Supporting Information

Sulfur Nanodots as Antiblocking Agent of MoS_2 for Stable Sodium Ion Battery Anodes

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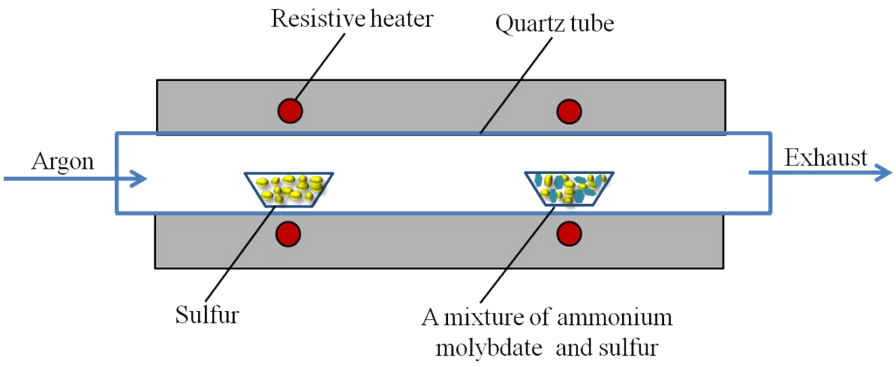

Figure S1. Diagram for the synthesis of the S/MoS_2 in a horizon tube furnace with two heating zones at the atmosphere of argon. A mixture of sulfur and ammonium molybdate as the starting materials for synthesis of MoS_2 was placed in the behind zone. Sulfur for deposition placed in the front zone was sublimed after heating.

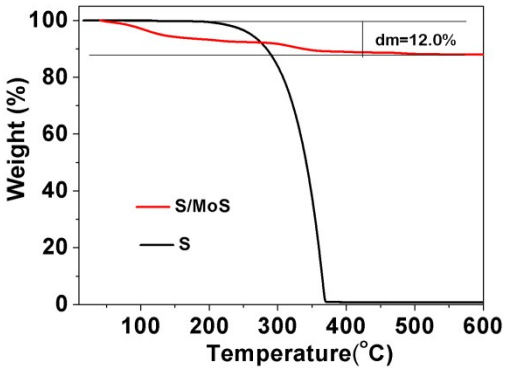

Figure S2. TGA curves of the S/MoS_2 with S as a baseline.

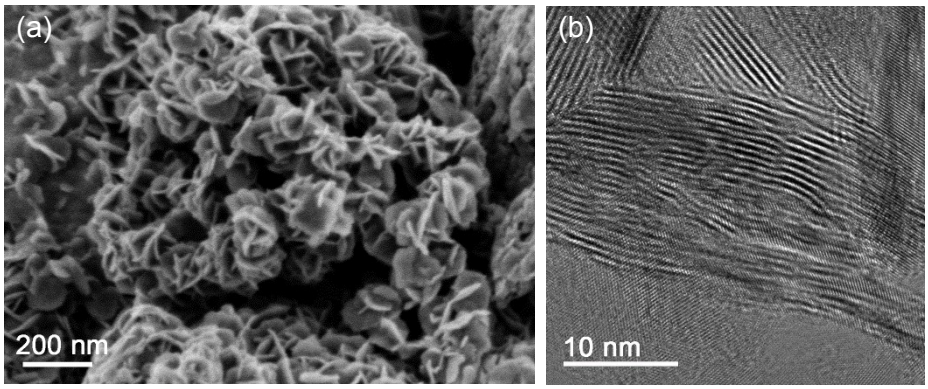

Figure S3. (a) SEM micrograph, and (b) HRTEM image of the MoS_2.

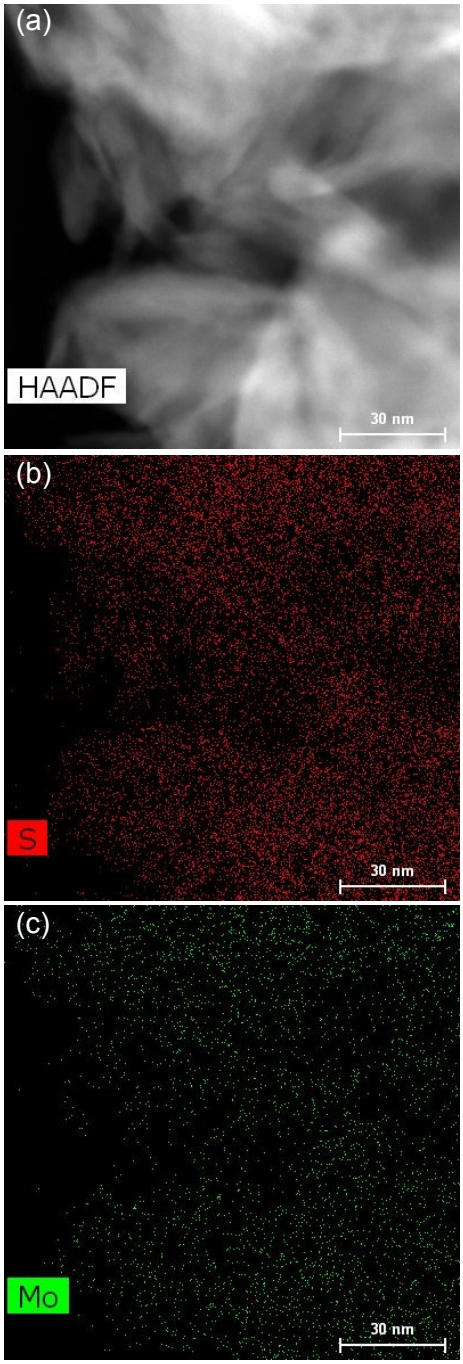

Figure S4. (a) TEM image and elemental mappings of (b) S, (c) Mo in the S/MoS_2.

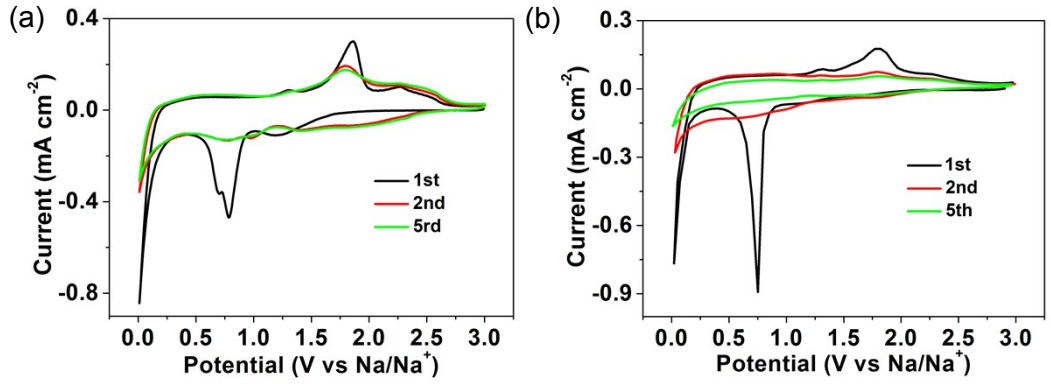

Figure S5. CV curves of (a) S/MoS_2 and (b) pure MoS_2.

The cycle voltammetry (CV) curves of the S/MoS_2 architectures and the pure MoS_2 display in Figure S5. The CV curves of the S/MoS_2 architectures and pure MoS_2 at the first scan show a broadening peak at 1.2 V corresponding to Na^+ intercalation to interlayer of MoS_2. A sharp and strong peak appears at 0.75 V, indicating MoS_2 conversion to Mo and Na_2S.[16] A very sharp and narrow reduction peak at 0.005 V appeared during the first negative scan contribute to Na^+ storage in the interface between Na_2S and Mo.[31] From the second negative scan, the broad wave occurred at 0.75 V, suggesting formed SEI.

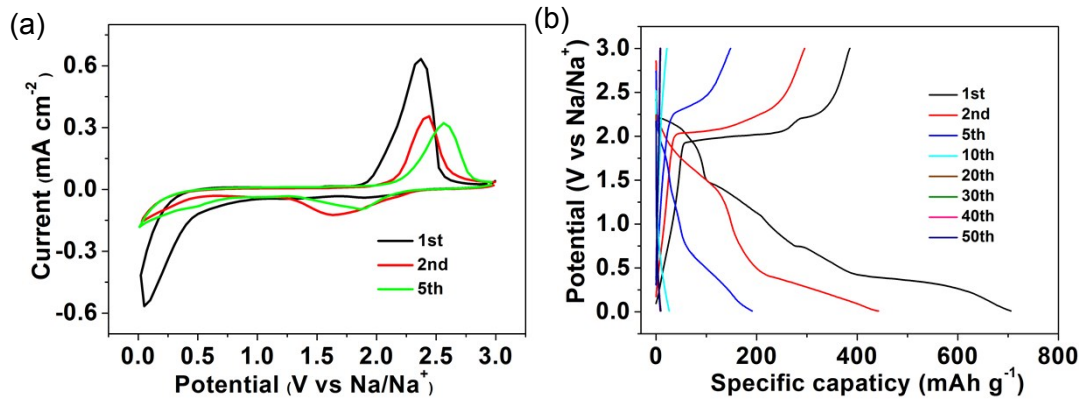

Figure S6 . (a) CV curves and (b) galvanostatic discharge/charge profiles of the baseline S.

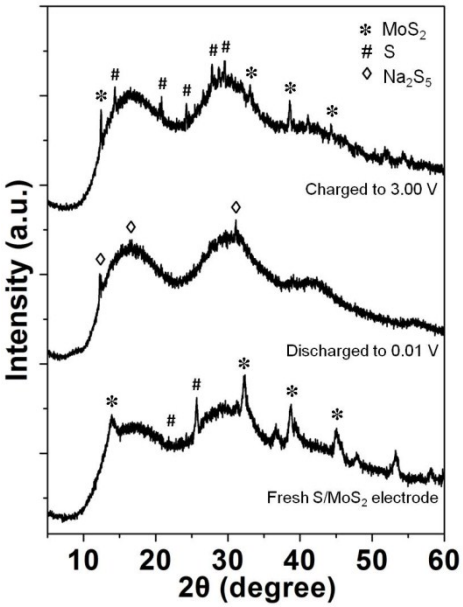

Figure S7 .XRD patterns of the fresh S/MoS_2 electrodes, discharged electrodes and charged electrodes.

The ex-situ XRD was carried out to study electrochemical mechanism of the S/MoS_2 electrodes. The cells were discharged to 0.01 V and charged to 3.00 V when they 50 cycled. Before XRD measurements, the electrodes were cleaned with DMC and were scraped off the active substance (fresh electrodes as a comparison). The XRD pattern of the fresh S/MoS_2 electrodes displays the strong peaks at 14.40°, 32.70°, 39.56°, 45.00°, assigned to the 2-H MoS_2 crystal (JCPDS 65-0160). The peak appears at 25.85° corresponding to sulfur (JCPDS 08-0247). After charged to 0.01 V, the three week peaks at 12.41°, 16.46°, 31.21° are indexed to Na_2S_5 (JCPDS 27-0792). Different from the conversion reaction of general MoS_2 in SIB to obtain Na_2S. Obtaining Na_2S_5 is possibly because S is involved in the conversion reaction.[16] The S in the electrodes can be observed when the electrodes were charged to 3.00 V, corresponding diffraction peaks at 14.38°, 20.79°, 24.25°, 27.85° and 29.51°, which indicates reversible transformation of S during discharge/charge. The peaks of MoS_2 are also observed, demonstrating S/MoS_2 electrochemically reacts with Na^+ through reversible conversion reaction.[16, 51]

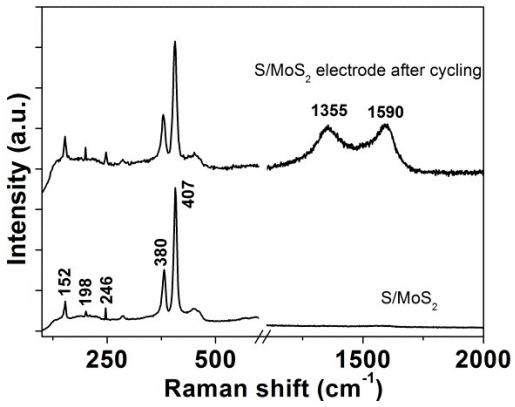

Figure S8 .Rama spectra of as-prepared S/MoS_2 composite and the S/MoS_2 electrode after 50 cycles.

Table S1. Typical Randles circuit resistance values of S/MoS_2 and bare MoS_2 after 5 cycles and 50 cycles.

Materials	Cycles	$\mathbf{R_e}$	$\mathbf{R_{sei}}$	$\mathbf{R_{ct}}$
S/MoS_2	5	13.31	28.21	72.89
	20	11.4	44.83	158.2
MoS_2	5	5.98	15.14	43.56
	50	22.57	105.80	537.00

Table S2. Comparison of the capacity values of the S/MoS_2 with the state-of-the-art MoS_2 in literatures.

Materials	Synthesis method	Current density [mA g^{-1}]	Capacity [mAh g^{-1}]	Voltage [V]	Reference
S/MoS_2	S nanodots deposited on few-layer MoS_2	100, 500, 1000, 2000	482, 366, 286, 238	0.01-3	This work
MoS_2@AMCRs	Few-layer MoS_2 anchored at nitrogen-doped carbon ribbons by pyrosis step	50, 100, 500, 1000, 2000	450, 425, 350, 310, 300	0.01-3	Pang et al. [48]
MoS_2/Graphene	Acid-exfoliated few-layer molybdenum disulfide and reduced graphene oxide flakes	25, 200	240, 173	0.01-2.25	David et al. [10]
Few-layer MoS_2 nanosheets	Liquid-Phase Exfoliation by NMP	10, 20, 40, 200, 400, 800	180, 165, 160, 140, 125, 115	0.4-2.8	Bang et al. [49]
MoS_2−x nm-TiO_2	ALD TiO_2-Coated Flower-like MoS_2 Nanosheets on Carbon Cloth	500	280	0.01−2.5	Ren et al. [50]
freestanding MoS_2@C	molybdenum disulfide nanosheets aligned vertically on carbon paper	40, 80, 320, 640, 1000	348, 321, 271, 230, 205	0.01-3	Xie et al. [51]
Micro-MoS_2	Na intercalation in MoS_2	50, 100, 150	420, 339, 290	0.01-3	Wang et al. [52]
MoS_2 Nanoflowers	Hydrothermal method	50, 200, 1000	350, 320, 300	0.4-3	Hu et al. [15]
Ultrathin MoS_2 Nanosheets	Exfoliation of MoS_2	40, 80, 160, 320	500, 330, 305, 251	0.01-3	Su et al. [21]
MoS_2–PEO	Interlayer expanded by insertion of PEO	250, 500, 1000	140, 125, 110	0.4-3	Li et al. [24]
Freestanding Metallic 1T MoS_2	the metallic 1T MoS_2 sandwich grown on graphene tube	500, 800, 1000, 1500, 2000	241, 222, 208, 190, 175	0.01-3	Geng et al. [12]