SUPPORTING INFORMATION

Co-MnO/C Nanoparticles Derived from MOFs with Improved Conductivity and Reduced Volume Change for Lithium-ion Batteries

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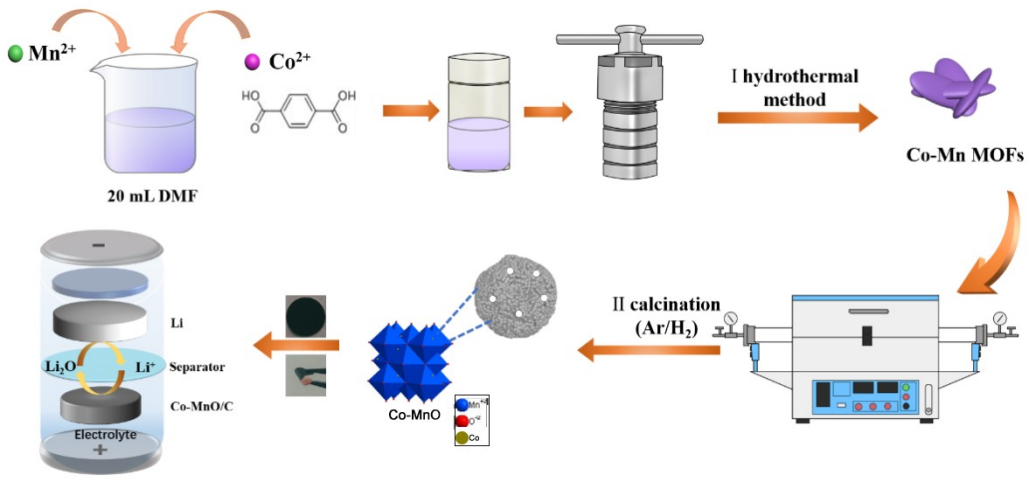
Declarations of interest: none



Scheme S1. Illustration of the method for the synthesis of Co-MnO/C anode

Experimental Section

1. Synthesis of materials

Synthesis of Co-MnO/C: Co-Mn MOF was prepared in a reported method with some modification[27]. Firstly, 0.08 g cobalt (II) hexahydratechloride and 0.16 g terephthalic acid (PTA) was dissolved in 20mL N, N-dimethylformamide (DMF, 99 %). Then, the prepared solution was mixed under ultrasonication and fully stirred at room temperature for 0.5h. The next step was to add 0.08 g manganese (Ⅱ) acetate into this solution under continuous stirring, then transferred them to a 50 mL Teflon-lined stainless-steel autoclave and heated under 120 °C for 24 hours. A violet color resultant can be obtained by washing with DMF and ethanol for three times respectively. Then, dry the extra solvent at 70 °C. The Co-MnO/C was prepared by annealing the Co-Mn MOFs under an Ar/H_2 (10%) atmosphere at different temperatures (400, 450 and 500 °C) in a tubular furnace for 240 min with the heating rate of 4 °C min^{-1}.

2. Characterization of materials

The Co-Mn MOF and Co-MnO/C were analyzed by various analytical characterization tests. The crystal structure of above composites was obtained by using BRUKER D2 PHASER X-Ray Diffractometer with Cu Kα radiation. Ranging from 400 to 4000 $cm^{-1}$of wavelength, Fourier transform infrared (FT-IR) transmission spectra by using a Nicolet AVATAR 370 infrared spectrometer was recorded.

Inductively coupled plasma spectroscopy (ICP), X-ray photoelectron spectroscopy (XPS) (Thermo ESCALAB 250XI), and energy dispersive X-ray spectroscopy (EDX) were used to test the elemental composition and chemical states of the materials. Through field-emission scanning electron microscope (FESEM, Hitachi S4800) and transmission electron microscopy (TEM, Hitachi H-800), the microscopic features of the products can be captured. Brunauer-Emmett-Teller (BET) method and Barrett-Joyner-Halenda (BJH) equation were calculated specific surface area and the average pore size of the materials, respectively.

3. Preparation of electrode and cell

Co-MnO/C, acetylene black and polyvinylidene fluoride (PVDF) were mixed in a weight ratio of 7:2:1, and then grinding in a mortar with N- methylpyrrolidone (NMP) as a solvent for four hours to obtain uniform slurry, which was evenly coated on a round copper foil and dried in the vacuum drying oven at 65°C for 24 hours. The mass loading of Co-MnO/C electrode materials was about 1.13 mg. A high-purity argon-filled vacuum glove box was used to assemble a coin cell, in which lithium sheet and Co-MnO/C material served as cathode material and anode material respectively, and 1 M $LiPF_6$ solution dissolved in ethylene carbonate (EC)/ dimethyl

carbonate (DMC)/ diethyl carbonate (DEC) (1/ 1 /1,v/v/v) was regarded as electrolyte.

4. Electrochemical Measurements

Charging and discharging measurements were tested with the cut-off voltage window ranging from 0.01 to 3.0 V at 100-2000 mA g^{-1}. The above test was carried out on NEWARE CT-3008. Under the voltage window of 0.01-3V, the cyclic voltammetry measurements and electrochemical impedance spectroscopy (EIS) observation were recorded with electrochemical workstation (CHI660D) at the scanning rate of 1.0 mV s^{-1}. The frequency of CV test rangeed from 0.01 Hz to 100 kHz, and the voltage disturbance was set to ±5 mV). (All the above tests were done at room temperature).

Figures

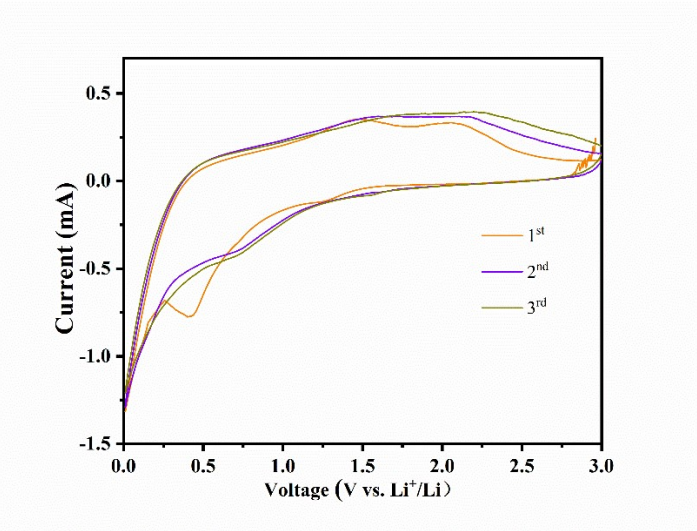


Figure S1. The CV curves Co-MnO/C electrode at 1.0 mV s^{-1}

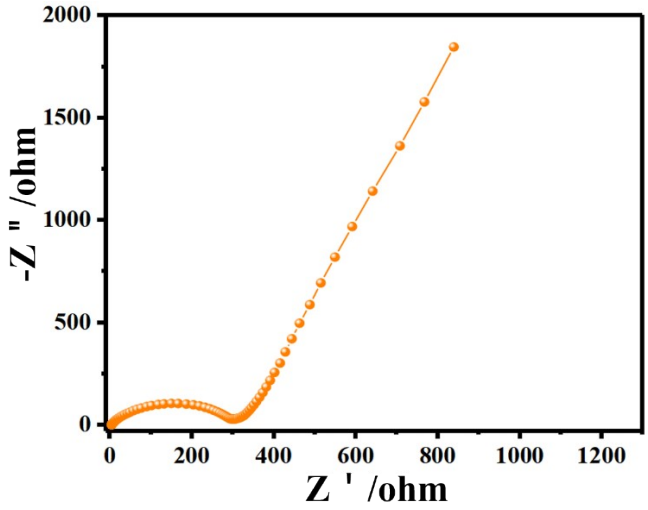


Figure S2. The EIS profiles of the MnO.

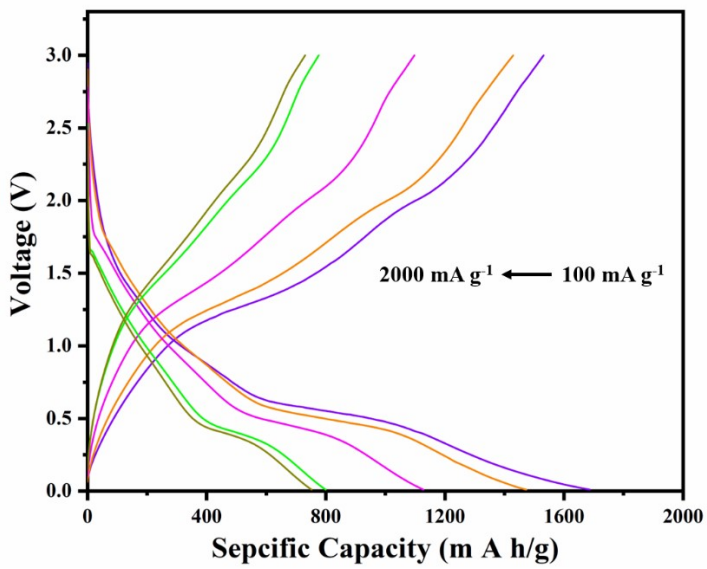


Figure S3. The charge/discharge curves at different current densities (from 100 to 2000 mA g^{-1}) of the Co-MnO/C

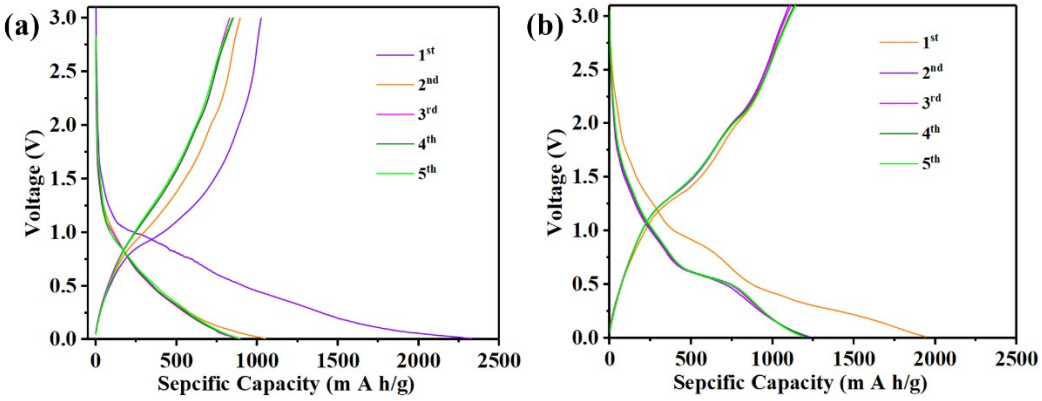
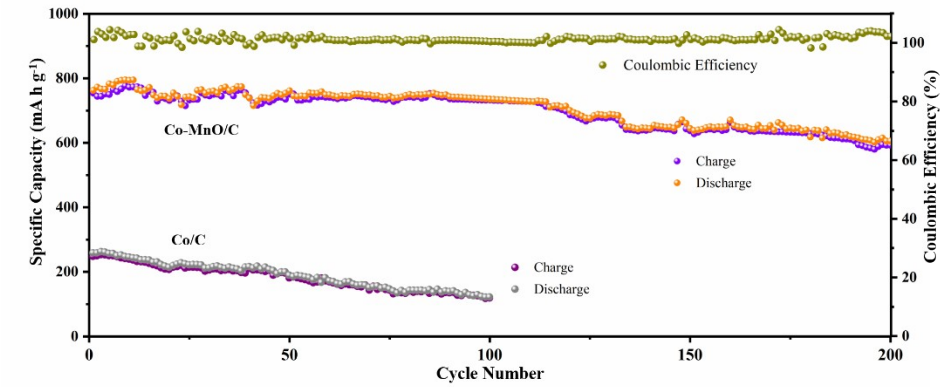


Figure S4. Galvanostatic charging/discharging curves of the Co-MnO/C-400 (a) and Co-MnO/C-500 (b)



Figures S5. Cycling performance of Co-MnO/C and Co/C at 2000 mA g^{-1}.