Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Rational Design of Interlayer Expanded MoS_2-N/O doped Carbon Tubular Composite for Excellent Potassium-Ion Storage

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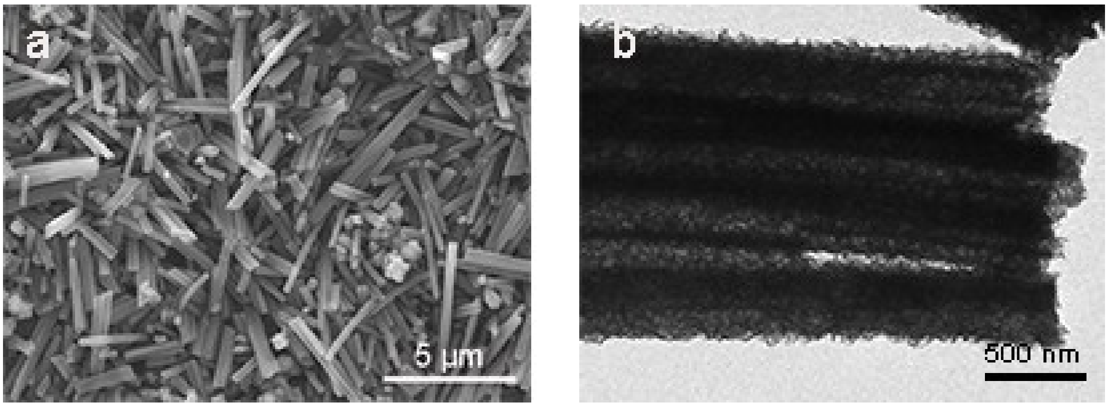

Fig. S1 a) FESEM image and b) FETEM image of E-MoS_2/NOC TC at low magnification.

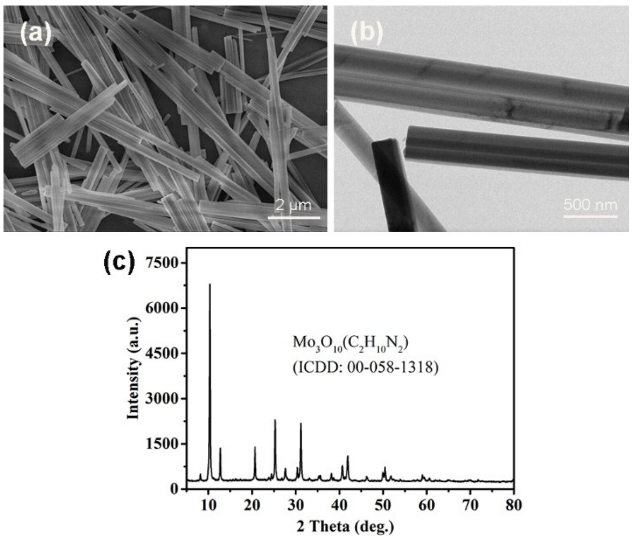

Fig. S2 a) FESEM image, b) TEM image, and c) XRD patterns of MoO_3-EDA.

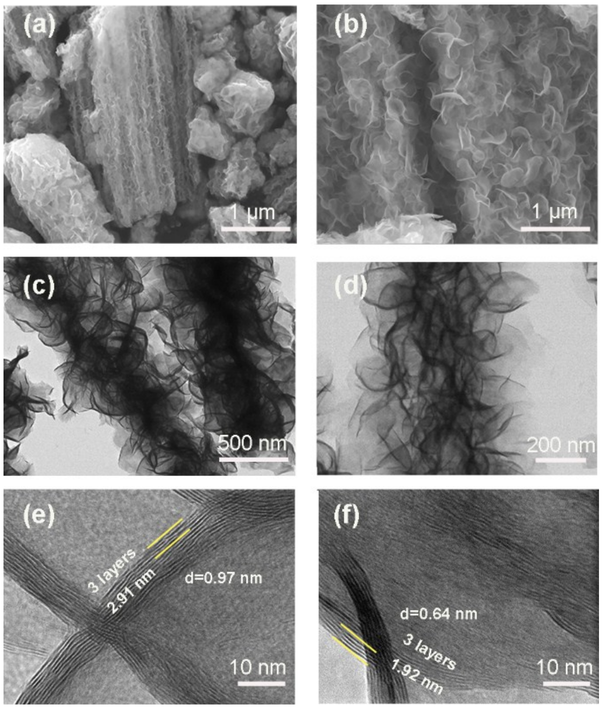

Fig. S3 FESEM images of a) E-MoS_2 NWs and b) MoS_2 NWs. TEM images of c) E-MoS_2 NWs and d) MoS_2 NWs. HRTEM images of e) E-MoS_2 NWs and f) MoS_2 NWs.

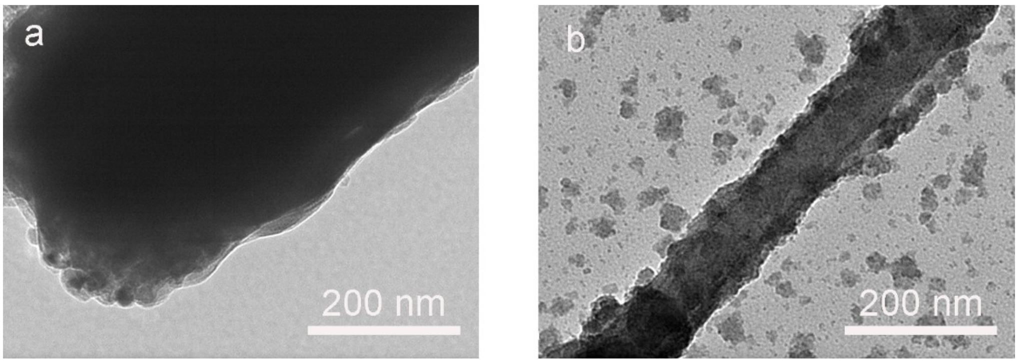

Fig. S4 TEM images of a) MoS_2 NWs and b) E-MoS_2/NOC TC after 100 cycles at 1000 mA g^{-1}.

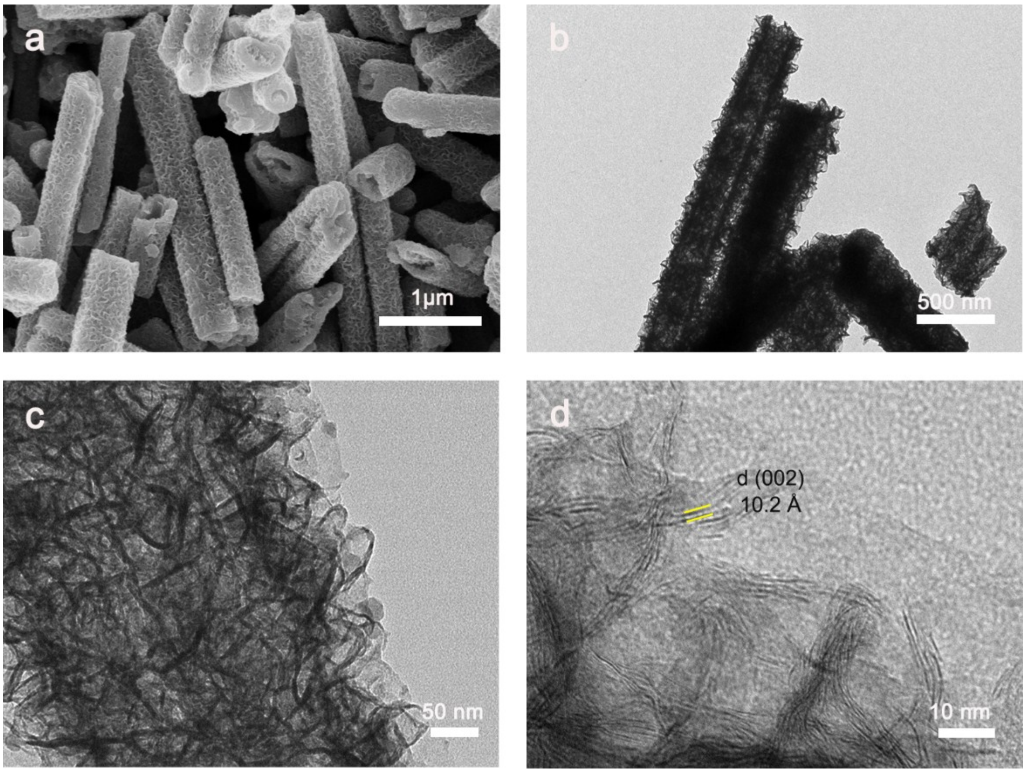

Fig. S5 FESEM images of a) E-MoS_2/PC TC. TEM images of b-c) E-MoS_2/PC TC. HRTEM images of d) E-MoS_2/PC TC.

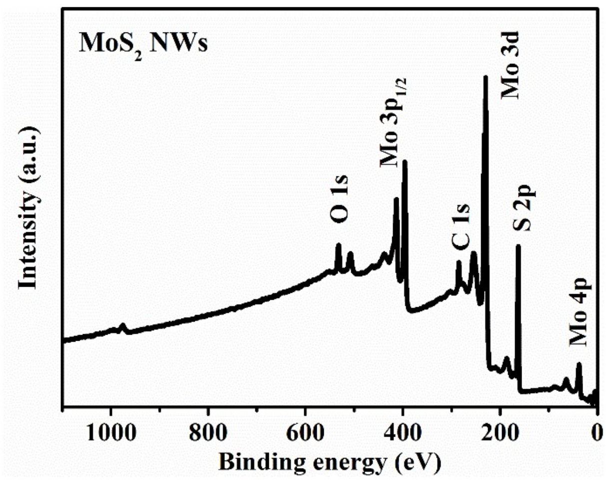

Fig S6 XPS survey scan of MoS_2 NWs.

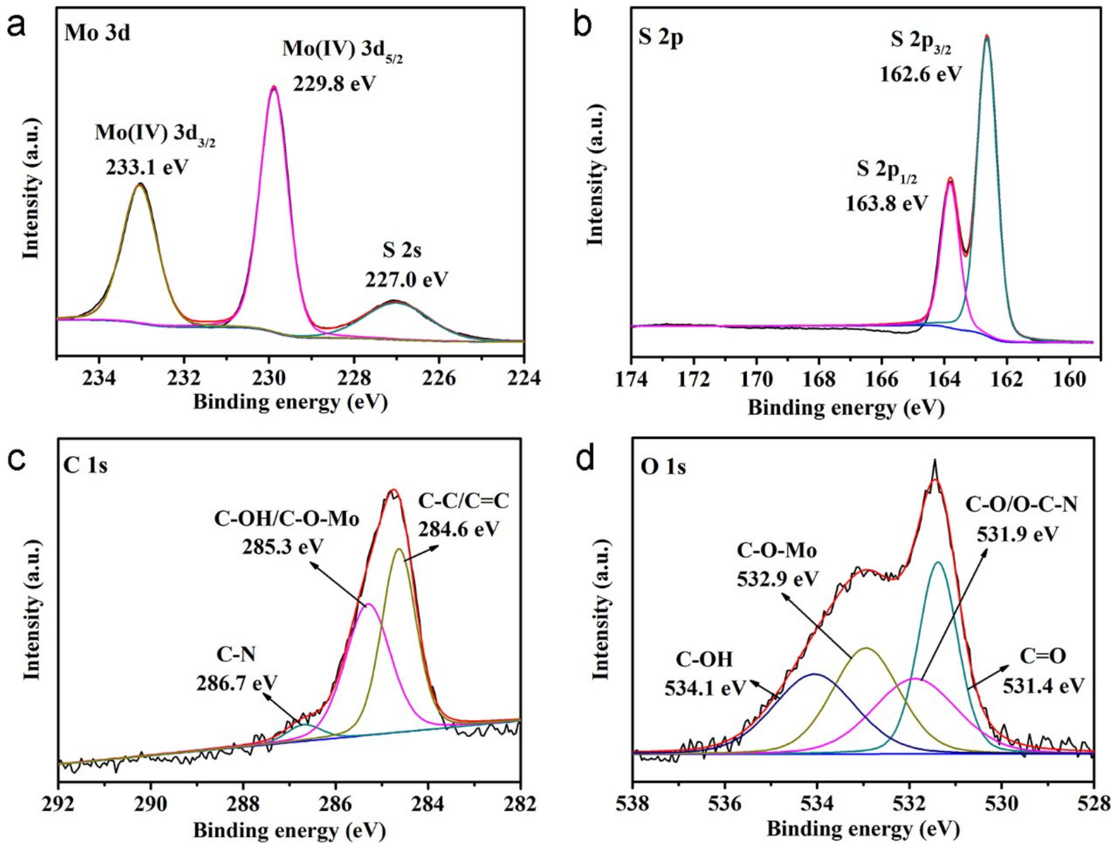

Fig. S7 High-resolution XPS spectra of a) Mo 3d, b) S 2p, c) C 1s, and d) O1s in MoS_2 NWs.

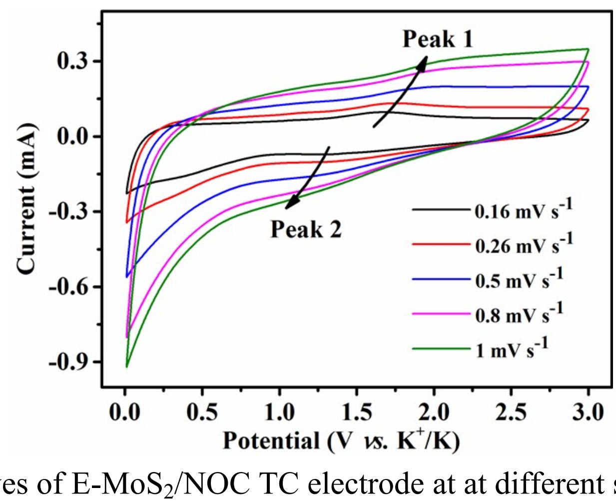

Fig. S8 a) CV curves of E-MoS_2/NOC TC electrode at at different scan rates.

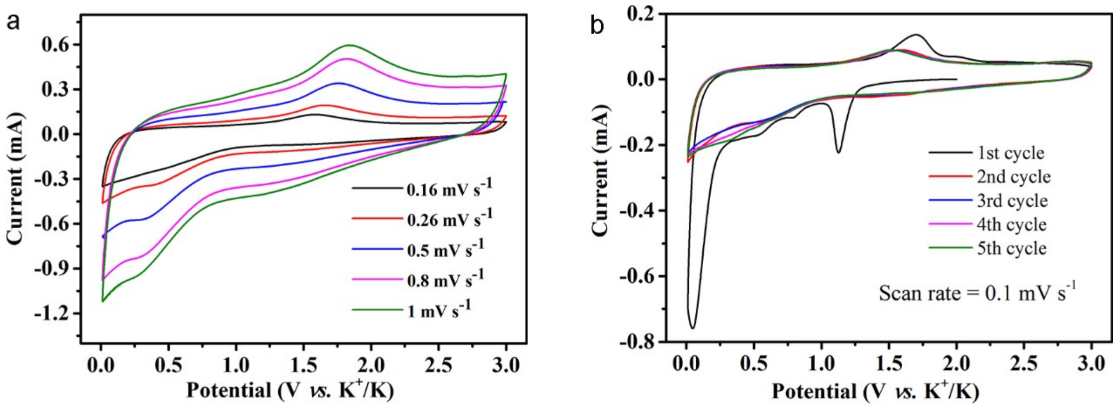

Fig. S9 a) CV curves of MoS_2 NWs electrode at at different scan rates; b) CV curves of MoS_2 NWs electrode for the first five cycles at a scan rate of 0.1 mV $^{-1}$.

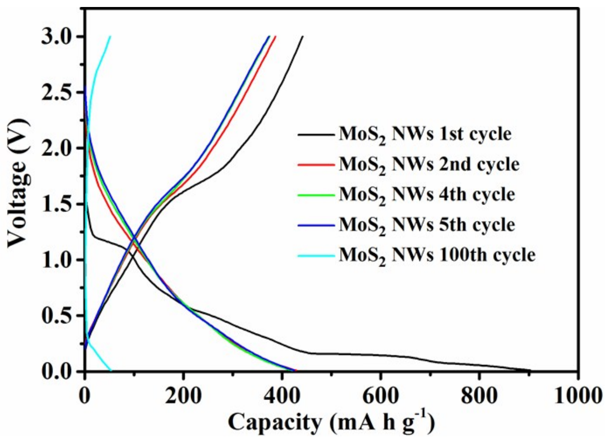

Fig. S10 Charge/discharge curves of MoS_2 NWs electrode for the first, second, forth, fifth and the hundredth cycles at a current density of 250 mA g^{-1}.

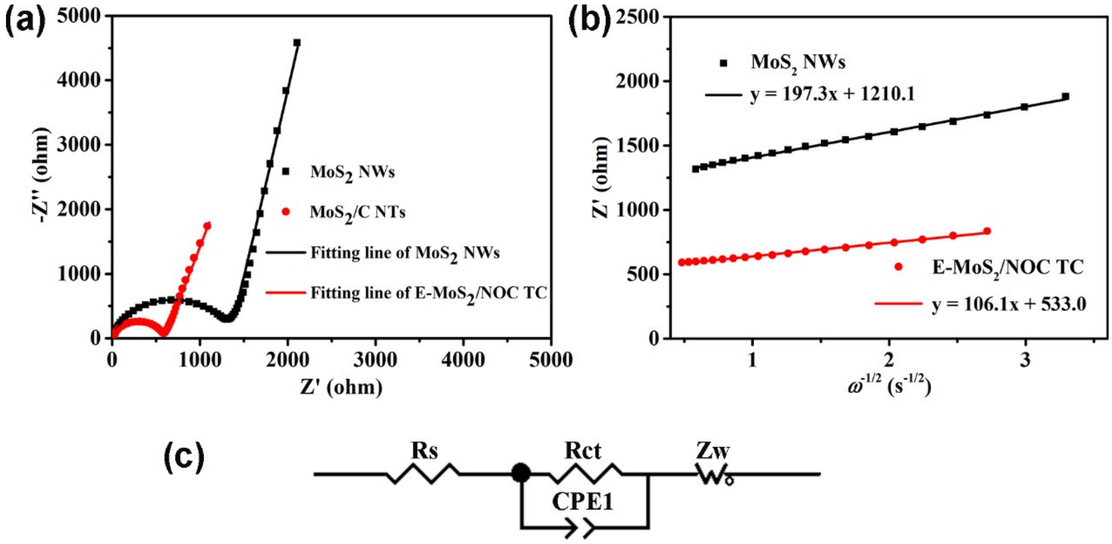

Fig. S11 (a) Nyquist plots and fitting line of the E-MoS_2/NOC TC and MoS_2 NWs the fresh electrodes. (c) Equivalent circuit used for fitting the EIS data. (b) Fitted lines and real part of impedance versus $\omega^{-1/2}$ for E-MoS_2/NOC TC and MoS_2 electrodes (Rs: the internal resistance of the coin-cell battery; Zw: the Warburg impedance; Rct: the charge-transfer resistance; CPE1: the constant phase-angle element that involves double layer capacitance).

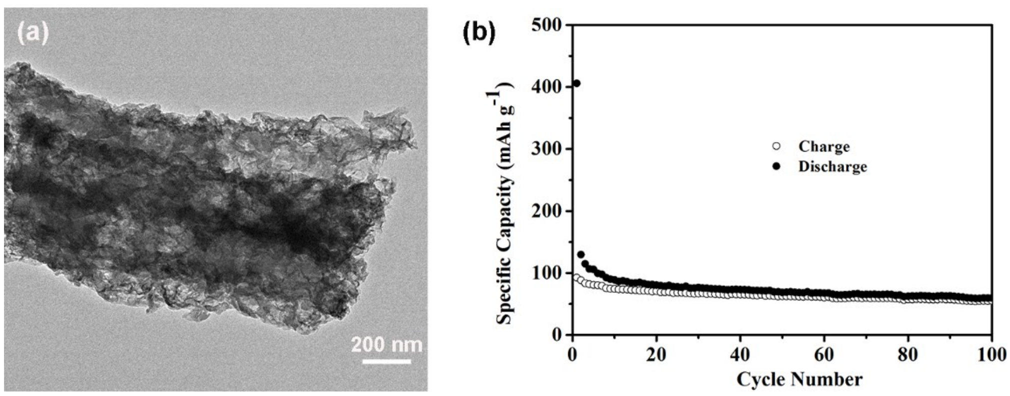

Fig. S12 a) TEM images of N/O-doped carbon skeleton prepared from E-MoS_2/NOC TC via removing MoS_2 by chloroazotic acid washing; b) cyclic performance of N/O-doped carbon skeleton electrodes at a current density of 250 mA g^{-1}. N/O-doped C nanotubes still keep the overall structural stability of E-MoS_2/NOC TC, which shows that MoS_2 is perfectly coated by N/O-doped carbon.

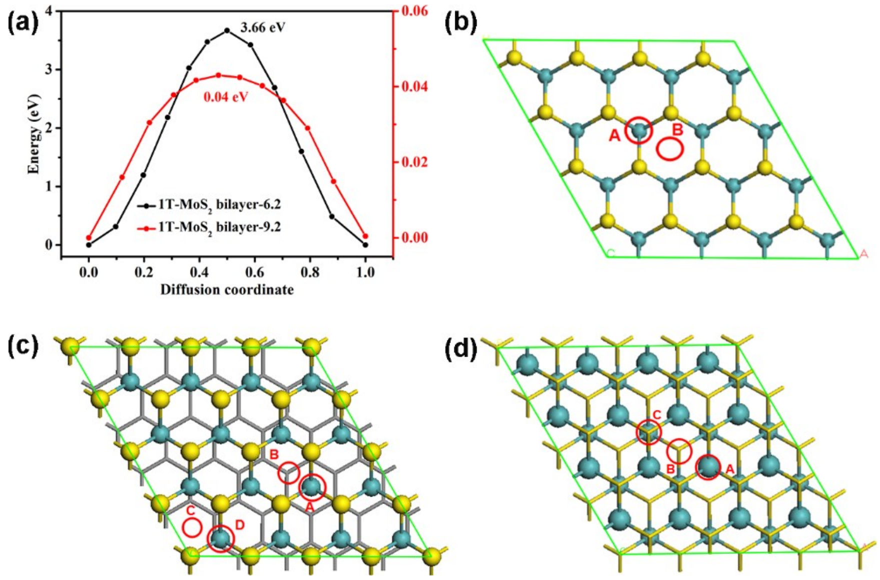

Fig. S13 a) Energy profiles along the diffusion path in the selected interlayer distances of 1T-MoS_2/MoS_2. b) Two representative configurations of one K confined in-between 2H-MoS_2/MoS_2 bilayer. A: Mo^{top}-S^{top}, B: Mo^{hollow}-Mo^{hollow}. Configuration A is the stable when the interlayer distance is 9.7 Å, while configuration B is stable when the interlayer distance is 6.2 Å. c) Four representative configurations of one K confined in-between MoS_2/C bilayer. A: Mo^{top}-graphene^{hollow}, B: Mo^{hollow}-C^{top}, C: Mo^{hollow}-graphene^{hollow}, D: Mo^{top}-C^{top}. Configuration A is the most stable one for the considered interlayer distances (6.2 and 9.2 Å). d) Several representative configurations of one K confined in-between 1T-MoS_2/MoS_2 bilayer. A: Mo^{top}-Mo^{hollow} , B: Mo^{hollow}-S^{top}, C: S^{top}-Mo^{top}. Each configuration is considered by putting K atom close to the top MoS_2 layer or far away from top MoS_2 layer. When the interlayer distance is 6.2 Å, configuration A is the most stable one, where the Mo^{top}-K distance is 3.2 Å. When the interlayer distance is 9.7 Å, configuration A is the most stable one,where the Mo^{top}-K distance is 4.3 Å.

Table S1. Mass percents of MoS_2 NWs and E-MoS_2/NOC TC with EA measurements

Material	C (wt %)	N (wt %)	S (wt %)	O (wt %)
MoS_2 NWs	2.0	0.6	35.0	4.1
E-MoS_2/NOC TC	10.6	1.7	25.7	2.9

Table S2. Structural Parameters for the MoS_2 NWs and E-MoS_2/NOC TC with N_2 sorption analysis.

Sample	S_{BET} (m^2/g)	V (cm^3/g)	d (nm)
MoS_2 NWs	15.9	0.09	2.6
E-MoS_2/NOC TC	53.9	0.26	2.6 & 37.8

Table S3. Summary of EIS fitting results of E-MoS_2/NOC TC and MoS_2 NWs fresh electrodes.

Sample	Rs (Ω)	Rct (Ω)	σ
MoS_2 NWs-Initial	3.2	1280	88.1
E-MoS_2/NOC TC - Initial	2.8	469	53.8

Table S4. Comparison of the potassium storage cycling performance of the recent anode materials.

Sample	Current density: mA/g	Capacity: mAh/g	Cycle number	Reference
E-MoS_2/NOC TC	250	247.8	100	This work
	1000	231.5	100	
Graphite	139.5	100	50	1
PC graphite	10	150	175	2
Hard Carbon	27.9	216	100	3
MoS_2	20	63.8	200	4
$MoSe_2$/C	200	322	100	5
Alkalized Ti_3C_2MXene	200	42	500	6
Mesoporous Carbon	1000	159.8	200	7
$K_2Ti_8O_{17}$	20	111	50	8
Sn/C	25	105	30	9
$MoSe_2$/N-Doped C	1000	180	100	10
SnSb-graphene-carbon	100	275	100	11
$K_2V_3O_8$	100	84	180	12

Reference

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