Supporting Information for

Mesoporous $ZnMn_2O_4$ microtubules derived from a biomorphic strategy for high performance lithium/sodium ion batteries

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Experimental details

The ZMO-MT is prepared via a biomorphic route as illustrated in Figure 1. In a typical synthesis process, both 1 mmol $Zn(CH_3COO)_2 \cdot 2H_2O$ and 2 mmol $Mn(CH_3COO)_2 \cdot 4H_2O$ were first dissolved in 15 mL deionized water, followed by constant magnetic stirring for 1 h to obtain a transparent solution. Next, 0.5 g piece of natural cotton was immersed in the solution and the wet cotton was dried at 75 $^{\circ}C$ for overnight. The ZMO-MT was finally obtained by calcination of the precursor at 700 $^{\circ}C$ for 3h in air atmosphere by heating at the rate of 2 $^{\circ}C$ min^{-1}. For comparison, bulk $ZnMn_2O_4$ was synthesized in a similar procedure to the preparation of ZMO-MT, but without using cotton.

Scanning electron microscope (SEM, Tecnai-450, FEI), transmission electron microscope (TEM, Talos F200X, FEI), infrared spectroscopy (IR) (TENSOR27 spectrophotometer, Bruker) and X-ray diffraction diffractometer (XRD, D8-Advance, Bruker) were used to study the structure and morphologies of the sample. The 2θ ranges from 10º to 80º with a scan rate of 4º/min and a step width of 0.02º. The valance states of ZMO-MT were investigated by X-ray photoelectron spectroscopy (XPS, Escalab 250Xi, Thermo Fisher). Thermogravimetric analysis (TG, Netzsch STA-449F3) was conducted in air between room temperature and 800 °C while heating at a rate of 10 °C min^{-1}. The Brunauer-Emmett-Teller (BET) surface area and pore size distribution of sample were recorded by a surface area analyzer (ASAP 2020 HD88, Micromeritics).

The lithium/sodium storage performances of the ZMO-MT and bulk $ZnMn_2O_4$ were studied using CR2032 coin-type cells. The working electrodes were obtained as follows. First, ZMO (70 wt%), acetylene black (20 wt%) and polyvinylidene fluoride

(10 wt%) were mixed in N-Methyl pyrrolidone (NMP) solvent, and then, the resulting slurry was used to coat a Cu foil, which was dried at 80 °C for 12h in a vacuum atmosphere. Typically, the loading mass of the active materials is about 1.8-2.3 mg/cm^2. LIBs were prepared in following manner: as the anode, the as-prepared working electrode was used; as the counter, a metallic lithium was used; as the separator, a Celgard Brand polymer membrane was used; and as the electrolyte, a solution of 1M $LiPF_6$ dissolved in a mixture of ethylene carbonate (EC) and diethyl carbonate (DEC) (1:1, volume ratio) was used. SIBs were prepared as follows: as the counter, a sodium foil was used; as the separator, a Whatman glass microfiber filters membrane was used; and as the electrolyte, a solution of 1M $NaClO_4$ dissolved in a mixture of ethylene carbonate (EC) and propylene carbonate (PC) (1:1, volume ratio) with 5% fluoroethylene carbonate (FEC) was used. The cyclic voltammograms and galvanostatic charge-discharge data of the sample were recorded in the potential range of 0.01 to 3.00 V (*vs.* Li^+/Li or Na^+/Na) by an electrochemical workstation (CHI 660E, Chenhua) and a battery testing system (CT 2001A, Land), respectively.

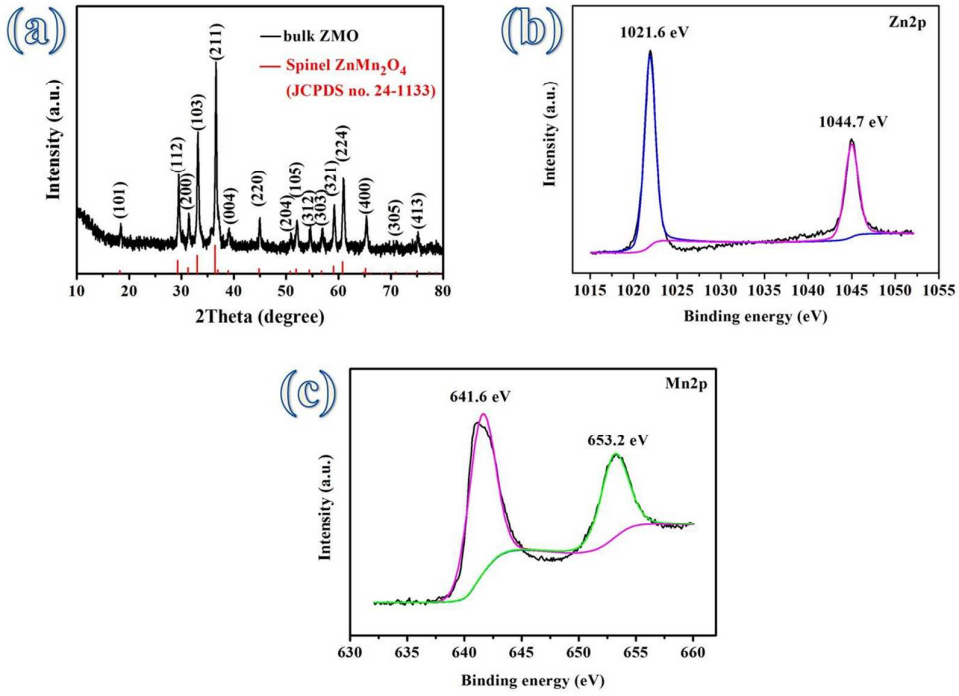

Figure S1 (a) XRD pattern; and (b) XPS spectrum of Zn2p, (c) Mn2p for bulk $ZnMn_2O_4$

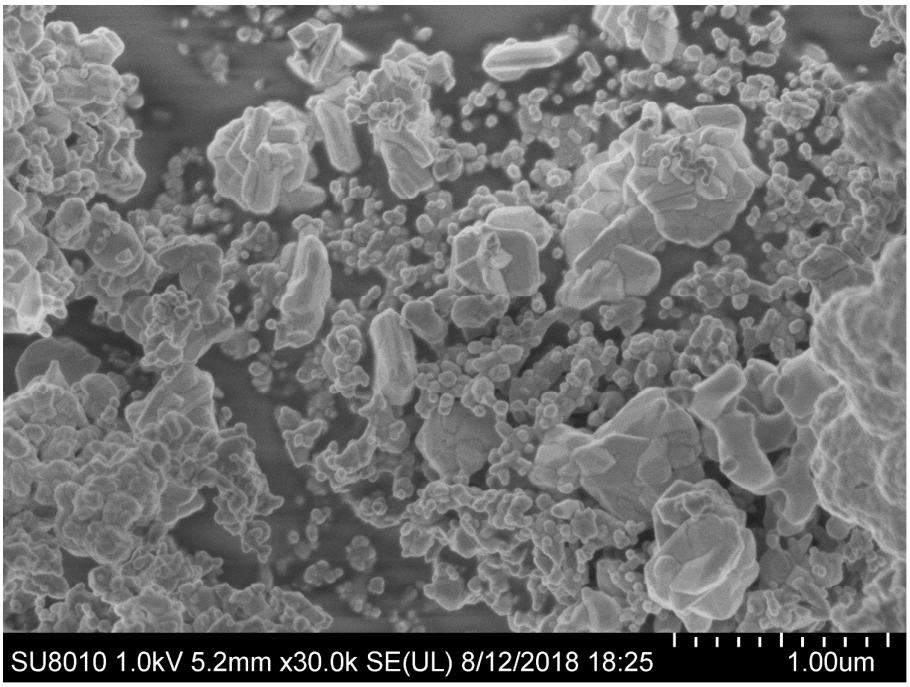

Figure S2 SEM image of bulk $ZnMn_2O_4$

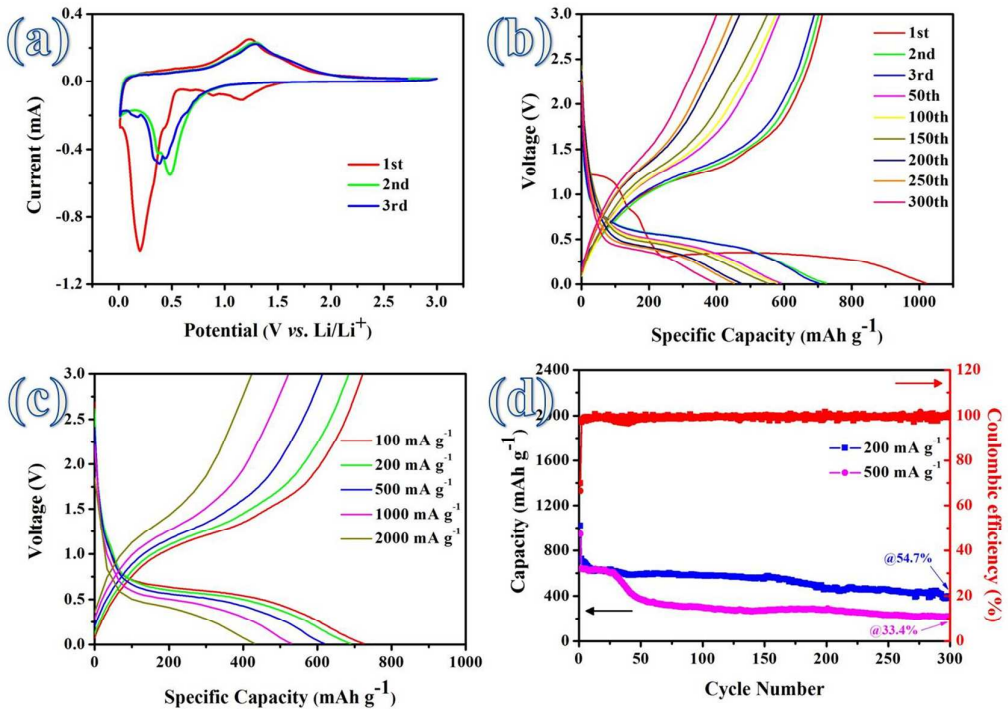

Figure S3 Electrochemical performances in LIBs: (a) Cyclic voltammetry curves; (b) charge-discharge profiles at 200 mA g^{-1}; (c) rate capabilities at various current densities; (d) cyclic life for bulk $ZnMn_2O_4$

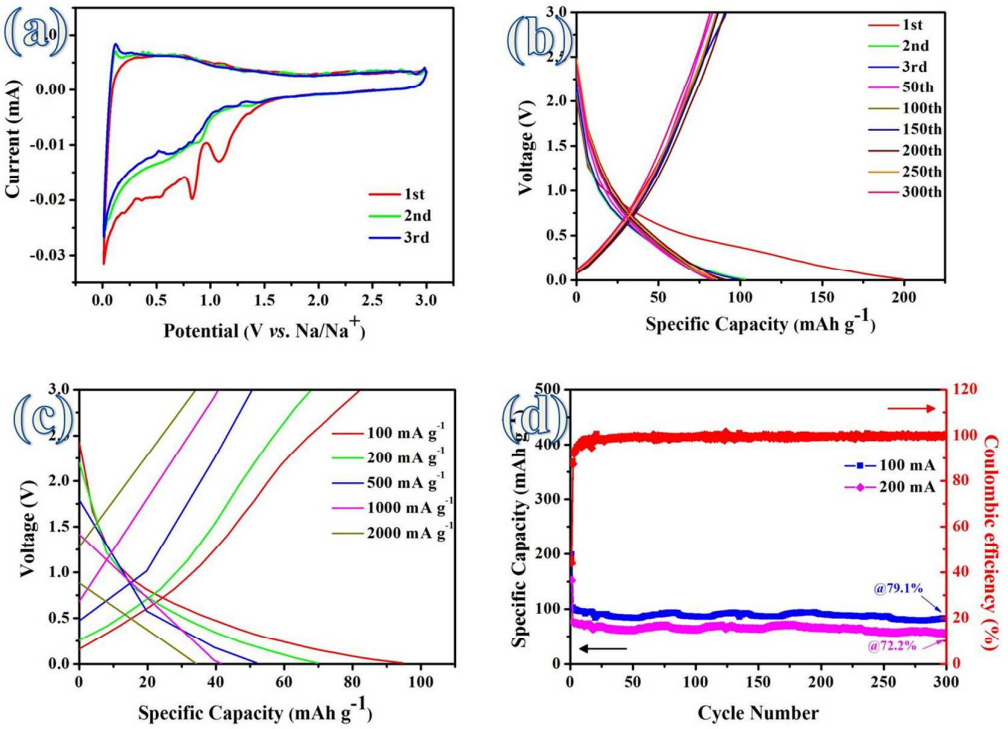

Figure S4 Electrochemical performances in SIBs: (a) Cyclic voltammetry curves; (b) charge-discharge profiles at 100 mA g^{-1}; (c) rate capabilities at various current densities; (d) cyclic life for bulk $ZnMn_2O_4$

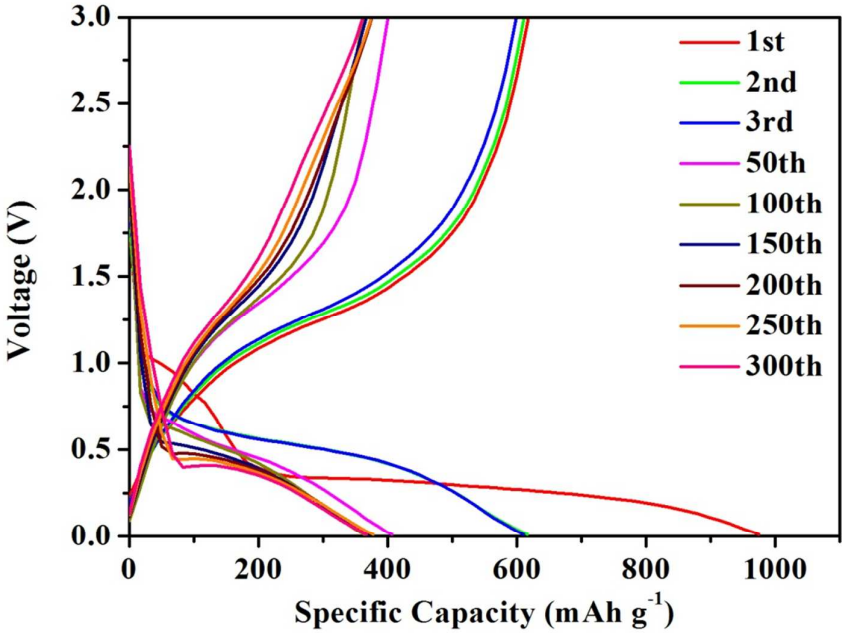

Figure S5 Charge-discharge profiles at 1A g^{-1} for 300 cycles of ZMO-MT