ADVANCED ENERGY MATERIALS

Supporting Information

for *Adv. Energy Mater.*, DOI: 10.1002/aenm.201702779

Ion Transport Nanotube Assembled with Vertically Aligned Metallic MoS_2 for High Rate Lithium-Ion Batteries

*Yucong Jiao, Alolika Mukhopadhyay, Yi Ma, Lei Yang, Ahmed M. Hafez, and Hongli Zhu**

Supplementary material

Ion Transport Nanotube Assembled with Vertically Aligned Metallic MoS_2 for High Rate Lithium-Ion Batteries

Yucong Jiao,[1] Alolika Mukhopadhyay,[1] Lei Yang,[1] Ahmed M. Hafez,[1] and Hongli Zhu[*,1]

[1]Department of Mechanical and Industrial Engineering, Northeastern University, Boston, Massachusetts 02115, United States.

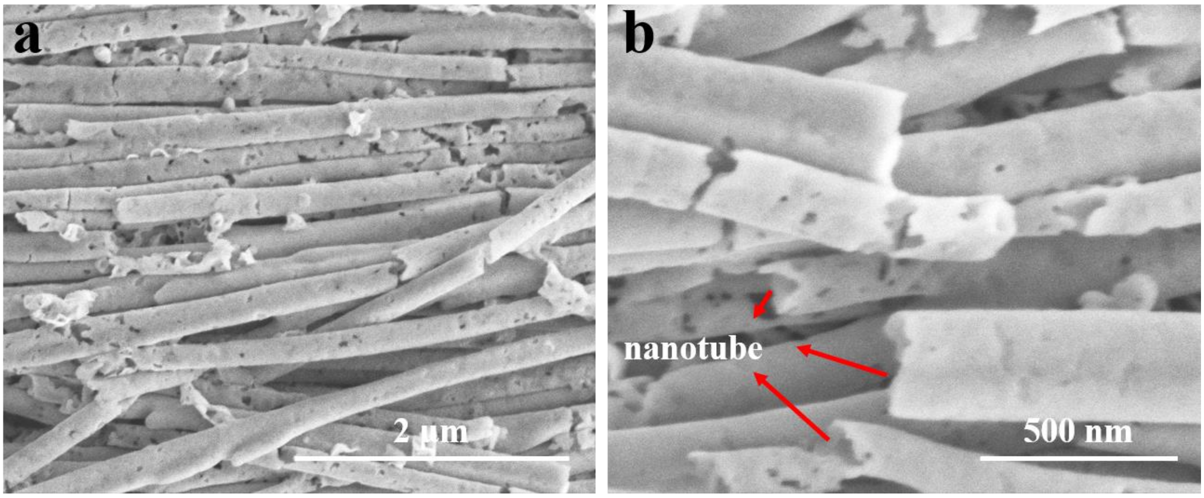

Figure S1 SEM images of the nanotube structure. a) Long-ranged nanotube structure under low magnification. b) Nanotube structure under high magnification.

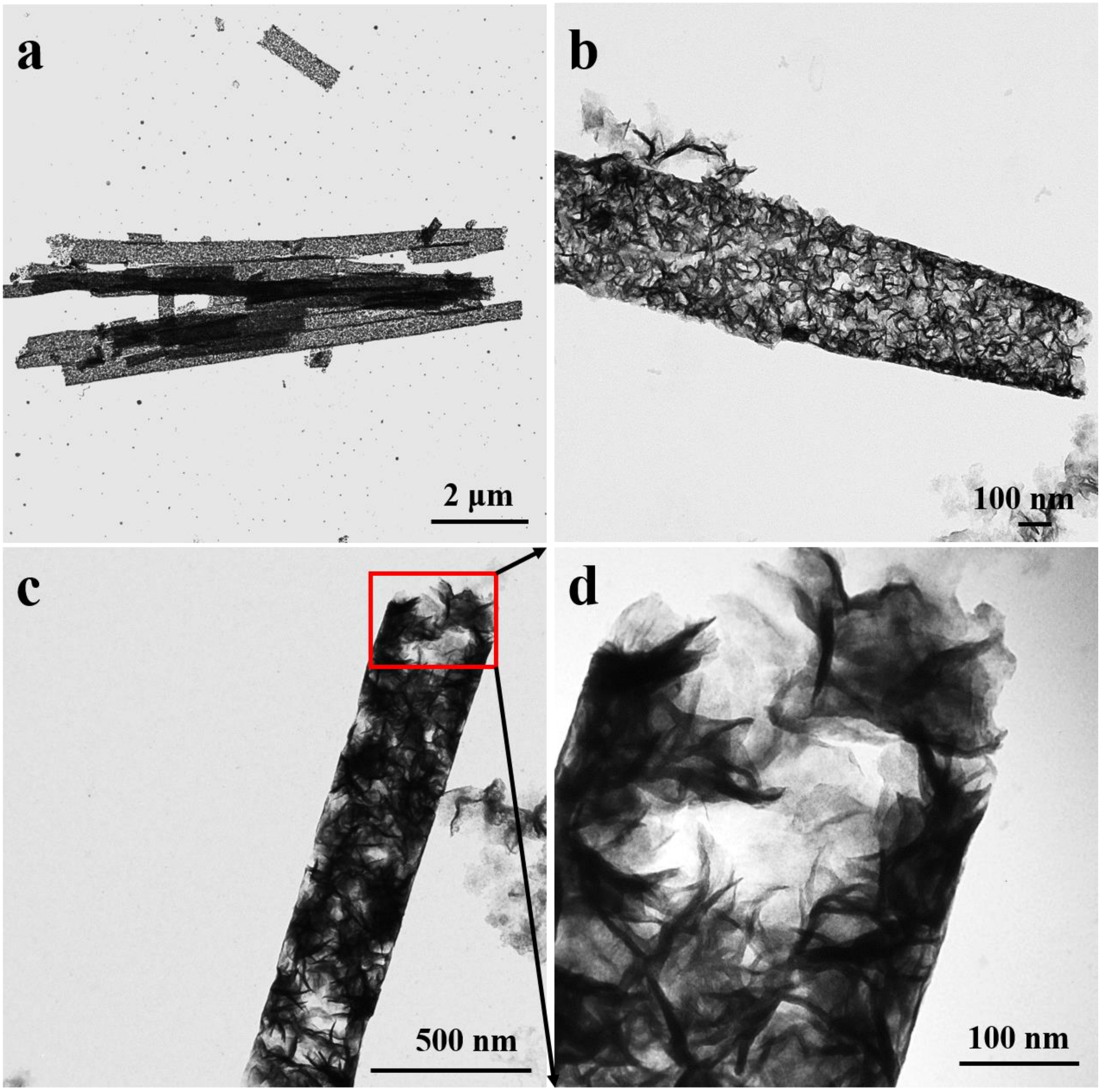

Figure S2 TEM images of the nanotube structure. a) MoS_2 nanotube under low magnification. b, c) Nanotube structure assembled with flower-like nanosheets. d) High magnification image of c).

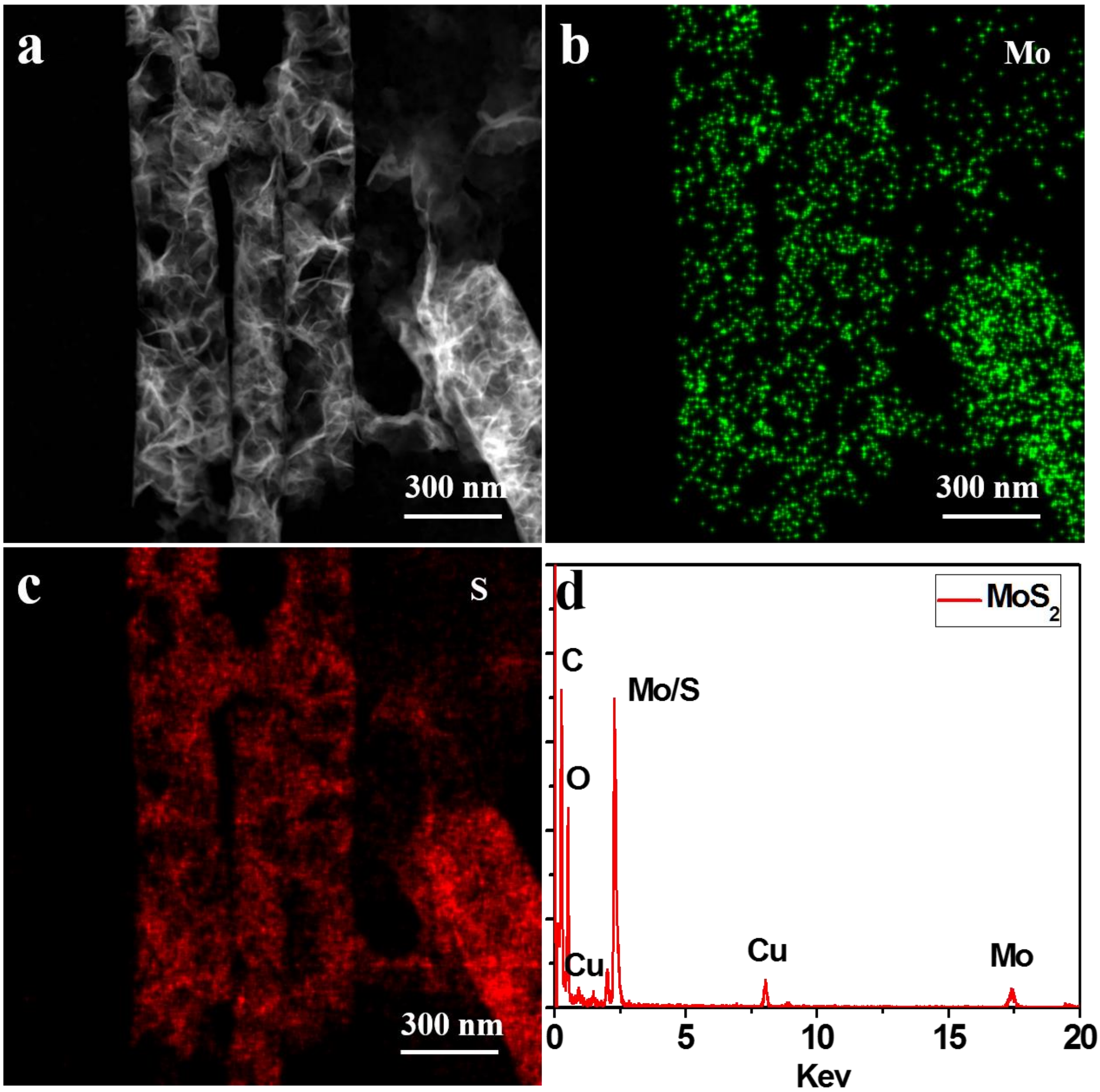

Figure S3 EDX elemental mapping of metallic MoS_2 nanotube. a) TEM image of MoS_2 nanotubes with flower-like structure. b) EDX mapping of Mo element. c) EDX mapping of S element. d) EDX spectrum of metallic MoS_2 nanotube. (C, O and Cu elements are coming from the Cu grid)

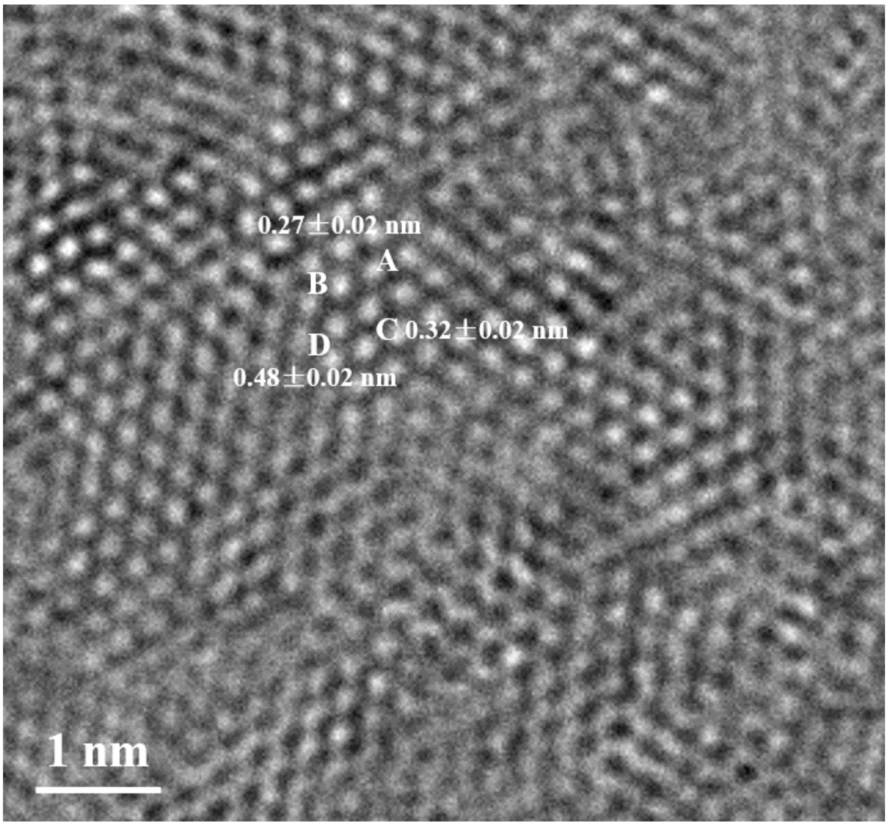

Figure S4 HRTEM image for the atom arrangement of metallic MoS_2

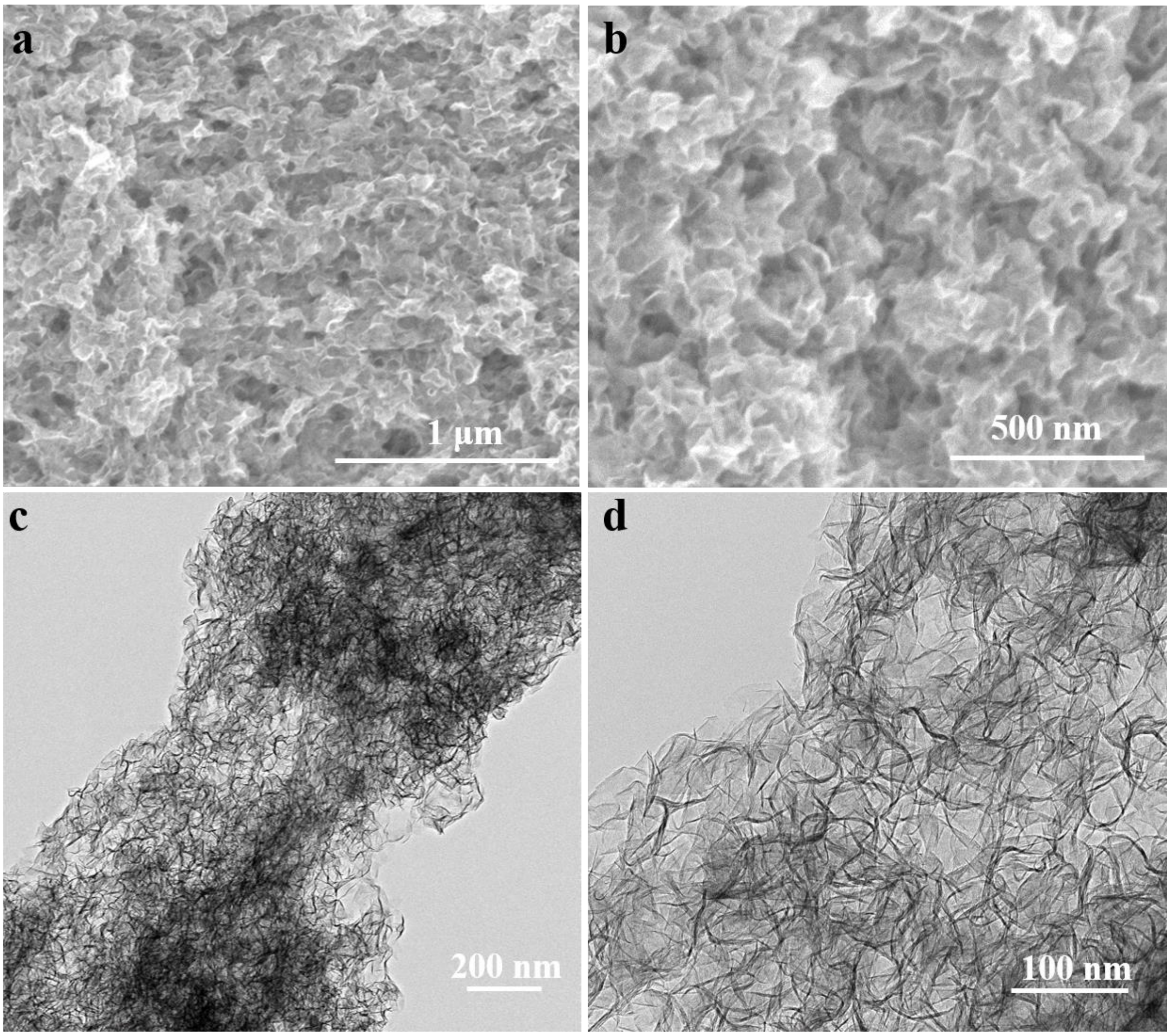

Figure S5 SEM images of 2H MoS_2 nanosheets (a, b), and TEM images of 2H MoS_2 nanosheets (c, d).

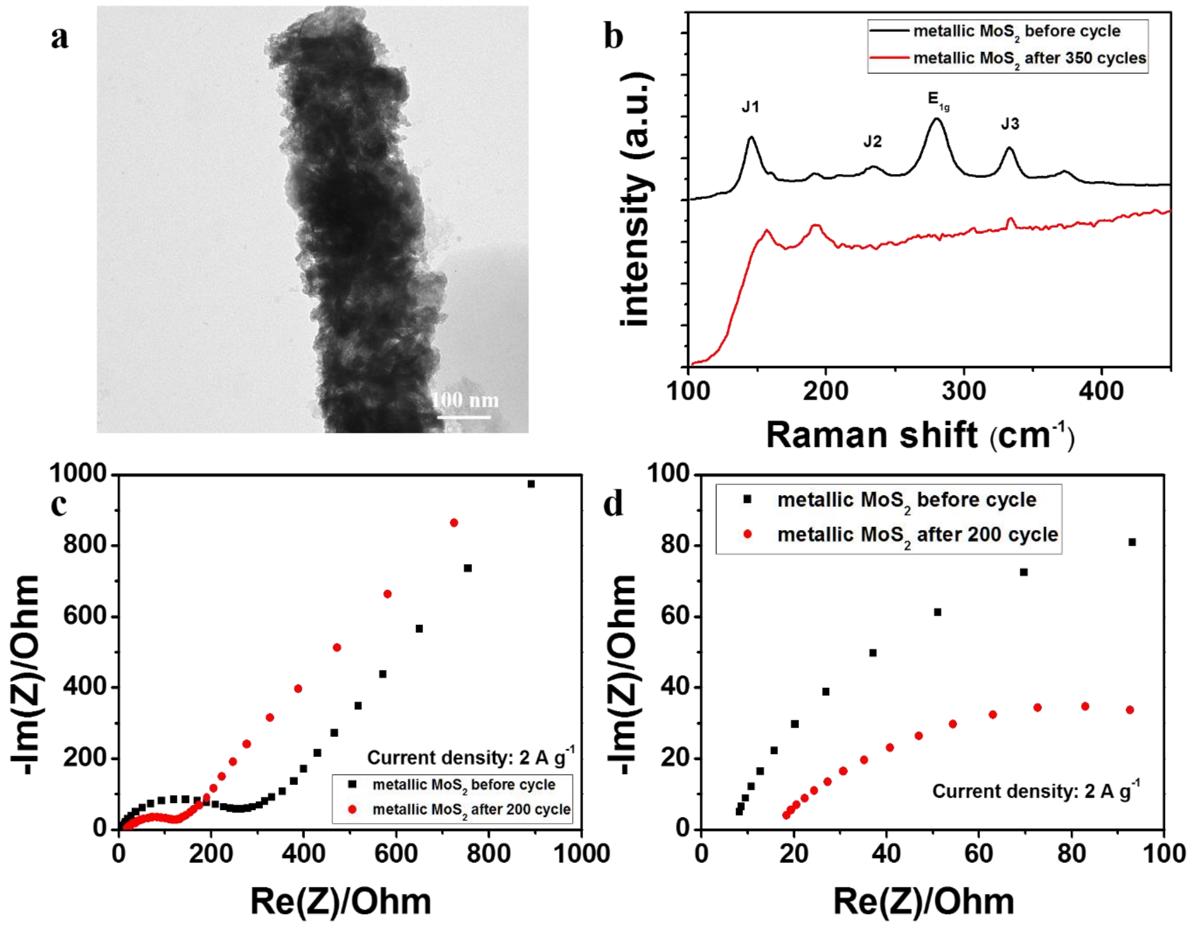

Figure S6 a) TEM image of the metallic MoS_2 nanotube after cycle, which proves the structure was robust enough and could still keep their structure even after 200 cycles. b) Raman spectra before and after 350 cycles of metallic MoS_2. c, d) EIS of MoS_2 before cycle and after 200 cycles. Agreeing with the EC performance, after 200 cycles, the resistance of the metallic MoS_2 electrode was improved because of the materials' activation during cycling.

Table S1. Summary of lithium-ion battery performance of MoS_2 materials under high current density.

Reference	Electrodes	method	Battery Performance	
			Current density	Specific capacity
[2]	2H MoS_2/graphene	L-cysteine-assisted hydrothermal	1 A g^{-1}	900 mA h g^{-1}
[3]	2H MoS_2 nanoplates	Hydrothermal route	1.06 A g^{-1}	900 mA h g^{-1}
[4]	2H MoS_2/graphene	L-cysteine-assisted hydrothermal	1 A g^{-1}	800 mA h g^{-1}
[7]	2H MoS_2 nanosperes	PVP-assisted hydrothermal	0.5 A g^{-1}	1000 mA h g^{-1}
[9]	metallic MoS_2/carbon fiber	Hydrothermal route	1 A g^{-1}	750 mA h g^{-1}
[10]	2H MoS_2/carbon nanofiber	Hydrothermal route	1 A g^{-1}	688 mA h g^{-1}
[11]	2H MoS_2/graphene	Acid-assisted hydrothermal	1 A g^{-1}	900 mA h g^{-1}
[12]	2H MoS_2/carbon nanotube	Hydrothermal route	5 A g^{-1}	800 mA h g^{-1}
[17]	metallic MoS_2/graphene	Solvothermal route	3.5 A g^{-1}	666 mA h g^{-1}
[22]	metallic @2H MoS_2/carbon cloth	Solvothermal route	2 A g^{-1}	510 mA h g^{-1}
[23]	2H MoS_2/graphene	Lithium intercalation	1 A g^{-1}	400 mA h g^{-1}
[25]	2H MoS_2/carbon nanotube	Sonicate exfoliation	20 A g^{-1}	580 mA h g^{-1}
[30]	2H MoS_2/graphene foam	Hydrothermal reaction	5 A g^{-1}	800 mA h g^{-1}
[31]	2H MoS_2/carbon nanosheet	Heat-treatment	2 A g^{-1}	709 mA h g^{-1}
[32]	2H MoS_2/mesoporous carbon	Hydrothermal route	10 A g^{-1}	400 mA h g^{-1}
[33]	2H MoS_2/graphene nanosheet	Heat-induced process	20 A g^{-1}	344 mA h g^{-1}
[34]	2H MoS_2/ mesoporous carbon	Acid-assisted hydrothermal	6.4 A g^{-1}	943 mA h g^{-1}
[35]	2H MoS_2@graphene	Chemical vapor deposition	5 A g^{-1}	900 mA h g^{-1}
[36]	2H MoS_2@graphene	Hydrothermal route	2.5 A g^{-1}	678 mA h g^{-1}
[37]	2H MoS_2@carbon	PANI assisted hydrothermal	1 A g^{-1}	320 mA h g^{-1}