Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.
This journal is © The Royal Society of Chemistry 2016

Supporting Information

Preparation of $Sn@SnO_2@C@MoS_2$ composite as high-performance anode material for lithium-ion batteries

Youguo Huang,[a] Qichang Pan,[a] Hongqiang Wang,*[a] Cheng Ji,[a] Xianming Wu,[b] Zeqiang He[b] and Qingyu Li*[c]

a School of Chemistry and Pharmaceutical Sciences, Guangxi Normal University, Guilin, 541004, China

b The Collaborative Innovation Center of Manganese-Zinc-Vanadium Industrial Technology (the 2011 Plan of Hunan Province)，Jishou, Hunan,416000

c Guangxi Key Laboratory of Low Carbon Energy Materials, Guilin, 541004, China

Experimental

Synthesis of Sn@C composite

In a typical experiment, 0.75 g $SnCl_2·2H_2O$, 5.0 g $Na_3C_6H_5O_7·2H_2O$, 40 g NaCl, 10 g H_2O and 30 g stainless-steel balls were into a stainless-steel vial. The vial was sealed and with a rotation speed of 500 rpm for 20 h. Then the obtained hybrids were dried at oven and then heat-treated at 700 ^oC for 2 h under a flowing Ar atmosphere. The as-synthesized products were washed with deionized water several times to remove NaCl and dried at 80 ^oC in a vacuum oven.

Synthesis of $Sn@SnO_2@C@MoS_2$ composite

Firstly, 0.38 g of sodium molybdate ($Na_2MoO_4·2H_2O$) and 0.24 g of thiourea (CN_2H_4S) were dissolved in 80 mL deionized water. Then, 0.8 g of as-obtained Sn@C composite was added, After stirring for 5 minutes, the solution was transferred into a 100mL Teflon-lined stainless steel autoclave and kept in an electric oven at 200^{o}C for 24h. The autoclave was then left to cool down to room temperature naturally. The black precipitate was collected by filter, washed thoroughly with deionized water three times, and dried at 80 ^{o}C for 12 h.

Characterization

The distribution, size and morphology of the as-prepared samples were characterized by scanning electron microscopy (SEM) (Philips, FEI Quanta 200 FEG). Transmission electron microscopy (TEM) and high-resolution TEM (HRTEM) measurements were conducted on a JEOL-2100. The chemical compositions and structures of the prepared samples was analysed by X-ray diffraction (XRD, Rigaku D/max 2500) . Raman measurement of the composite was performed by laser Raman spectroscopy (Jobin Ybon, T6400). Thermogravimetric analysis (TGA) was carried out with a NETZSCH STA 409 PC apparatus at a heating rate of 5 ^{o}C min^{-1} in air flow.

Electrochemical measurements

The electrochemical performance for all samples were tested using CR2025 coin-type cells. The working electrodes were firstly prepared by mixing 80 wt% active materials (Sn@SnO_2@C@MoS_2 composite or Sn@C composite), 10 wt% acetylene black (Super-P), and 10 wt% polyvinylidene fluoride (PVDF) in N-methyl-2-pyrrolidone (NMP) solution, followed onto a copper foil and dried at 80 ^{o}C in vacuum for 12h before pressing. Standard CR2025 coin-type cells were assembled in an Ar-filled glovebox by using the as-prepared electrodes, Li metal foil as the counter electrode, The electrolyte was 1 M $LiPF_6$ in ethylene carbonate/dimethyl carbonate/diethyl carbonate (1:1:1 vol%). Galvanostatic charge/discharge cycles were tested by a LAND (BT2013A ,Wuhan, China) battery measurement system at various current densities in the cut off voltage range of 3.00 V to 0.005 V versus Li/Li$^+$ at room temperature. Cyclic voltammograms (CVs) measurements were carried out on electrochemical workstation (IM6, Germany) over the potential range of 3.0 to 0 V at a scan rate of 0.1 mV s^{-1}.

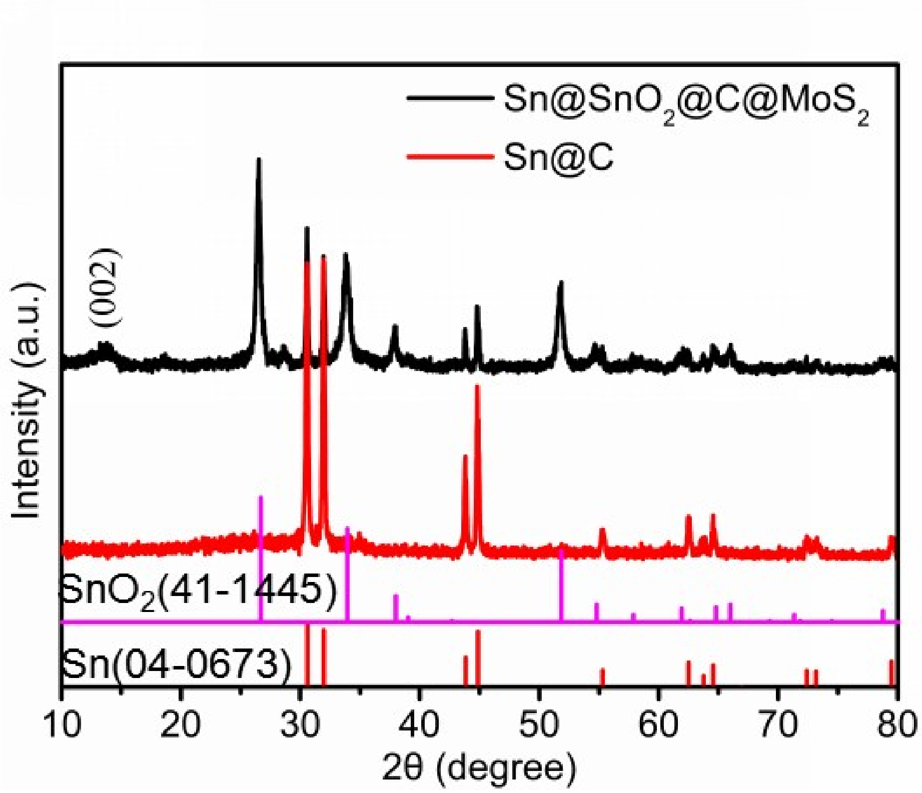

Fig. S1 XRD pattern of Sn@C composite and Sn@SnO$_2$@C@MoS$_2$ composite.

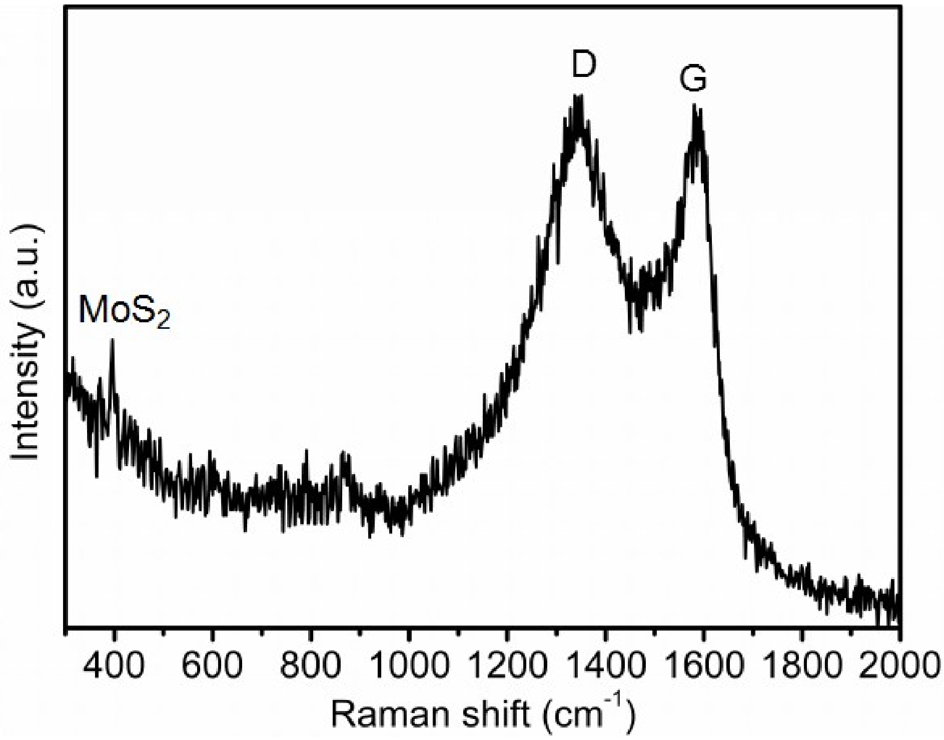

Fig. S2 Raman spectra of the Sn@SnO_2@C@MoS_2 composite.

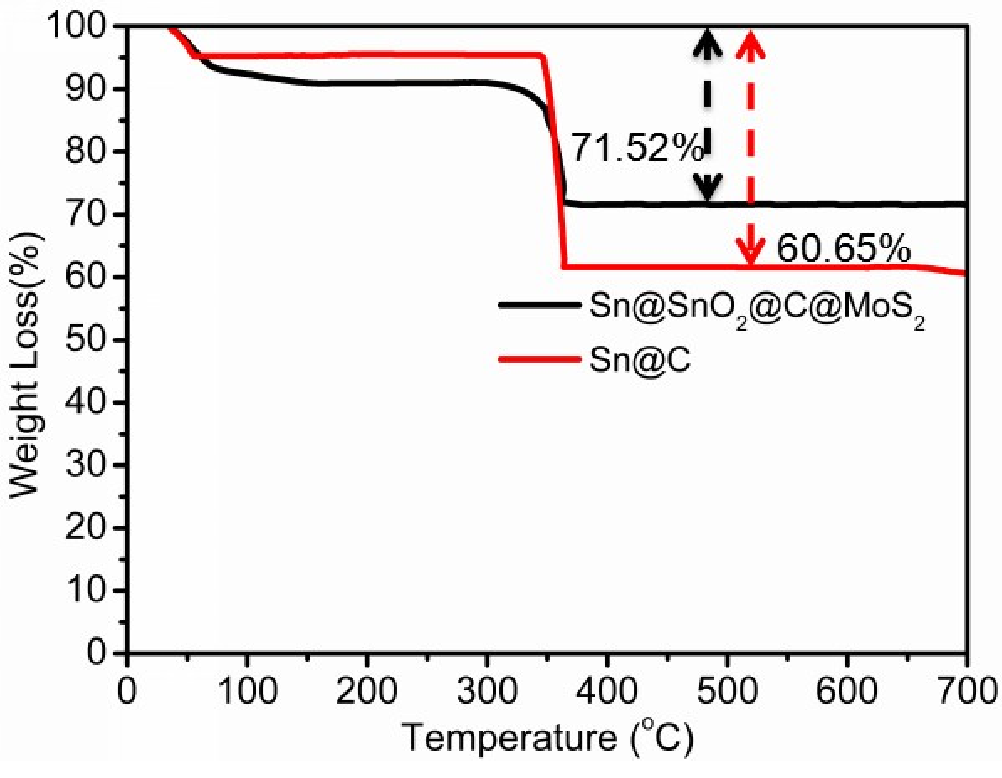

Fig. S3 TGA curves of the Sn@SnO_2@C@MoS_2 composite.

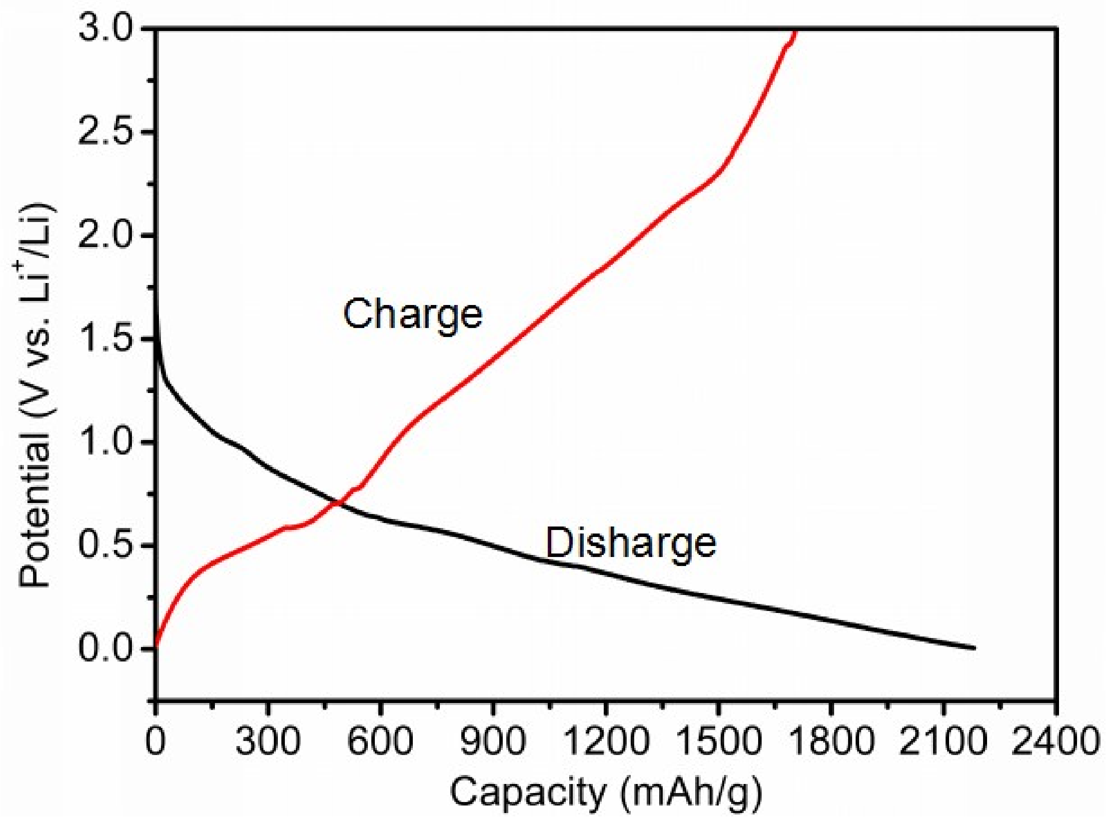

Fig. S4 First discharge-charge curves of the $Sn@SnO_2@C@MoS_2$ composite.

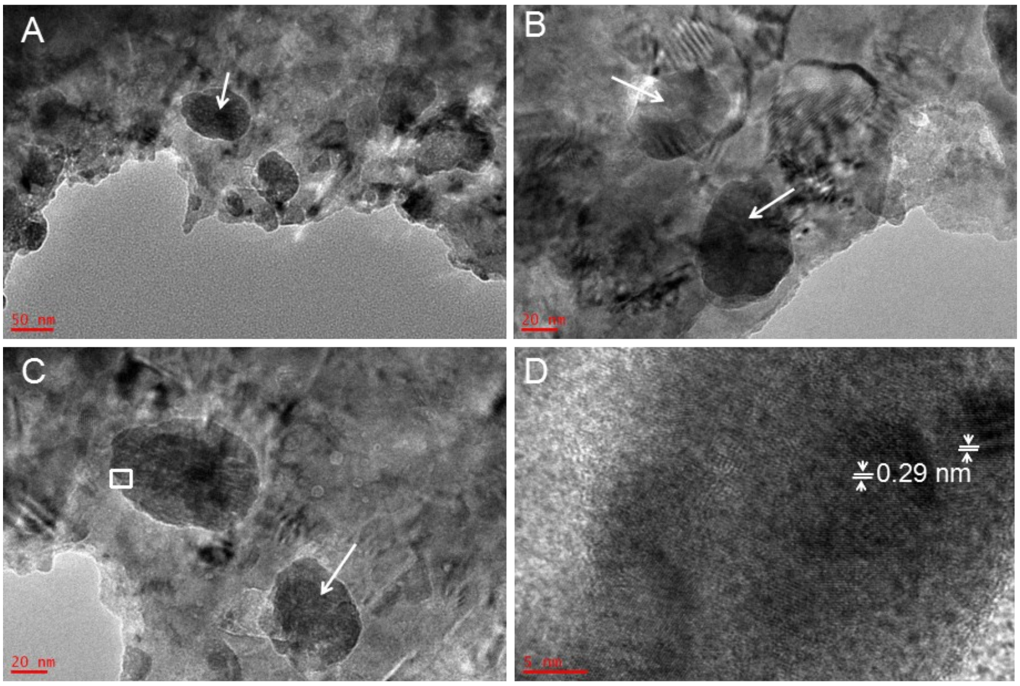

Fig. S5 TEM images of $Sn@SnO_2@C@MoS_2$ composite after 400 cycles at current density of 1.0 A/g.