Supporting Information

Dopamine-Assisted Synthesis of MoS_2 Nanosheets on Carbon Nanotube for Improved Lithium and Sodium Storage Properties

*Han Zhou, Ruifang Zhang, Shili Song, Chunhui Xiao, Guoxin Gao, Shujiang Ding**

Department of Applied Chemistry, School of Science, MOE Key Laboratory for Nonequilibrium Synthesis and Modulation of Condensed Matter, State Key Laboratory for Mechanical Behaviour of Materials, State Key Laboratory of Electrical Insulation and Power Equipment, Xi'an Jiaotong University, Xi'an-710049, China

* Corresponding author: dingsj@xjtu.edu.cn

Experimental Section

1. Materials synthesis:

1.1 Synthesis of polydopamine@CNTs (PDA@CNT).

The synthesis of PDA@CNT were according a previously reported method.[27] First, CNTs (50 mg) were washed with 50 mM tris(hydroxymethyl) aminomethane-chloride acid (Tris-HCl) buffer (pH = 8.5) and centrifuged for three times. Then the washed CNT (50 mg) were dispersed into 100 mL 50 mM Tris-HCl by sonication, then added with 200 mg DA. The mixture was strong stirred for 24 h at room temperature, and the product was collected by centrifugation, washed with Tris-HCl buffer, and followed by drying in vacuum at 60 °C overnight, respectively.

1.2 Synthesis of MoS_2@CNT

In a typical synthesis of MoS_2@CNT, PDA@CNT (50 mg) was dispersed into 10 mL ethanol and 25 m deionized water by ultrasonication for 5 min. Then, 0.3 g sodium molybdate hexahydrate ($Na_2MoO_4 \cdot 6H_2O$) and 0.6 g thiourea was added with continuous stirring. The solution was transferred into a Teflon-lined stainless steel autoclave (50 mL) and reacted at 200 ^oC for 24 h. The autoclave was then cooled to room temperature. The black precipitate was collected by centrifugation, washed thoroughly with ethanol, and finally dried at 80 ^oC for 12 h. The as-prepared MoS_2@PDA@CNT material was further treated at 500 ^oC in an atmosphere of H_2-N_2 (5:95, Volume/Volume) for 3 h with a heating rate of 1 ^oC min^{-1} obtain MoS_2@CNT.

2. Characterization

SEM was carried out using a JSM-7000F field-emission scanning electron microscopy (JEOL, Tokyo, Japan). TEM was performed by using a JEM-2100 transmission electron microscope (JEOL, Tokyo, Japan). Crystallographic information of the sample was collected using powder X-ray diffraction (XRD; SHIMADZU, Lab X XRD-6000). Thermogravimetric analysis (Perkin-Elmer TGA 7) was carried out under a flow of air with a temperature ramp of 10 oC/min from room temperature to 800 ^oC. The surface properties of the as-made samples were studied by X-ray photoelectron spectroscopy (XPS, Thermo Fisher Scientific ESCALAB Xi+).

3. Electrochemical Measurements

For electrochemical measurements, the working electrode was prepared by mixing 70 wt% of the active material (MoS_2@CNT), 20 wt% of conducting agent (carbon black, super-P-Li), and

10 wt% of binder (polyvinylidene difluoride, PVDF, Aldrich). Then it was uniformly cast onto a Cu foil and vacuum dried at 60 ^{o}C overnight. The loading mass of the active materials was ~ 1.0 mg cm^{-2}. The cells (CR 2016) were assembled in an Ar-filled glove box (O_2≤0.3 ppm, H_2O≤0.1 ppm). Sodium (lithium for LIBs) serves as both the counter electrode and the reference electrode. For NIBs, the electrolyte is 1M $NaClO_4$ in ethylene carbonate (EC) and diethyl carbonate (DEC) (1:1 v/v) with 5% fluoroethylene carbonate (FEC) additive. For LIBs, the electrolyte is 1.0 M $LiPF_6$ in EC and DEC (1:1 v/v). Cyclic voltammetry was performed using an electrochemical workstation (CHI 660D). The charge–discharge tests were performed using a NEWARE battery tester.

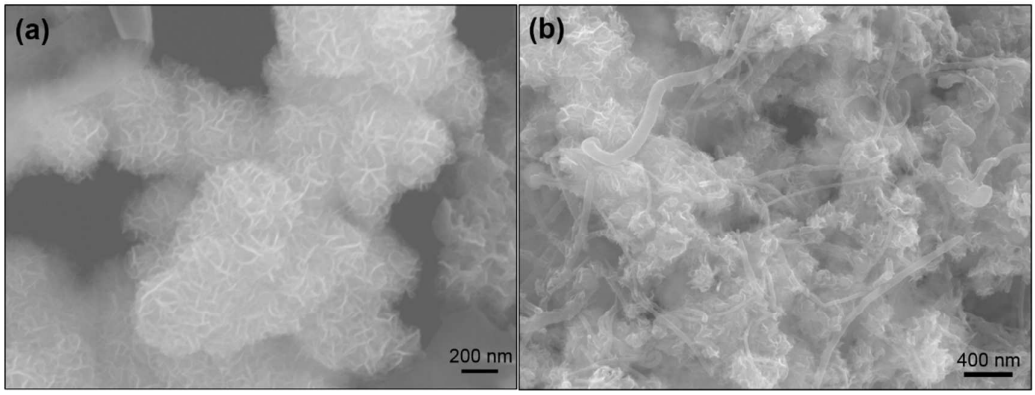

Figure S1. SEM images of a) pure MoS_2; b) MoS_2@CNT synthesized with untreated CNTs.

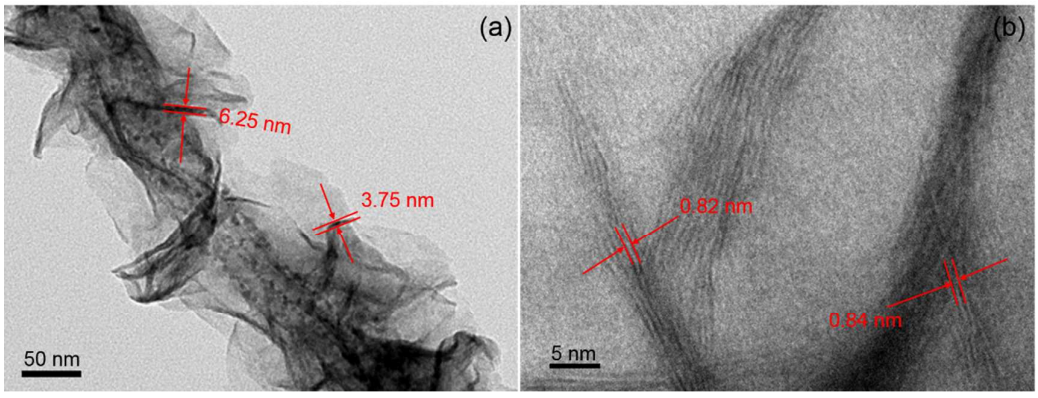

Figure S2 a) TEM iamge and b) HRTEM iamge of Mo_2@CNT.

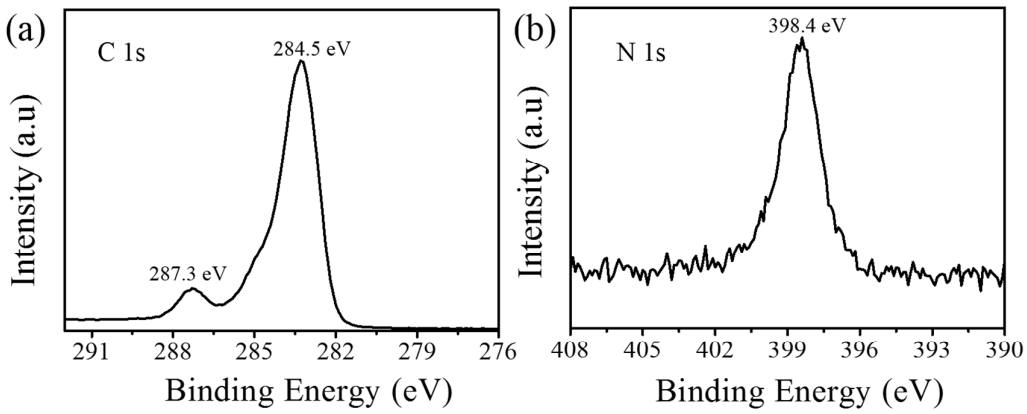

Figure S3. XPS partterns of a) C 1s and b) N 1s in MoS_2@CNT.

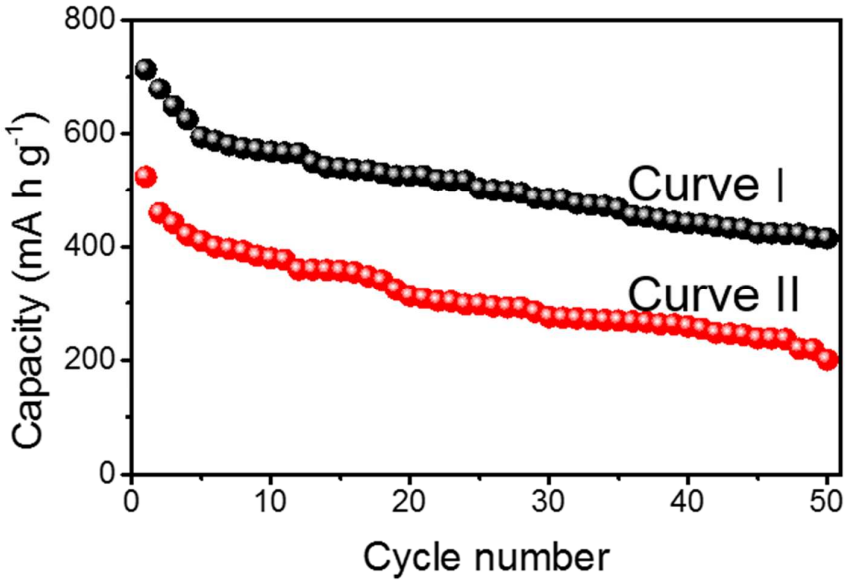

Figure S4 Cycling performance of MoS_2@CNT without polydopamine at current density of 200 mA g^{-1}. Curve I is the lithium ion storage property and Curve II is the sodium ion storage property.

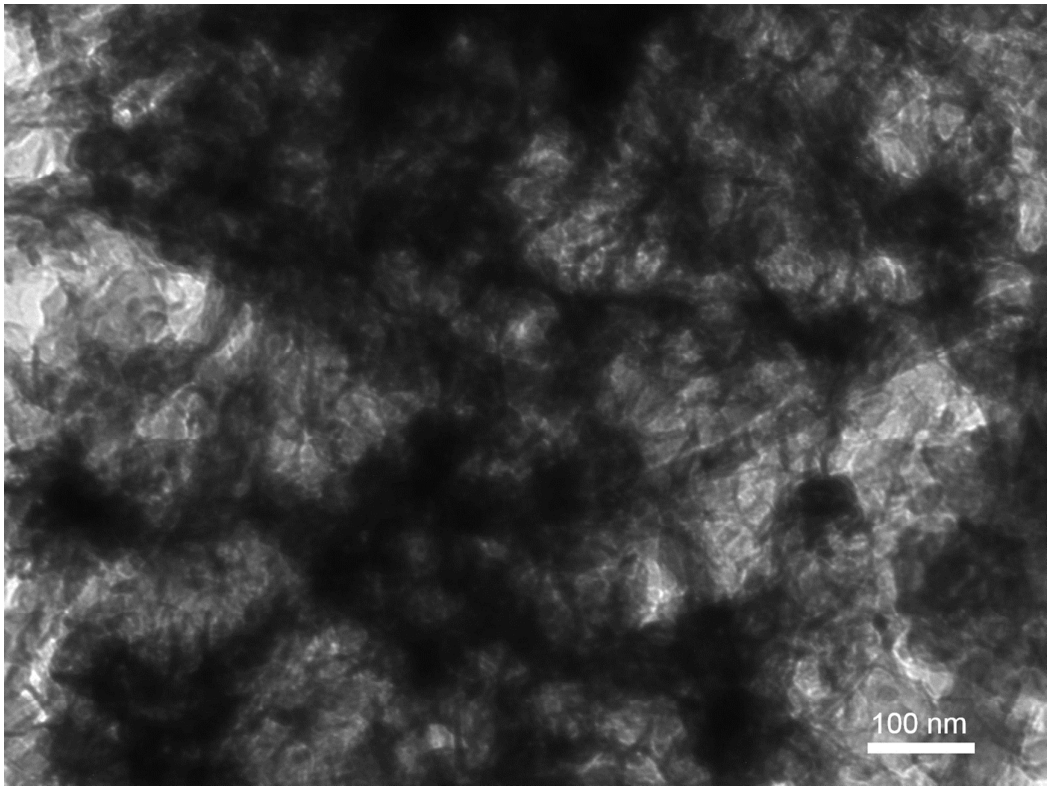

Figure S5 TEM images of MoS_2@CNT after 30 cycles.

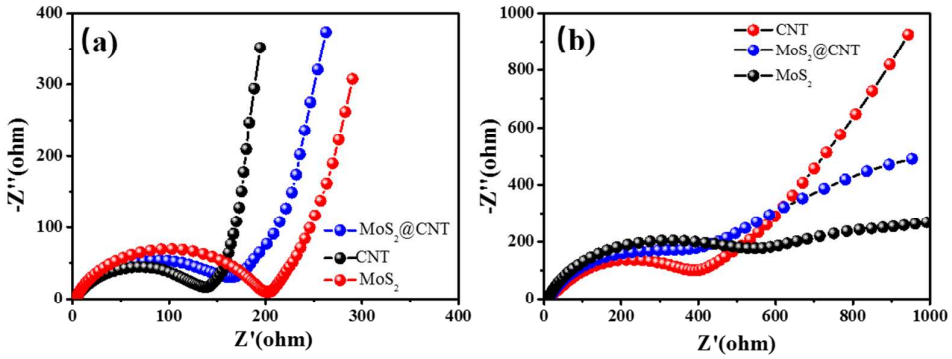

Figure S6. Nyquist plots of the MoS_2@CNT, pure MoS_2 and CNT anode a) incipient state; b) after 5 cycles.

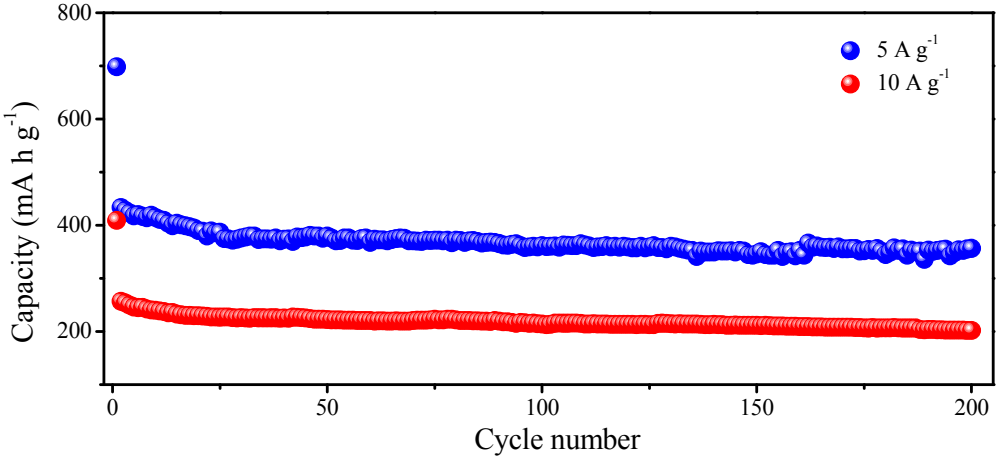

Figure S7 Cycling performance of MoS_2@CNT at 5 current density of 5 A g^{-1} and 10 A g^{-1}.

Table S1 Comparison of sodium ion storage performance of this present work with previous works.

Materials	Capacity (mAh g^{-1})	Current density(mAg^{-1})	Cycles	Ref.
MoS_2@rGo	305	100	50	1
MoS_2@C nanosheets	475	200	200	2
MoS_2@graphene foam	290	100	50	3
MoS_2@Carbon Fiber	286	80	100	4
MoS_2@C core shell	337	100	300	5
MoS_2@CNT	420.5	200	80	6
MoS_2@rGo	284	1000	160	7
MoS_2 nanosheets	161	20	100	8
MoS_2@rGo	339	500	300	9
MoS_2@Go paper	218	25	20	10
MoS_2@C network	443	1000	500	11
MoS_2@C	319	1000	1500	12
MoS_2@CNT	512.4	200	100	This work

Reference

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