Supporting information for

MoS_2 Architectures Supported on Graphene Foam/Carbon Nanotube Hybrid Films: Highly Integrated Frameworks with Ideal Contact for Superior Lithium Storage

By Jin Wang, Jilei Liu, Jingshan Luo, Pei Liang, Dongliang Chao, Linfei Lai, Jianyi Lin and Zexiang Shen**

J. Wang, Prof. Z. X. Shen
Energy Research Institute (ERI@N), Interdisciplinary Graduate School, Nanyang Technological University, Research Techno Plaza, 50 Nanyang Drive, 637553, Singapore
E-mail: Zexiang@ntu.edu.sg (Z.X. Shen)
E-mail: Lijy@ntu.edu.sg (J.Y. Lin)

J. Wang, J. L. Liu, J. S. Luo, P. Liang, D. L. Chao, Prof. Z. X. Shen
Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological University, 21 Nanyang Link, 637371, Singapore

P. Liang
College of Optical and Electronic Technology, China Jiliang University, Hangzhou 310018, China

L. F. Lai, Prof. J. Y. Lin
Energy Research Institute (ERI@N), Nanyang Technological University, 50 Nanyang Drive, 637553, Singapore

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Table S1 A survey of electrochemical properties of MoS_2 and its hybrid composites.

Electrode description	**1st Specific capacity ($mAhg^{-1}$)**	**1st Coulombic efficiency**	**Cycling stability**	**Rate performance**
Worm-like MoS_2 nanoarchitectures on GF/CNTs film (this work)	1568 mAh g^{-1} at 100 mA g^{-1}	79.8%	1112 mAh g^{-1} after 120 cycles at 200 mA g^{-1}	1368, 1140, 1064, 1006 and 823 mAh g^{-1} at 200, 500, 1000, 2000 and 5000 mA g^{-1}
Honeycomb-like MoS_2 nanoarchitectures on 3DGF [1]	1397 mAh g^{-1} at 100 mA g^{-1}	82.9%	1100 mAh g^{-1} after 60 cycles at 200 mA g^{-1}	1172, 1095, 1007, 966 and 800 mAh g^{-1} at 200, 500, 1000, 2000 and 5000 mA g^{-1}
MoS_2@graphene nanocables [2]	1150 mAh g^{-1} at 500 mA g^{-1}		900 mAh g^{-1} after 700 cycles at 5 A g^{-1}	1150 and 700 mAh g^{-1} at 500 mA g^{-1} and 10 A g^{-1}
MoS_2-carbon nanofiber composite [3]	1712 mAh g^{-1} at 100 mA g^{-1}	74%	1007 mAh g^{-1} after 100 cycles at 1 A g^{-1}	1095, 986, 768, 637, 620, 548 and 347 mAh g^{-1} at 0.5, 1, 5, 10, 20, 30 and 50 A g^{-1}
MoS_2-graphene-carbon nanotube nanocomposites [4]	949 mAh g^{-1} at 100 mA g^{-1}		886 mAh g^{-1} after 100 cycles at 1 A g^{-1}	949, 883, 858, 737 and 652 mAh g^{-1} at 100, 500, 1000, 5000 and 10000 mA g^{-1}
Hierarchical C@MoS_2 microspheres [5]			750 mAh g^{-1} after 50 cycles at 100 mA g^{-1}	500 mAh g^{-1} at 1000 mA g^{-1}
MoS_2 nanoflake array/carbon cloth[6]	3.5 mAh cm^{-2} at a current density of 0.15 mA cm^{-2}	97.6%		3.26, 2.73, 2.39, 1.72, 1.24, and 0.85 mAh cm^{-2} at current densities of 0.15, 0.3, 0.75, 1.5, 2.25, and 3.0 mA cm^{-2}
MoS_2/3DGN[7]	1222 mAh g^{-1} at 100 mA g^{-1}	83.50%	877 mAh g^{-1} after 50 cycles at 100 mA g^{-1}	849, 782, 692, 597 and 466 mAh g^{-1} at 100, 200, 500, 1000 and 4000 mA g^{-1}
MoS_2/graphene nanosheet[8]	2200 mAh g^{-1} at 100 mA g^{-1}	59.10%	1290 mAh g^{-1} after 50 cycles at 100 mA g^{-1}	1040 mAh g^{-1} at 1000 mA g^{-1}

MoS_2/graphene composites[9]	1462 mAh g^{-1} at 100 mA g^{-1}	58.5%	1187 mAh g^{-1} after 100 cycles at 100 mA g^{-1}	900 mAh g^{-1} at 1000 mA g^{-1}
MoS_2/amorphous carbon[10]	2100 mAh g^{-1} at 100 mA g^{-1}	44.10%	912 mAh g^{-1} after 100 cycles at 100 mA g^{-1}	
CNT@MoS_2[11]	1434 mAh g^{-1} at 100 mA g^{-1}	60.01%	698 mAh g^{-1} after 60 cycles at 100 mA g^{-1}	653, 459 and 369 mAh g^{-1} at 200, 500 and 1000 mA g^{-1}
MoS_2/amorphous carbon[12]	2108 mAh g^{-1} at 100 mA g^{-1}	79%	755 mAh g^{-1} after 100 cycles at 100 mA g^{-1}	850 mAh g^{-1} at 400 mA g^{-1}
MoS_2/PS microspheres[13]	1160 mAh g^{-1} at 100 mA g^{-1}	68.20%	672 mAh g^{-1} after 50 cycles at 100 mA g^{-1}	726, 581 and 353 mAh g^{-1} at 200, 500 and 1000 mA g^{-1}
Graphene-network-backnoned MoS_2[14]	1200 mAh g^{-1} at 600 mA g^{-1}	68%	1200 mAh g^{-1} after 30 cycles at 600 mA g^{-1}	620 and 270 mAh g^{-1} at 7200 and 84000 mA g^{-1}
MoS_2 nanoplates[15]	1062 mAh g^{-1} at 1062 mA g^{-1}	87%	907 mAh g^{-1} after 50 cycles at 100 mA g^{-1}	790 and 700 mAh g^{-1} at 31.8 and 53.1A g^{-1}
3D MoS_2 flowers[16]	869 mAh g^{-1} at 100 mA g^{-1}	65.90%	633 mAh g^{-1} after 50 cycles at 100 mA g^{-1}	848 and 740 mAh g^{-1} at 100 and 400 mA g^{-1}
Mesoporous MoS_2[17]	1052 mAh g^{-1} at 100 mA g^{-1}	83.90%	876 mAh g^{-1} after 100 cycles at 100 mA g^{-1}	903, 880, 845, 795, 748, 670 and 608 mAh g^{-1} at 100, 200, 500, 1000, 2000 and 5000 mA g^{-1}
MoS_2/CNT network[18]	1715 mAh g^{-1} at 200 mA g^{-1}	76.10%	1456 mAh g^{-1} after 50 cycles at 200 mA g^{-1}	1431, 1367, 1302 and 1224 mAh g^{-1} at 400, 600, 800 and 1000 mA g^{-1}
MoS_x/CNT[19]	1549 mAh g^{-1} at 50 mA g^{-1}	74.80%	≥1000 mAh g^{-1} after 40 cycles at 50 mA g^{-1}	1119, 904, 659, 358 and 197 mAh g^{-1} at 50, 200, 500 and 1000 mA g^{-1}
MoS_2-CNT film[20]	1117 mAh g^{-1} at 100 mA g^{-1}	73.40%	960 mAh g^{-1} after 100 cycles at 100 mA g^{-1}	670 (3200) 670 mAh g^{-1} at 3200 mA g^{-1}
Hollow MoS_2 nanoparticles[21]	1236 mAh g^{-1} at 100 mA g^{-1}	74%	902 mAh g^{-1} after 80 cycles at 100 mA g^{-1}	1030, 950, 910, 850 and 780 mAh g^{-1} at 100, 200, 300, 500

				and 1000 mA g^{-1}
3D MoS_2 assembly tubes[22]	1172 mAh g^{-1} at 100 mA g^{-1}	68.30%	839 mAh g^{-1} after 50 cycles at 100 mA g^{-1}	600 and 500 mAh g^{-1} at 1000 and 5000 mA g^{-1}
MoS_2-graphene composites[23]	1367 mAh g^{-1} at 100 mA g^{-1}	66.70%	808 mAh g^{-1} after 100 cycles at 100 mA g^{-1}	571 mAh g^{-1} at 1000 mA g^{-1}
PEO/MoS_2/graphene[24]	1150 mAh g^{-1} at 50 mA g^{-1}	74%	≥1000 mAh g^{-1} after 180 cycles at 50 mA g^{-1}	650 mAh g^{-1} at 200 mA g^{-1}
MoS_2/polyaniline[25]	1460 mAh g^{-1} at 100 mA g^{-1}	72.80%	953 mAh g^{-1} after 50 cycles at 100 mA g^{-1}	1006 mAh g^{-1} at 200 mA g^{-1}
MoS_2/C nanotube[26]	1320 mAh g^{-1} at 200 mA g^{-1}	70.50%	776 mAh g^{-1} after 100 cycles at 200 mA g^{-1}	450-600 mAh g^{-1} at 1000 mA g^{-1}
MoS_2@carbon spheres[5]	1020 mAh g^{-1} at 100 mA g^{-1}	73.50%	750 mAh g^{-1} after 50 cycles at 100 mA g^{-1}	500 mAh g^{-1} at 1000 mA g^{-1}
MoS_2@carbon layer[27]	1251 mAh g^{-1} at 1000 mA g^{-1}	90.70%	814 mAh g^{-1} after 100 cycles at 1000 mA g^{-1}	600 mAh g^{-1} at 4000 mA g^{-1}
MoS_2@CMK-3[28]	1056 mAh g^{-1} at 250 mA g^{-1}	78.03%	602 mAh g^{-1} after 100 cycles at 250 mA g^{-1}	832, 774, 666 and 564 mAh g^{-1} at 250, 500, 1000 and 2000 mA g^{-1}
Fe_3O_4/MoS_2[29]	1320 mAh g^{-1} at 100 mA g^{-1}	81.74%	1200 mAh g^{-1} after 560 cycles at 500 mA g^{-1}	1189, 943, 569, 362 and 270, 224 mAh g^{-1} at 1000, 2000, 4000, 6000, 8000 and 10000 mA g^{-1}
MoS_2/TiO_2[30]	931 mAh g^{-1} at 100 mA g^{-1}	74%	472 mAh g^{-1} after 100 cycles at 100 mA g^{-1}	713, 636, 533 and 461 mAh g^{-1} at 100, 200, 500 and 1000 mA g^{-1}

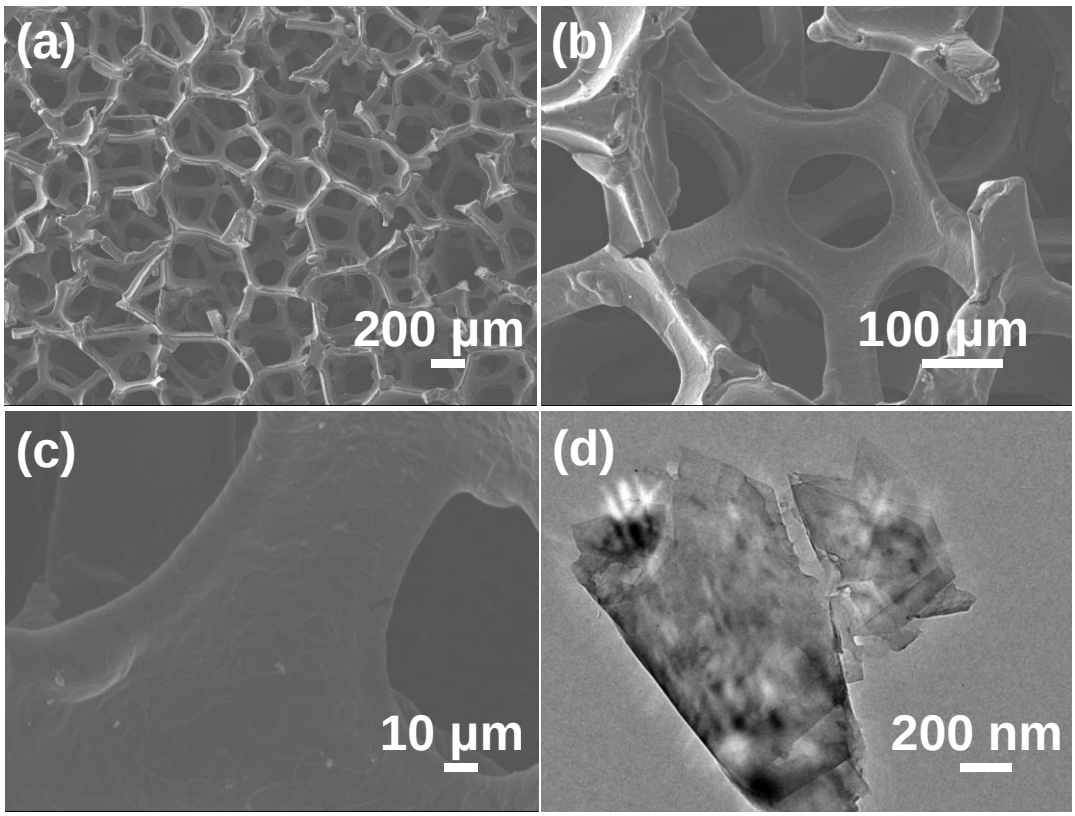

Figure S1 SEM images of GF (a), (b) and (c), and TEM image of GF.

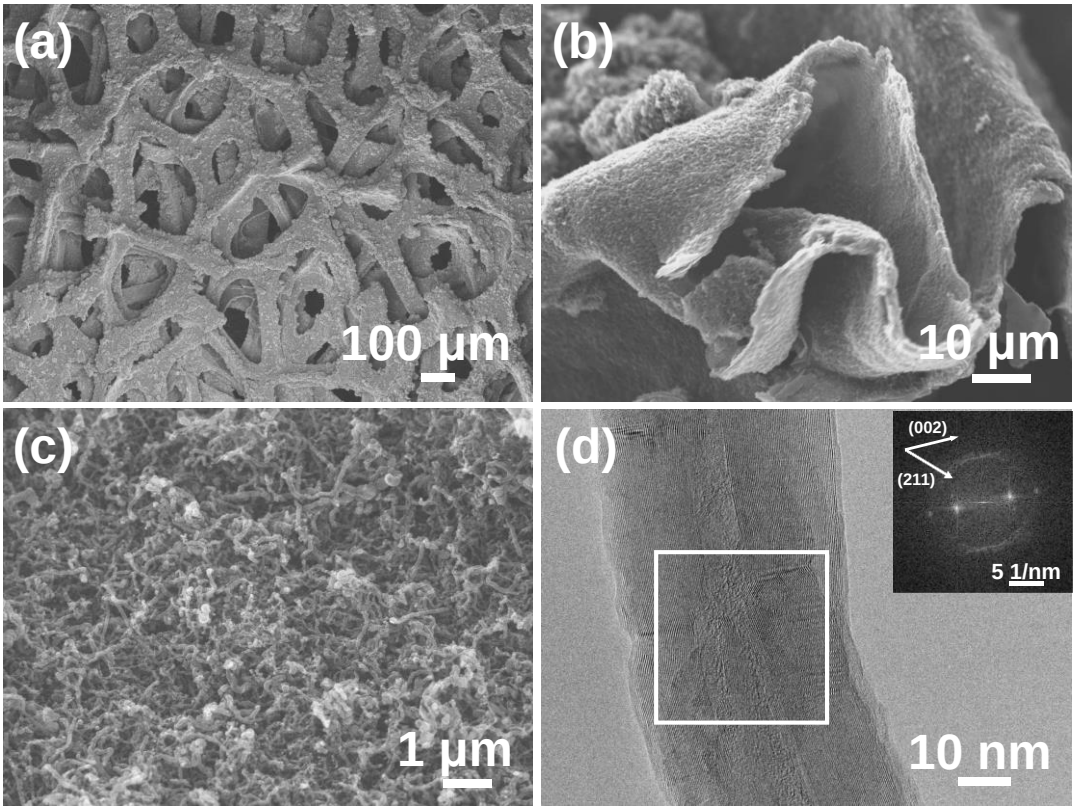

Figure S2 (a) Low-magnification SEM of the CNT-GF, (b), (c) and (d) TEM of the CNTs. Inset in (d) shows the FFT pattern taken from the marked area.

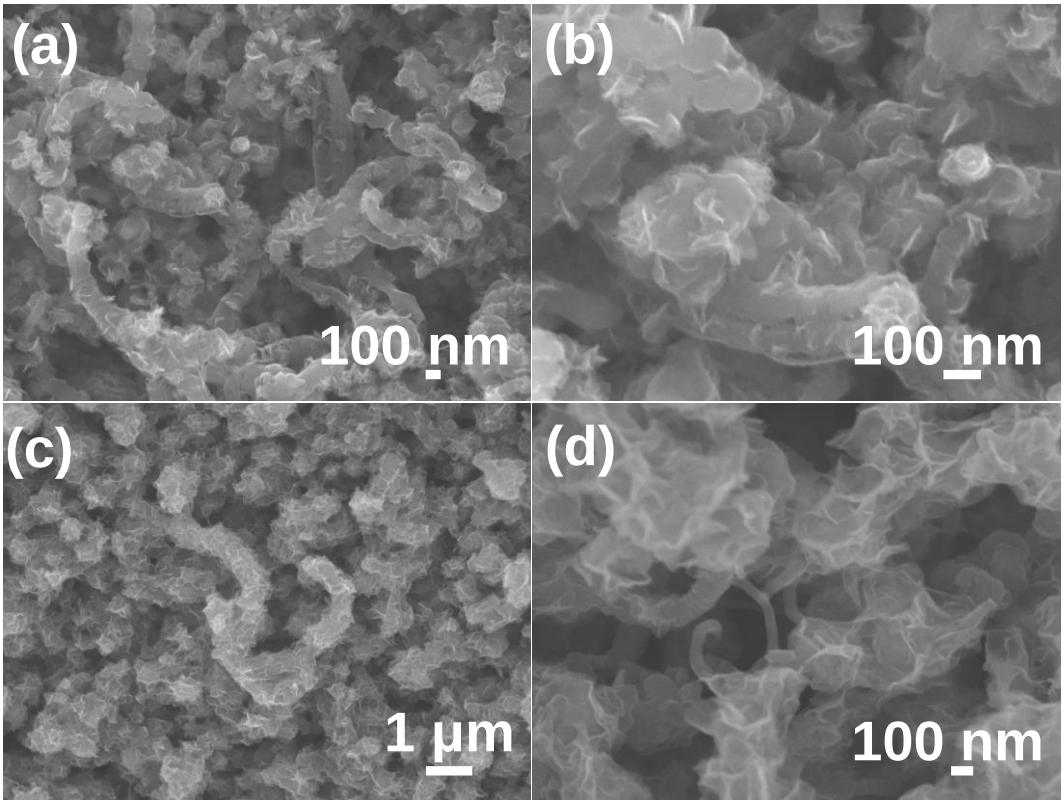

Figure S3 SEM images of samples prepared with different concentration of reactants: (a) and (b) the MoS_2@GF/CNTs sample prepared with 1.33 mg ml^{-1} of TAA and 0.67 mg ml^{-1} of sodium molybdate. (c) and (d) the MoS_2@GF/CNTs sample prepared with 2 mg ml^{-1} of TAA and 1 mg ml^{-1} of sodium molybdate.

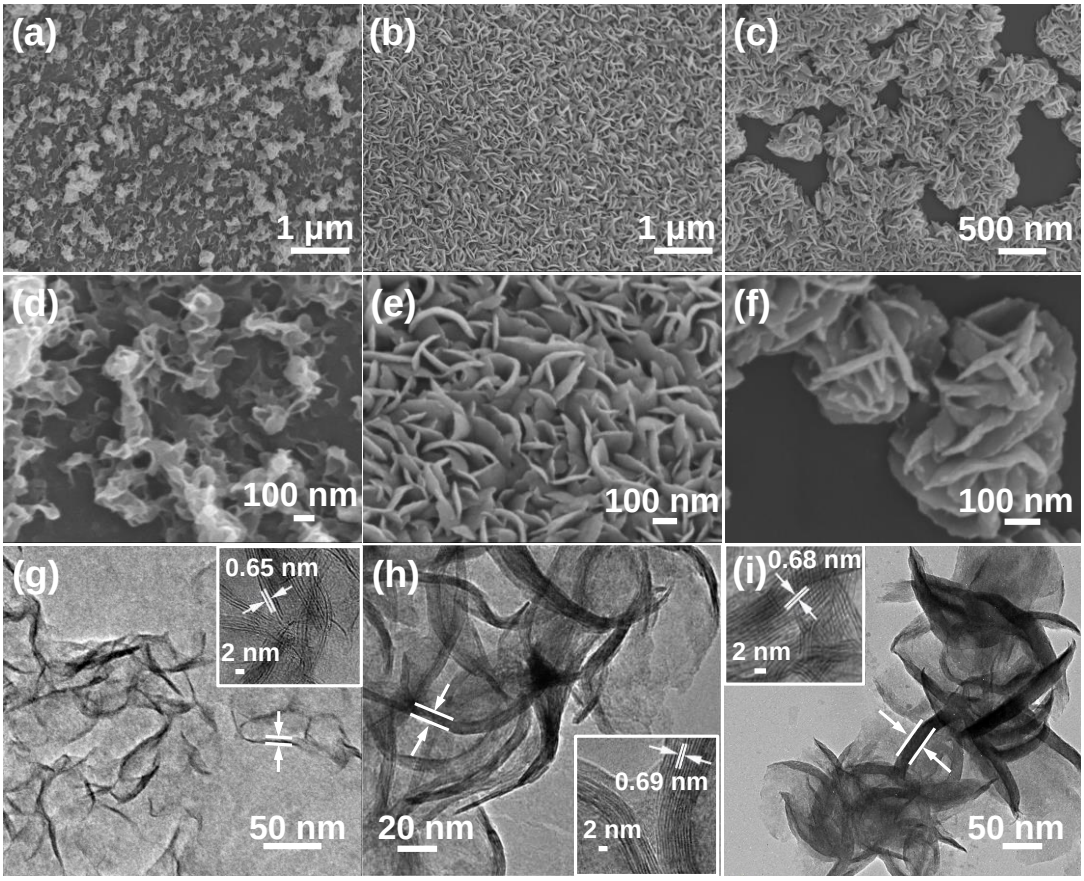

Figure S4 SEM and TEM images of samples prepared with different concentration of reactants: (a), (d) and (g) the MoS_2@GF sample prepared with 2 mg ml^{-1} of TAA and 1 mg ml^{-1} of sodium molybdate. (b), (e) and (h) the MoS_2@GF sample prepared with 3.33 mg ml^{-1} of TAA and 1.67 mg ml^{-1} of sodium molybdate. (c), (f) and (i) the MoS_2@GF sample prepared with 4 mg ml^{-1} of TAA and 2 mg ml^{-1} of sodium molybdate.

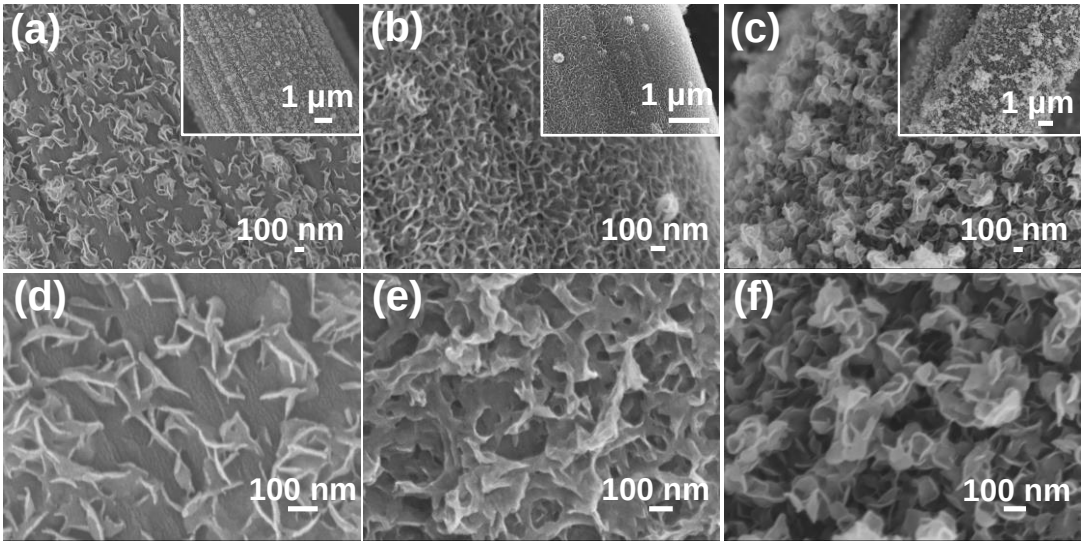

Figure S5 SEM images of samples prepared with different concentration of reactants: (a) and (d) the MoS_2@carbon cloth sample prepared with 1.67 mg ml^{-1} of TAA and 0.83 mg ml^{-1} of sodium molybdate. (b) and (e) the MoS_2@carbon cloth sample prepared with 2 mg ml^{-1} of TAA and 1 mg ml^{-1} of sodium molybdate. (c) and (f) the MoS_2@carbon cloth sample prepared with 3 mg ml^{-1} of TAA and 1.5 mg ml^{-1} of sodium molybdate.

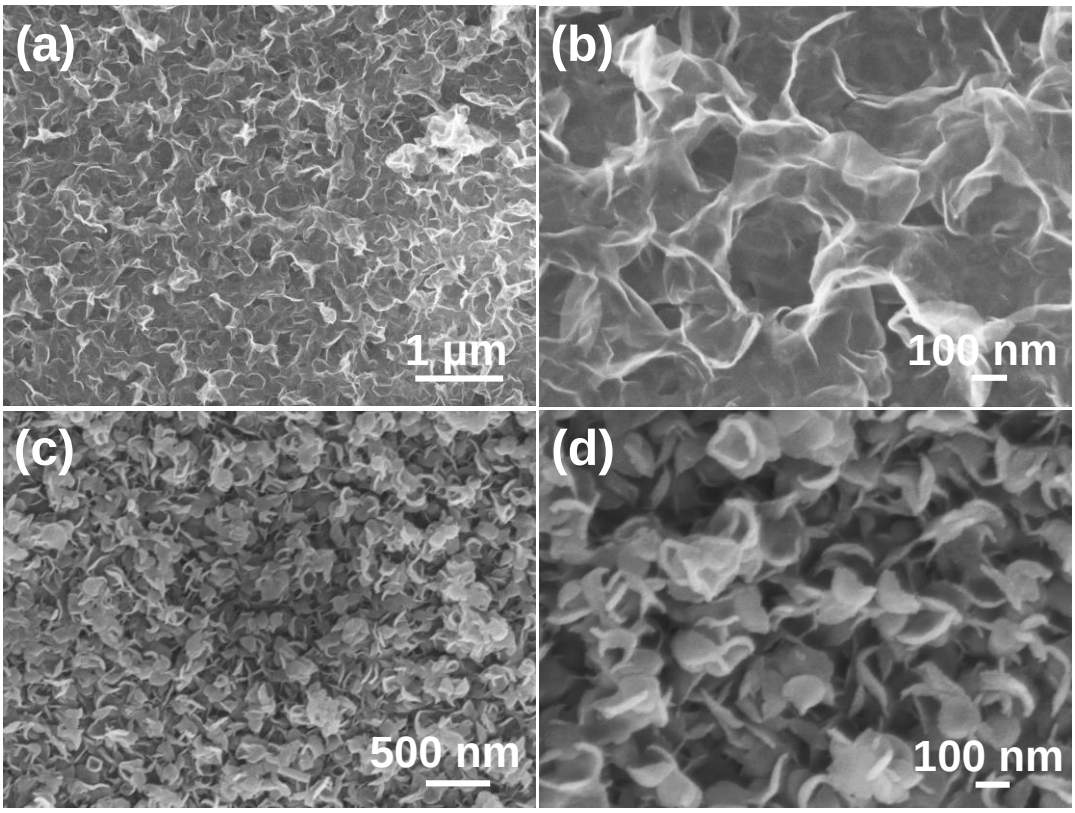

Figure S6 SEM images of samples grown on different substrates prepared with 3 mg ml^{-1} of TAA and 1.5 mg ml^{-1} of sodium molybdate: (a) and (b) on the Ti foil. (c) and (d) on the stainless steel.

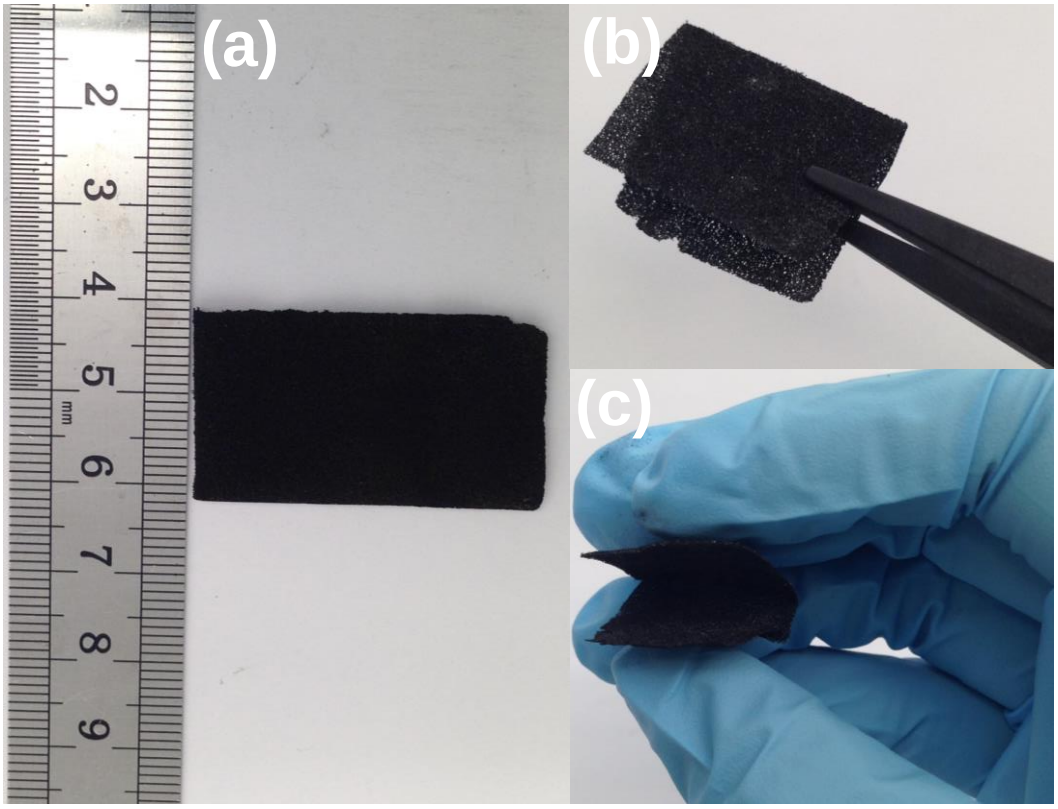

Figure S7 (a, b and c) Representative photograph showing the dimension and flexibility of the MoS_2@GF/CNT electrode.

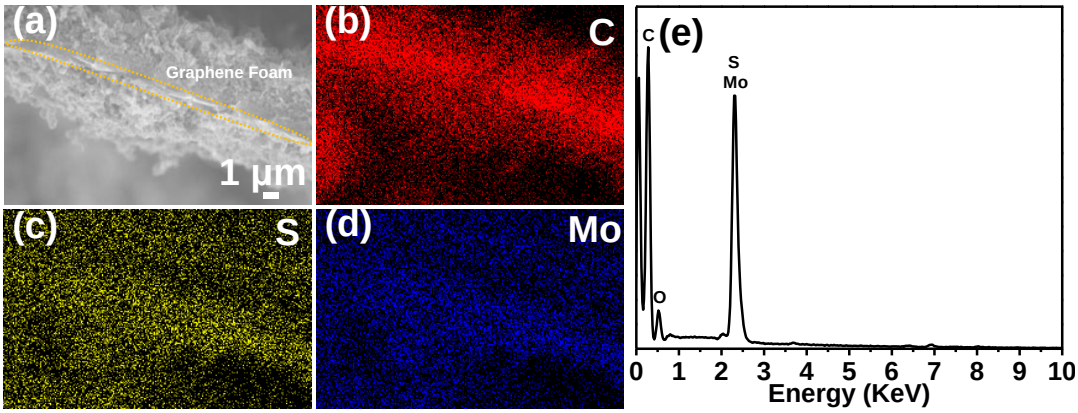

Figure S8 (a) SEM images of cross-sectional images of MoS_2@GF/CNT branch. Corresponding elemental mapping images of C (b), S (c) and Mo (d), indicating the uniform covering of MoS_2@CNTs on GF. And (e) EDS spectrum.

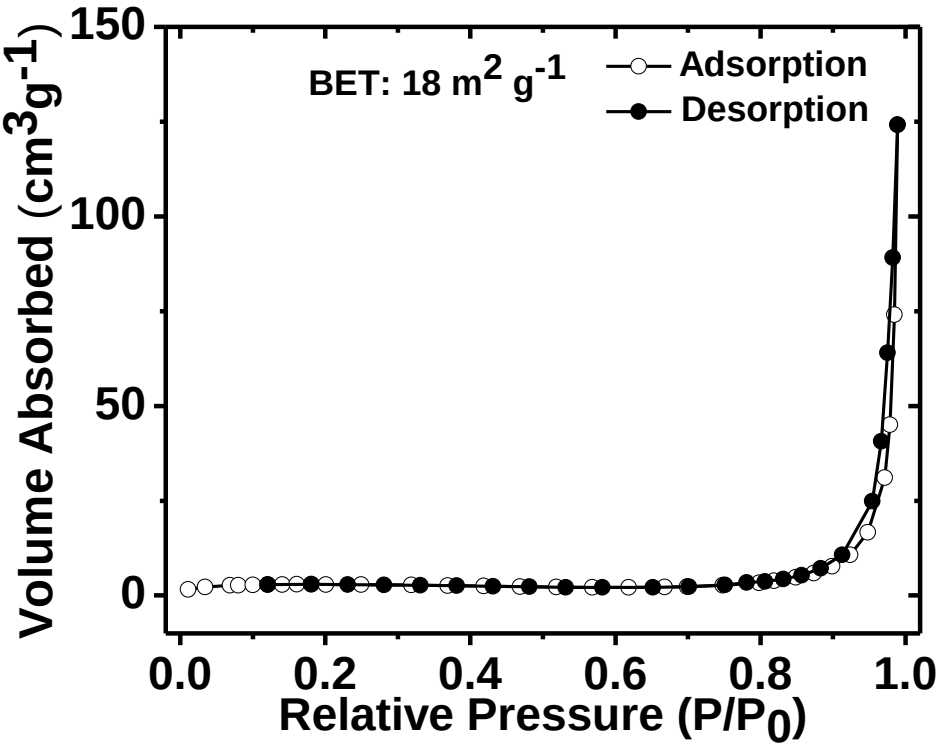

Figure S9 N_2 adsorption/desorption isotherms, and the insert corresponding pore size distribution of MoS_2@GF composites prepared with 2.67 mg ml^{-1} of sodium molybdate and 1.33 mg ml^{-1} of TAA.

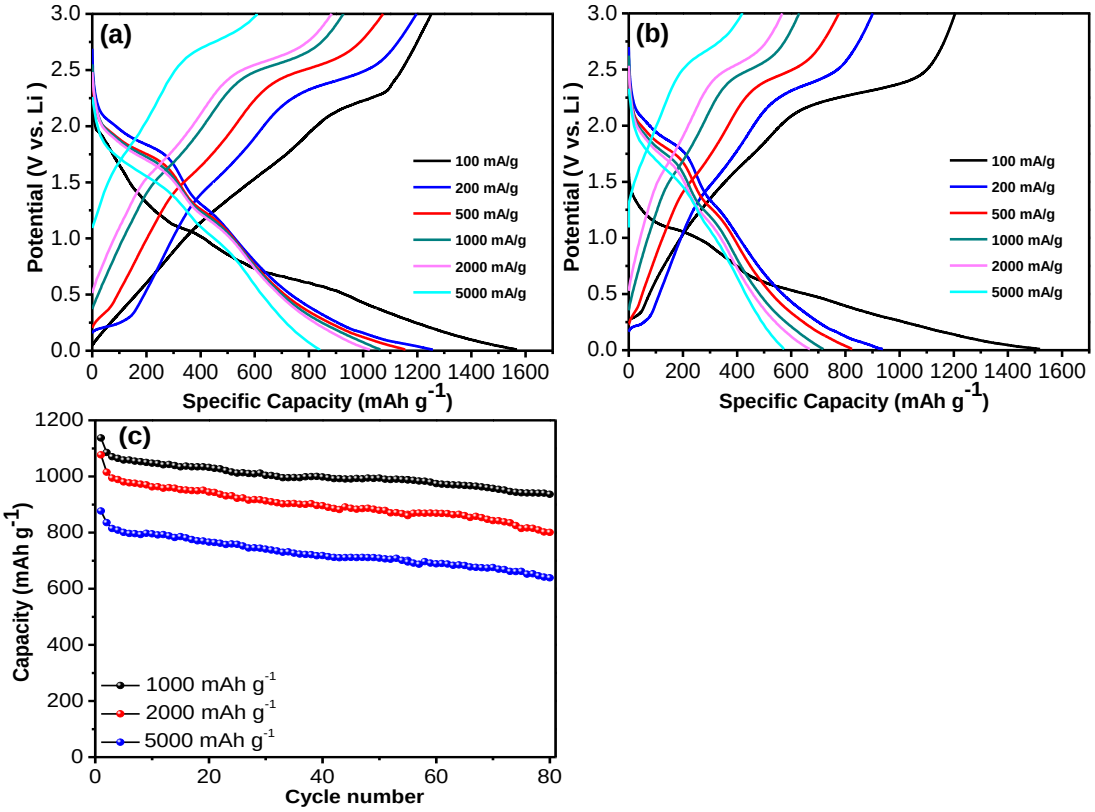

Figure S10 Charge and discharge curves of (a) MoS_2@GF/CNT and (b) MoS_2@GF at different C-rates. (c) Cycling behaviors of MoS_2@GNF at current densities of 1000, 2000 and 5000 mAh g^{-1}.

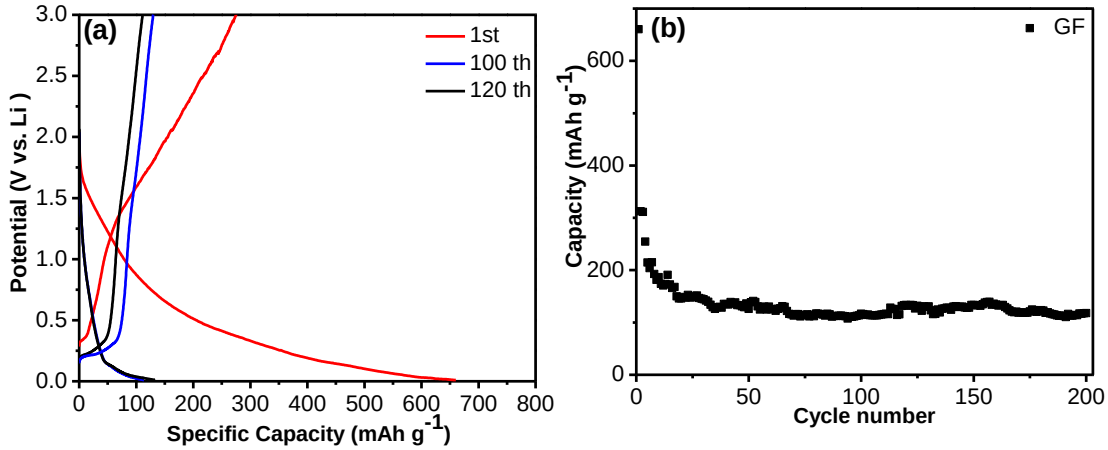

Figure S11 (a) Charge and discharge curves and (b) cycling behavior of pure GF at a current density of 200 mAh g^{-1}.

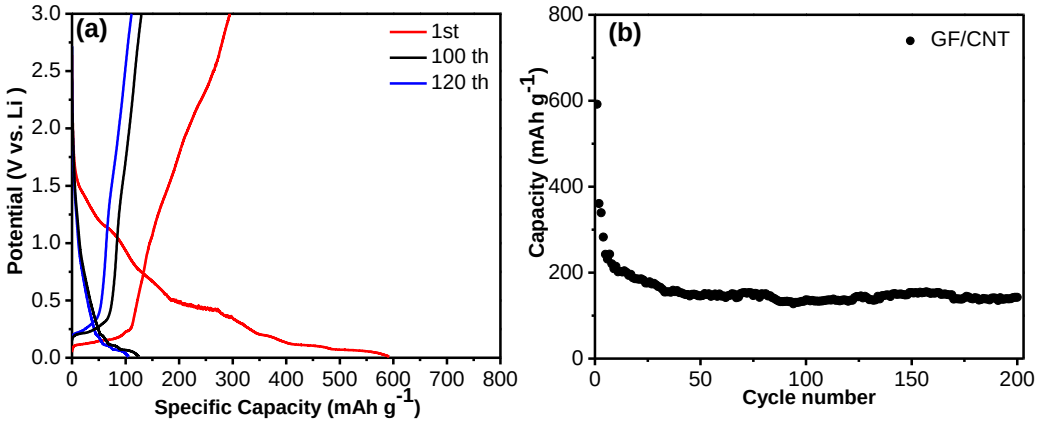

Figure S12 (a) Charge and discharge curves and (b) cycling behavior of pure GF/CNT at a current density of 200 mAh g^{-1}.

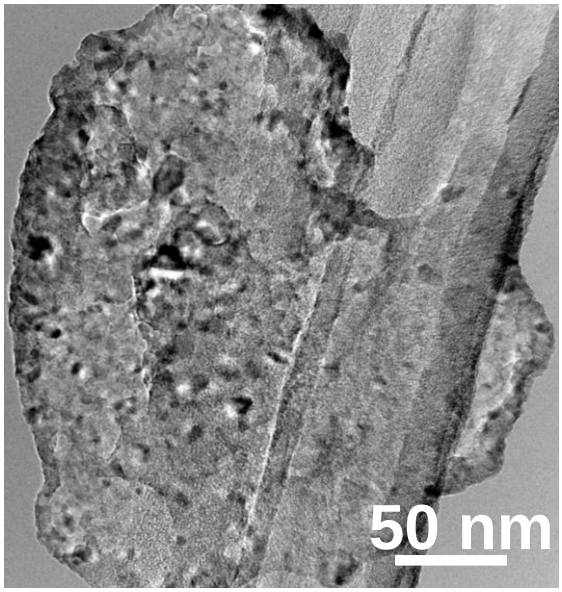

Figure S13 TEM images of MoS_2@GF/CNT electrode after cycling for 120 cycles.

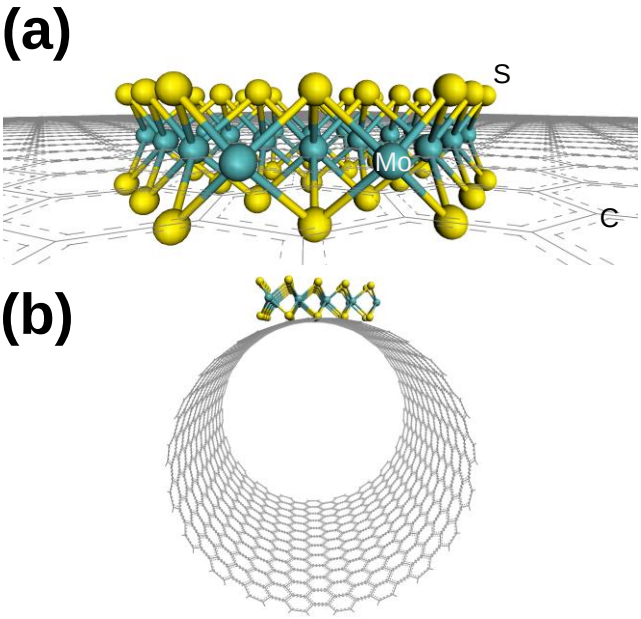

Figure S14 Cross-section illustration of MoS_2 cluster bonding with (a) graphene and (b) CNT.

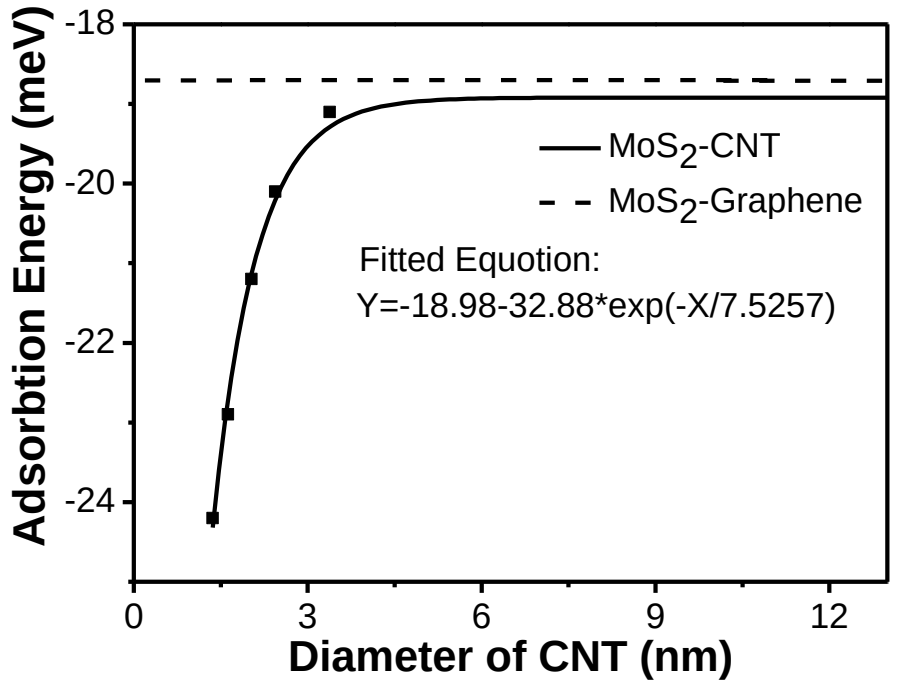

Figure S15 The relationship between the adsorption energies and diameters of CNTs.

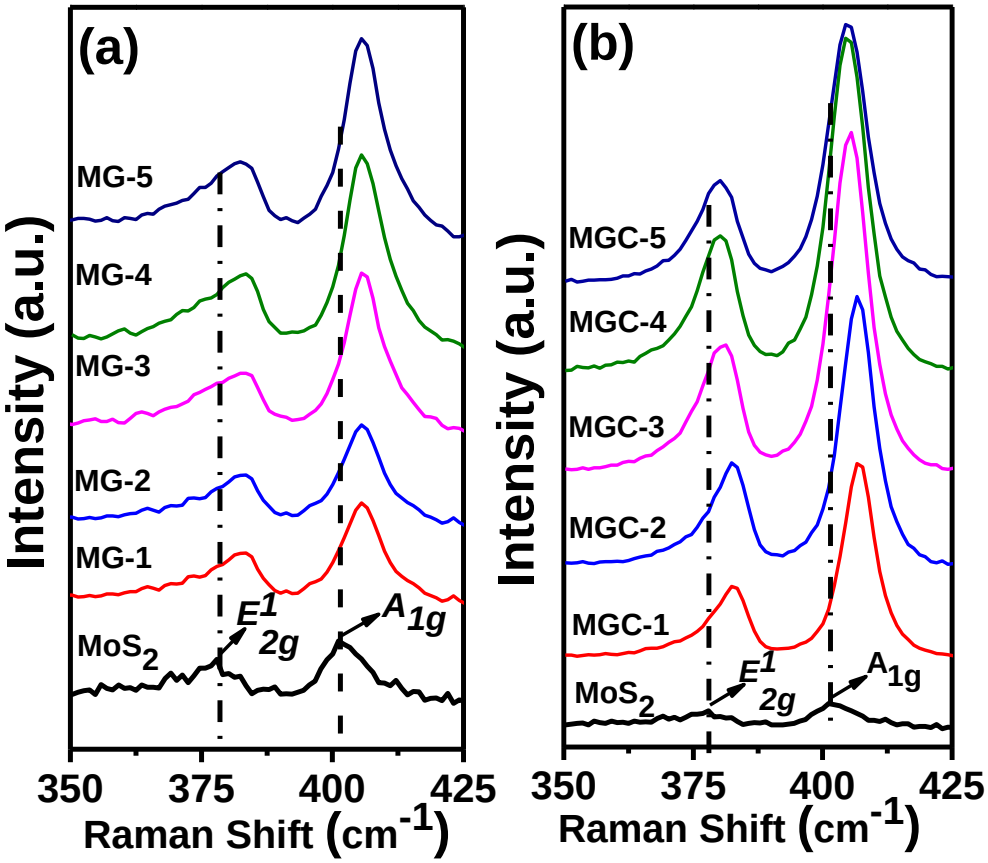

Figure S16 The Raman spectra of E_{2g}^1 and A_{1g} modes of (a) the MoS_2@GF taken at different five points and MoS_2 nanosheets.(b) the MoS_2@GF/CNT taken at five different points and MoS_2 nanosheets.

Table S2 The comparison of electrochemical performances for two electrodes, MoS_2@GF/CNTs, and MoS_2@GF.

Electrode description	**1st Specific capacity ($mAhg^{-1}$)**	**1st Coulombic efficiency**	**Cycling stability (%)**	**Rate performance**
MoS_2@GF/CNTs	1568 mAh g^{-1} at 100 mA g^{-1}	79.8%	1125 mAh g^{-1} after 80 cycles at 200 mA g^{-1}	984, 927 and 820 mAh g^{-1} at 1000, 2000 and 5000 mA g^{-1}
MoS_2@GF	1502 mAh g^{-1} at 100 mA g^{-1}	65.2%	798 mAh g^{-1} after 80 cycles at 200 mA g^{-1}	713, 664 and 565 mAh g^{-1} at 1000, 2000 and 5000 mA g^{-1}

Table S3 Calculated adsorption energies of MoS_2 cluster at various active sites of Graphene and CNT with different diameters. For all calculated models, one unit contains 20 MoS_2 units and 216 carbon atoms.

Sample		**Active site**	**Diameter (nm)**	**Adsorption energy E_{ab} (meV)**
CNT	(10, 10)	T	1.3597	-24.2
	(12, 12)	T	1.6272	-22.9
	(15, 15)	T	2.0328	-21.2
	(18, 18)	T	2.44	-20.1
	(25, 25)	T	3.38	-19.1
Graphene		H	_	-18.7

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