Supporting Information

Crystalline coordination polymers derived MoS_2 quantum dot doped carbon nanoflakes with ultrafast Li^+ transfer

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Materials

All the reagents were used without further purification.

Dopamine hydrochloride (DA-HCl, 98%), sodium molybdate dehydrate ($Na_2MoO_4 \cdot 2H_2O$), sodium lauryl sulfate, sulfur powder were from Sigma-Aldrich.

MoS_2 quantum dot was from Xianfeng nano Materials Technology Co. Ltd.

Synthesis of MoS_2-N-C nanoflakes

In a typical process, 0.1 g sodium molybdate dihydrate was dissolved in 300 ml of deionized water with stirring, then 0.3 g sodium lauryl sulfate was dissolved in the solution with ultrasonic. Then, 0.1 g dopamine hydrochloride was added in the above solution with vigorous stirring. After stirring for 12 h, the generated 2D precursors were collected by suction filtration and washed with deionized water and ethanol for three times by centrifugal separation, then dried in air dry oven under 70 ^oC. Then the as-synthesized 2D precursor were mixed with excess sulfur powder by grinding and annealed under Ar flow atmosphere at 700 ^oC for 2 h, with a heating rate of 5 ^oC min^{-1}.

Synthesis of N-C nanoflakes

N-C nanoflakes was prepared by NaCl template method. In a typical synthesis, 100 mg dopamine hydrochloride was dissolved in 10 ml deionized water, then mixed well with 100 g NaCl, then the mixture was refrigerated at a low temperature for 24 h. Then the frozen mixture is freeze-dried for 2 days. Then the dried mixture was annealed under Ar flow atmosphere at 700 ^oC for 2 h, with a heating rate of 5 ^oC min^{-1}.

Then then products was wash with deionized water to remove NaCl template, then dried at 70 ^{o}C for use.

Materials characterization

Morphologies and structures of the products were characterized with scanning electron microscopy (SEM, Hitachi S-4800 field emission scanning electron microscope at an accelerating voltage of 10 kV and 15 kV) and transmission electron microscopy (TEM, FEI Tecnai G2 S-Twin instrument). The N_2 adsorption–desorption isotherm was performed on a Micromeritics ASAP 2020 instrument. The crystallographic information was collected by a powder X-ray diffraction (XRD, Bruker D8 Focus and D/max 2500pc power X-ray diffractometer using Cu Kα radiation at a scan rate of 5° min^{-1}). Thermogravimetric (TGA) curve was carried out on a STA 449 °C Jupiter (NETZSCH) thermogravimetry analyzer from room temperature to 800/1000 °C under air atmosphere with a heating rate of 10 °C min^{-1}. X-ray photoelectron spectroscopy (XPS) characterizations were carried out in an ESCALAB 250 instrument with 150 W Al Kα probe beam.

Electrochemical measurements

The anode electrode slurry for lithium-ion battery was prepared by mixing 70% MoS_2-N-C powders, 20% carbon black as conductive agent and 10% polyvinylidene fluoride (PVDF) as binder with N-methylpyrrolidone (NMP) dispersion medium, and then coated evenly onto a copper foil (thickness of 10 μm) where the content of active material was around 1 mg cm^{-2}. A solution of 1 M $LiPF_6$ dissolved in ethylene carbonate (EC) and dimethyl carbonate (DMC) with a volume ratio of 1:1 was

employed as electrolyte. The coin cells (CR-2025) contained Cellgard 2300 separator and lithium foils asthe counter electrode. The charge-discharge performances were tested galvanostatically in the voltage range of 0.01 to 3.0 V at various current densities using a programmable battery testing system (LAND CT2001A) at 25 ^{o}C.

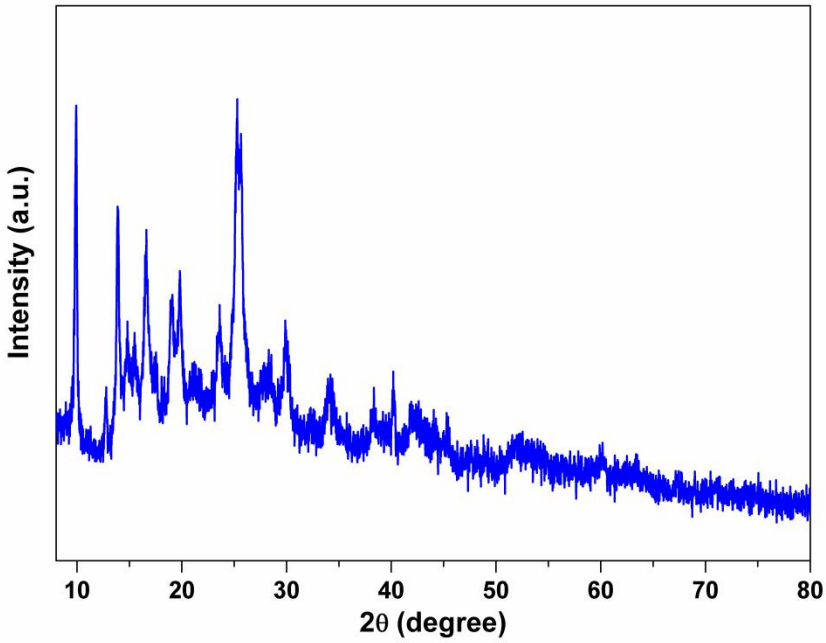

Fig. S1 XRD pattern of 2D Molybdate - dopamine precursor.

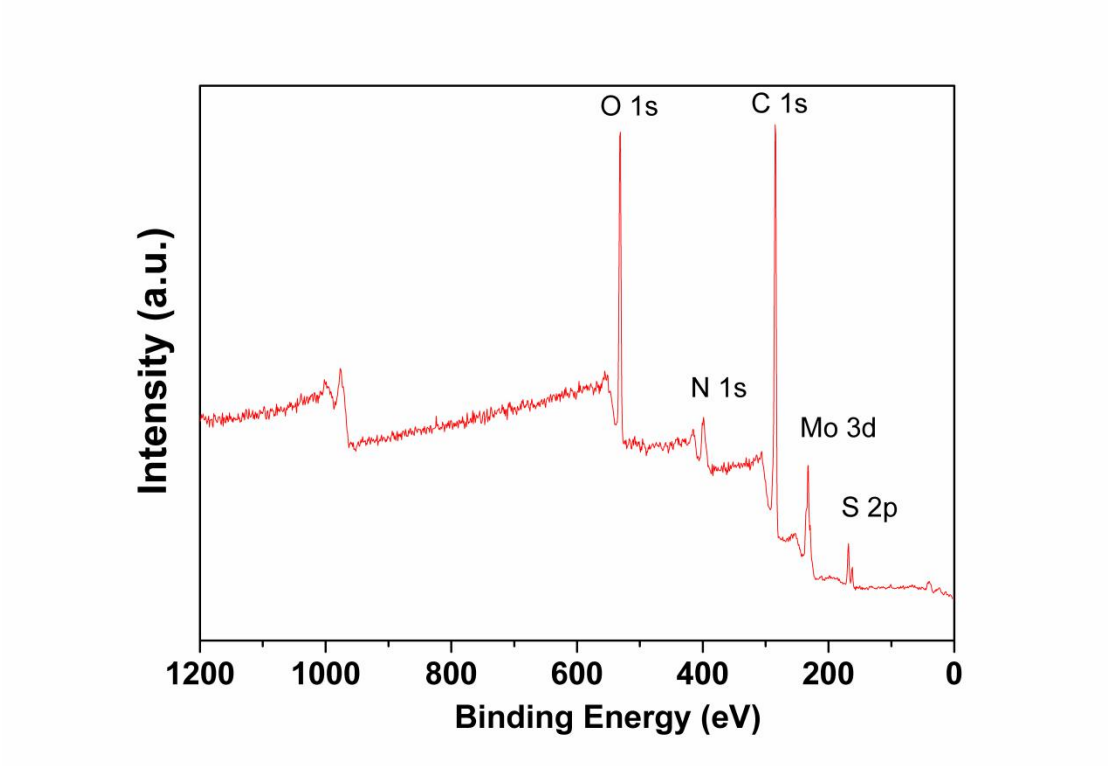

Fig. S2 XPS pattern of MoS_2-N-C nanoflake.

The mass content of MoS_2 could be calculated by the equations:

$$m(MoS_2) = m(MoO_3) * M(MoS_2) / M(MoO_3) \quad \text{(S1)}$$

$$=49.1\%*160/144=54.56\%$$

According to the equations, the mass contents of MoS_2 is 54.56%.

Table S1- Surface element distribution by XPS

Name	Peak BE	FWHM eV	Area (P) CPS.eV	Atomic %
C1s	284.63	1.71	29389.98	75.84
N1s	397.82	2.99	3181.3	5.08
S2p	931.84	1.47	5082.04	0.98
Mo3d5	231.91	1.22	2846.53	1.11
O1s	532.44	4.6	17421.59	16.99

The content of N = (1-54.56%)*(14/(14+12*15))=3.28%

By XPS analyses, the atomic ratio of C and N on the surface of the MoS_2-N-C is 15:1, presumably, C and N in the whole structure than the same as the 15:1, ignore the influence of oxygen after surface oxidation in the process of test, combined with the result of TG, the content of N in the sample is about 3.28%.

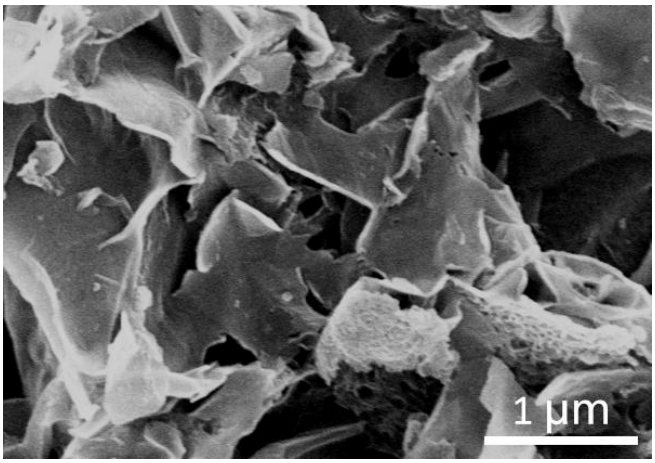

Fig. S3 SEM image of N-C nanoflake.

Table. S2 Summary of electrochemical performances of different MoS_2-based anodes for lithium-ion battery.

Sample	Current density (A g^{-1})	Maximum stable capacity（mA h g^{-1}）	Cycle number	Capacity retention (%)	Refer.
ANL MoS_2@CNFs	1	802	500	75	*Chem. Commun.*, 2020,56, 141-144
NDG/MoS_2/NDG	0.1	600	600	92	*Nano Energy.* 2017, 41, 154-163
Layered C_3N_4/NRGO/MoS_2	0.1	938	100	91	*Nano Energy.* 2014, 8, 157-164.
MoS_2@CMK-3 Nanocomposite	0.25	824	100	73	*Nanoscale.* 2012, 4, 5868-71
Core-shell MoS_2	0.1	690	100	94	*Small*. 2014, 10, 4975-4981.
Quasi-hollow C@MoS_2	0.1	900	200	91	*Journal of Materials Chemistry A.* 2016, 4, 10425-10434.
MoS_2 Quantum dots-N-C	2 /5 /10	914 /626 /509	500 /600 /1950	80 /75 /51.2	*This work*