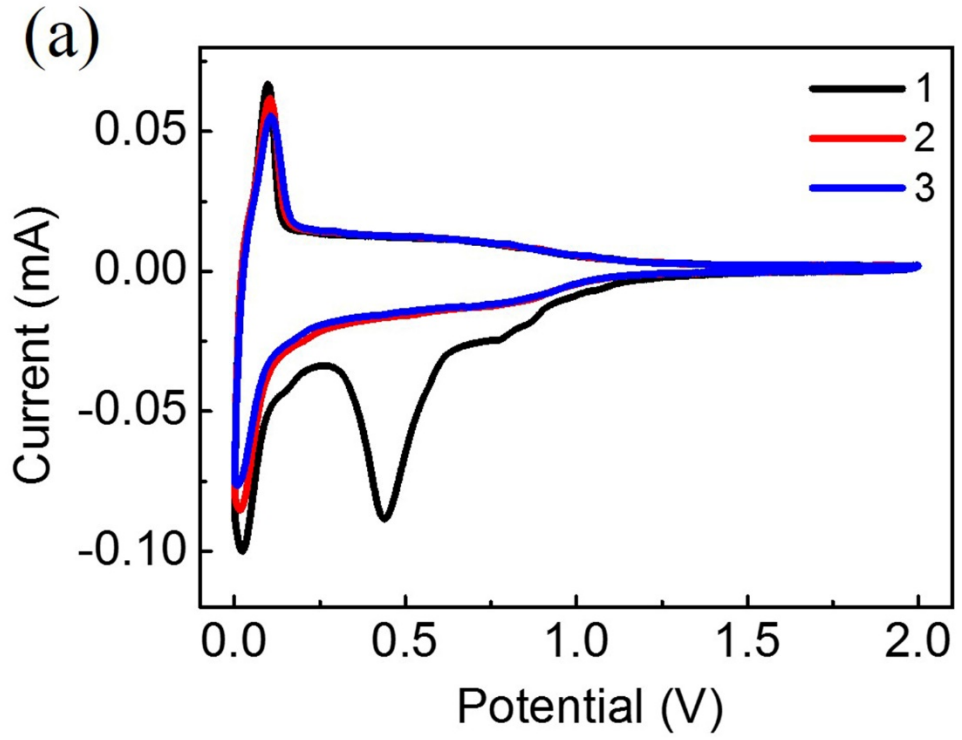
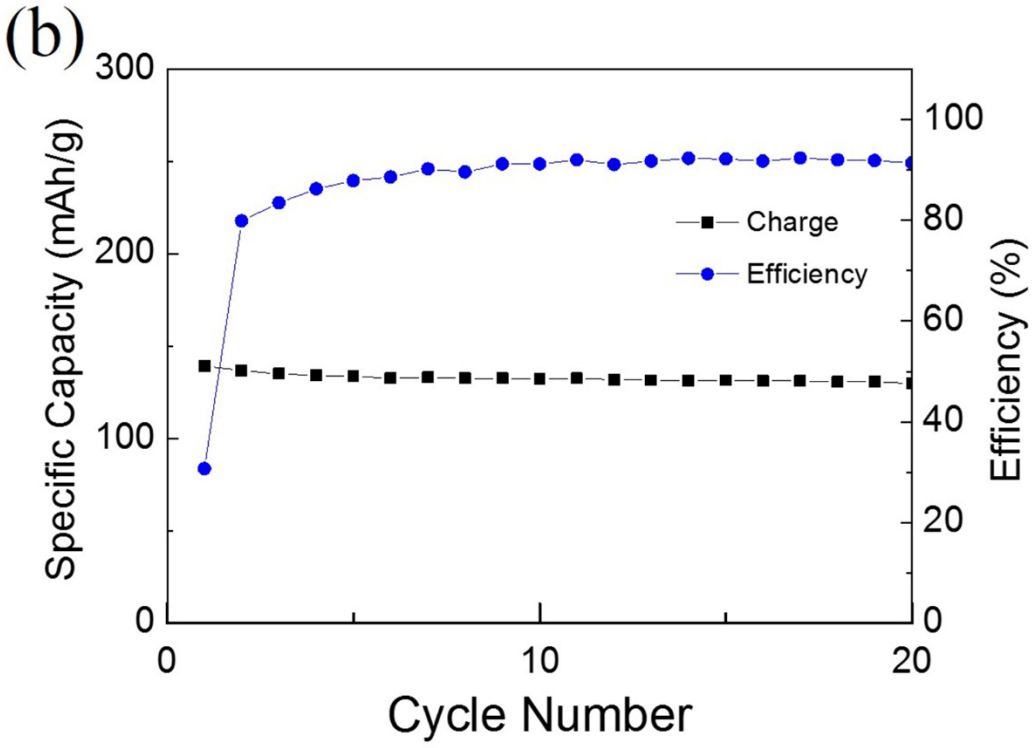


Fig. S3 (a) Survey XPS spectrum of C@BM-KTLO. (b) High-resolution XPS spectrum of Ti_{2p} in C@BM-KTLO.





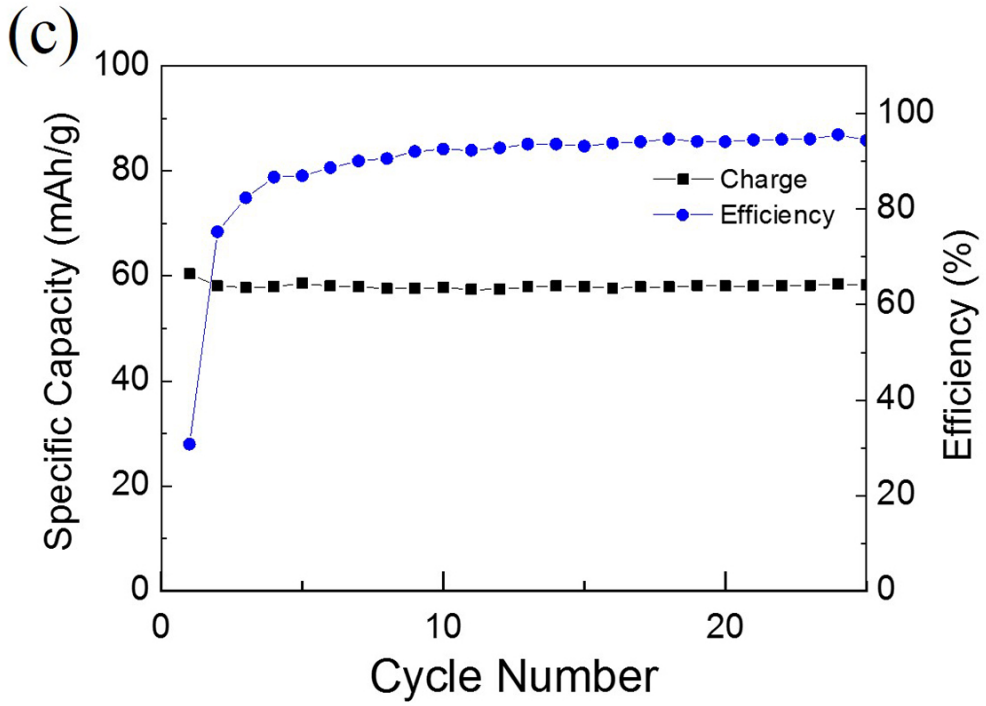


Fig. S4 (a) CV curves of SP electrode at a scan rate of 0.1 mV S^{-1} from 0.001V to 2V vs. Na^+/Na. Desodiation cycling performance of the (b) SP electrode and (c) C@BM-KTLO electrode without SP.

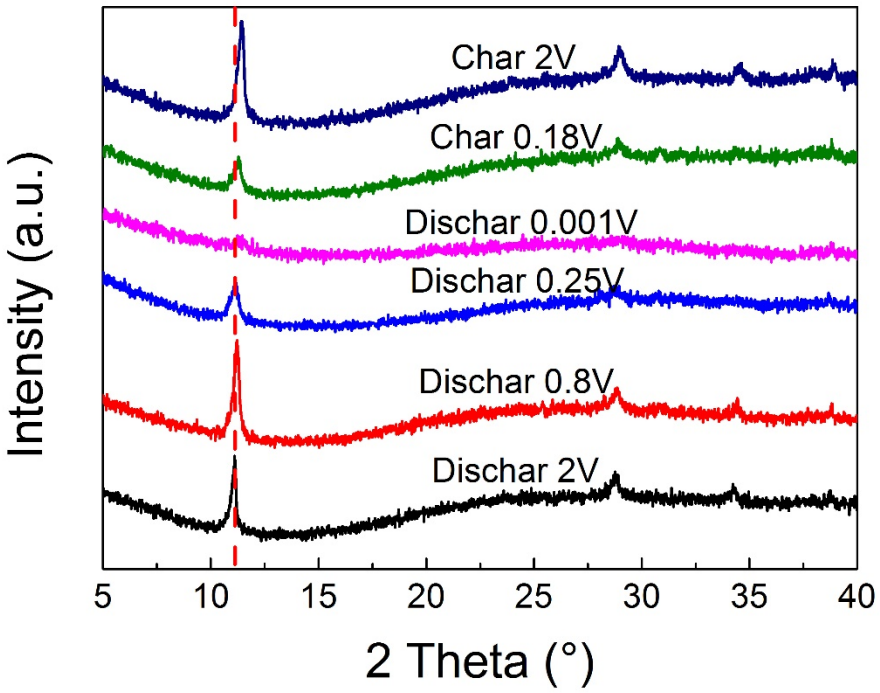


Fig. S5 Ex-situ XRD patterns of C@BM-KTLO during charge and discharge.

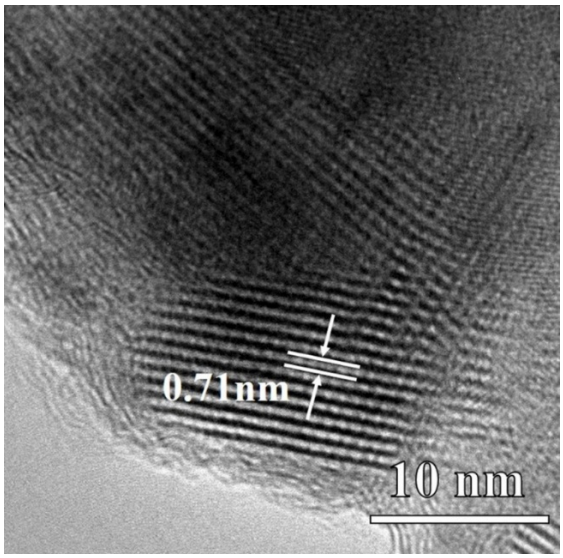


Fig. S6 HRTEM image of C@BM-KTLO after 50 cycles.