Electronic Supplementary Information (ESI)

Hierarchical 1T-MoS_2 Nanotubular Structures for Enhanced Supercapacitive Performance

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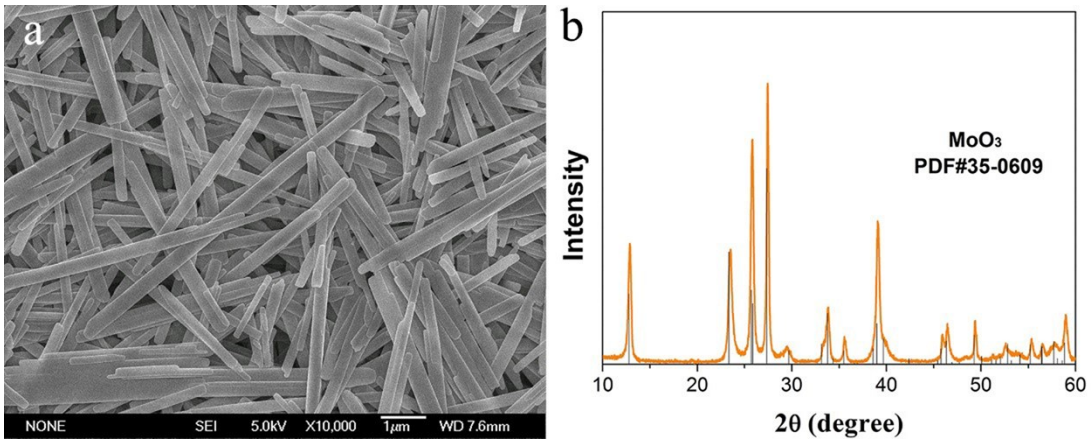

Fig. S1 (a) SEM image and (b) XRD pattern of the as-prepared MoO_3 nanobelts.

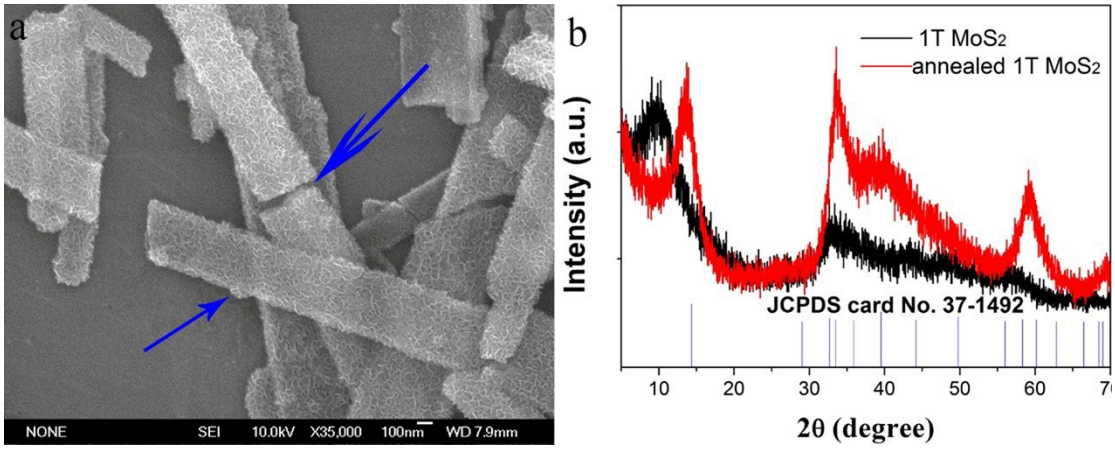

Fig. S2 (a) SEM image of the as-prepared 1T-MoS_2; (b) XRD patterns of as-prepared 1T-MoS_2 and annealed 1T-MoS_2.

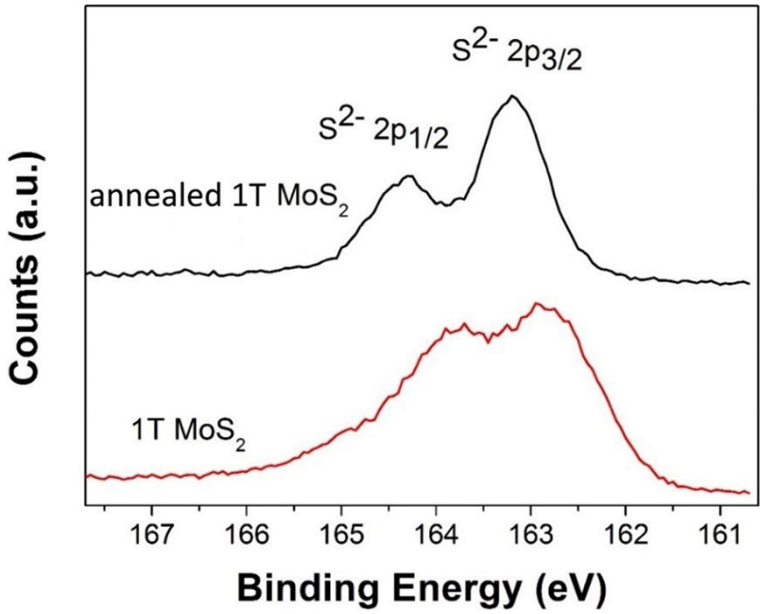

Fig. S3 S 2p XPS spectrums of as-prepared 1T-MoS_2 and annealed 1T-MoS_2.

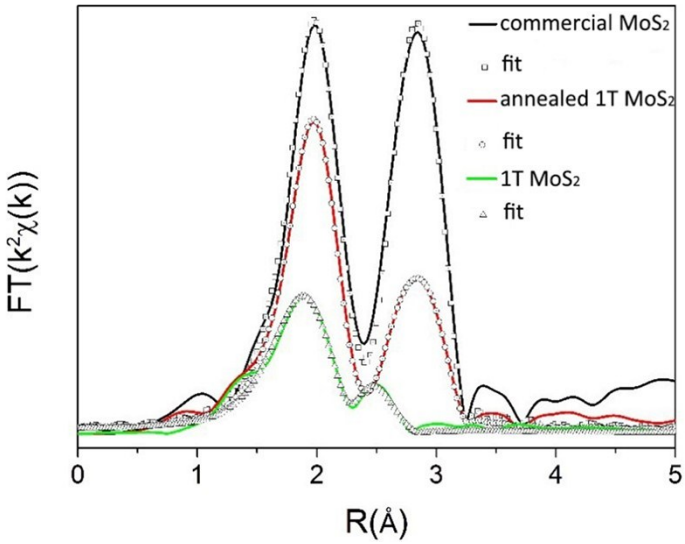

Fig. S4 Fitting curves for EXAFS data of the Mo K-edge for commercial MoS_2, annealed 1T-MoS_2 and as-prepared 1T-MoS_2.

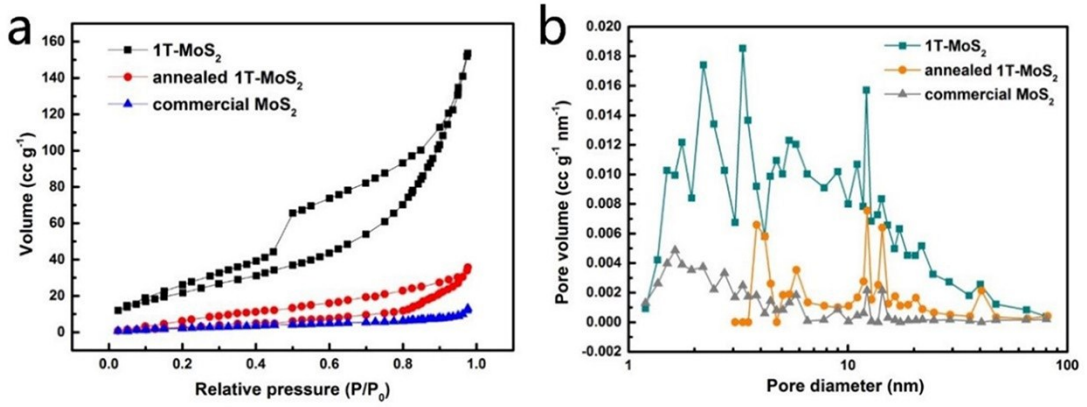

Fig. S5 (a) Nitrogen adsorption-desorption isotherm and (b) pore diameter distribution of as-prepared 1T-MoS_2, annealed 1T-MoS_2 and commercial MoS_2.

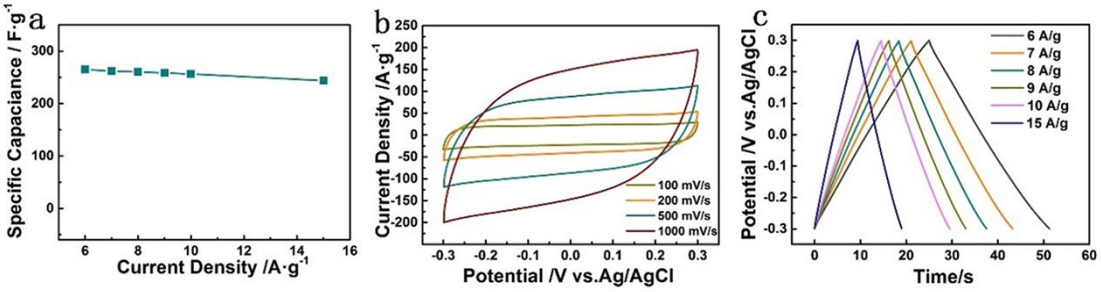

Fig. S6 (a) Specific capacitances for a current density range from 6 to 15 A g^{-1}, (b) CV curves for a scan rate range from 100 to 1000 mV s^{-1}, and (c) GCD profile for a current density range from 6 to 10 A g^{-1} for the as-prepared 1T-MoS_2 tested in a three-electrode system.

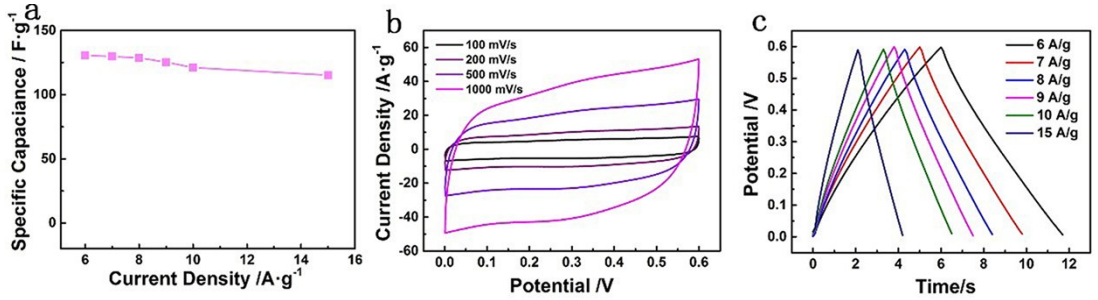

Fig. S7 (a) Specific capacitances for a current density range from 6 to 15 A g^{-1}, (b) CV curves for a scan rate range from 100 to 1000 mV s^{-1}, and (c) GCD profiles for a current density range from 6 to 10 A g^{-1} for the as-prepared 1T-MoS_2 tested in a two-electrode system.

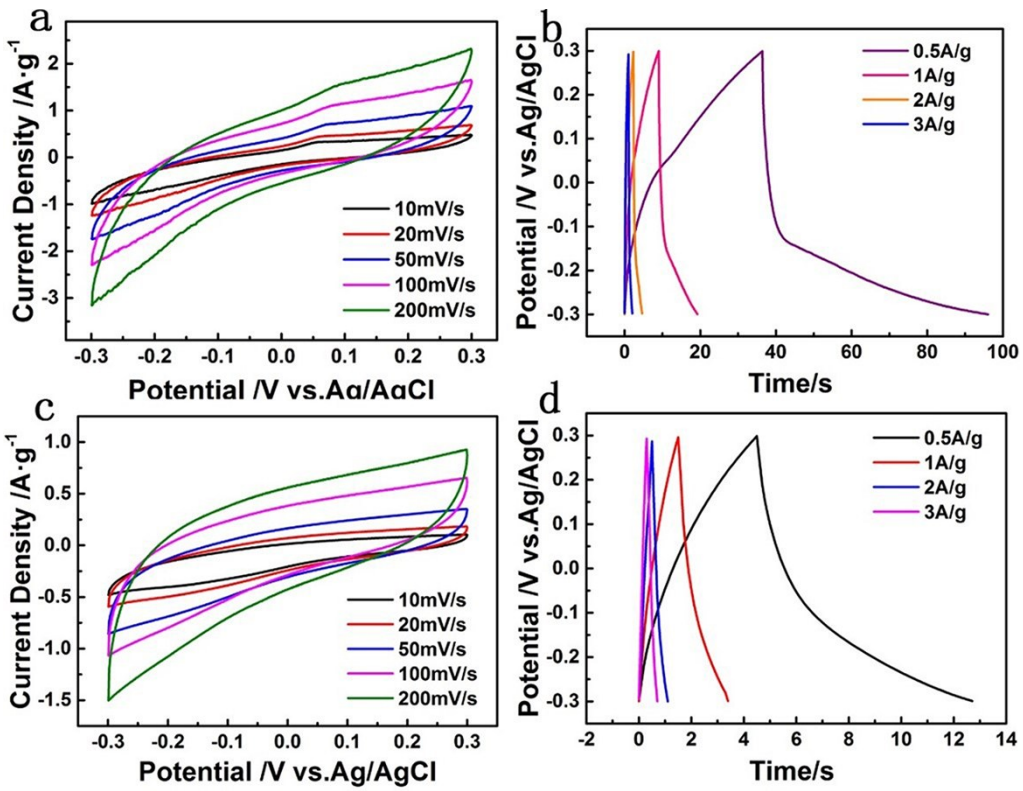

Fig. S8 CV curves and GCD profiles for the (a, b) annealed 1T-MoS_2, and (c, d) commercial MoS_2, measured using a three-electrode system.

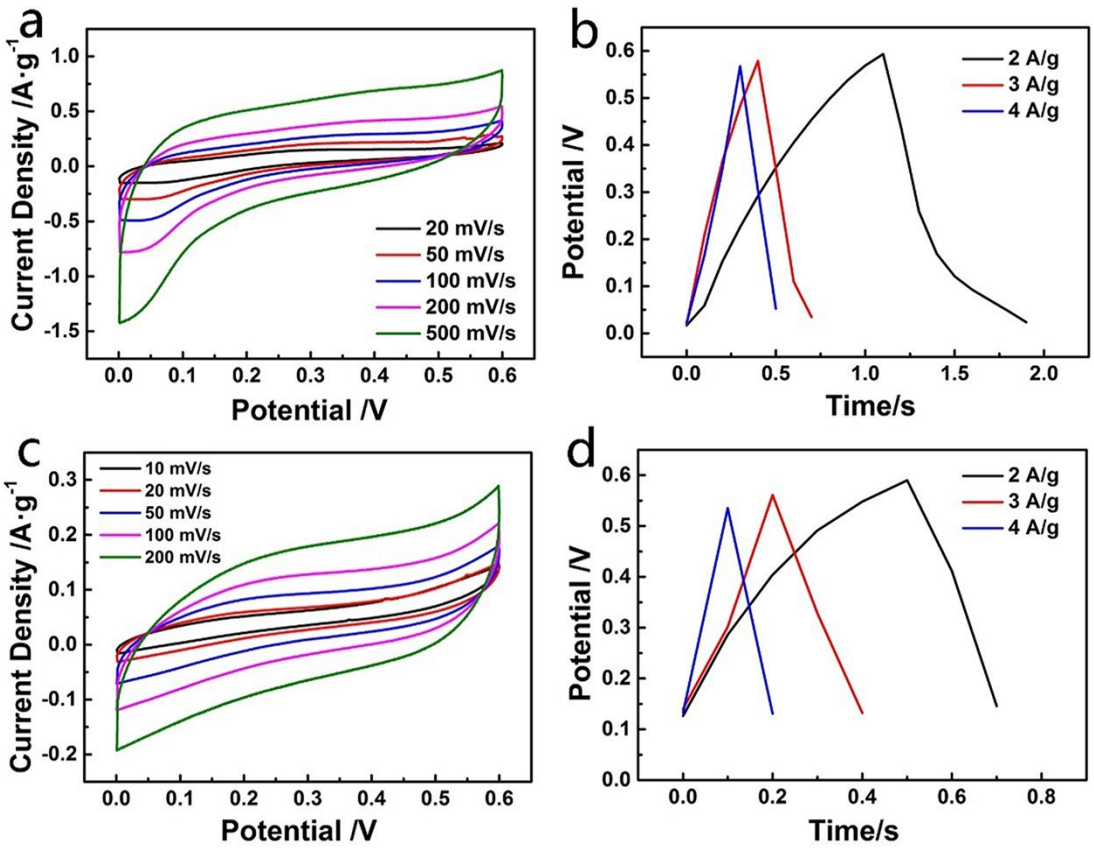

Fig. S9 CV curves and GCD profiles for the (a, b) annealed 1T-MoS_2, and (c, d) commercial MoS_2, measured using a two-electrode symmetrical cell.

Table S1 Local structural parameters for Mo and S atoms in commercial MoS_2, annealed 1T-MoS_2 and as-prepared 1T-MoS_2 fitted from EXAFS data. R is the length of bond, N is the coordination number and σ^2 is Debye-Waller factor.

Sample	Path	R (Å)	N	σ^2 (10^{-3}Å)
Commercial MoS_2	Mo-S	2.41	6	3.6
	Mo-Mo	1.37	6	3.1
Annealed 1T-MoS_2	Mo-S	2.41	4.7	3.7
	Mo-Mo	3.16	3.7	5.4
1T-MoS_2	Mo-S	2.38	3.8	9.2
	Mo-Mo	2.76	1.5	10.7

Table S2 Synthesis conditions and specific capacitances comparisons of various materials reported from references with our obtained 1T- MoS_2.

Materials	Synthesis Method	Specific Capacitance	Electrolyte	Ref.
MoS_2 nanosheet	Hydrothermal	129.2 F/g (1 A/g)	1 M Na_2SO_4	1
MoS_2 nanosheet	Hydrothermal	8 mF/cm^2	1 M Na_2SO_4	2
MoS_2 nanosheet	Hydrothermal	92 F/g (0.5 mA/cm^2)	1 M Na_2SO_4	3
MoS_2 nanosphere	Hydrothermal	122 F/g (1 A/g)	1 M KCl	4
2D MoS_2 on graphene oxide	Microwave Heating	265 F/g (10 mV/s)	1 M $HClO_4$	5
Flower-like MoS_2	Hydrothermal	168 F/g (1 A/g)	1 M KCl	6
MoS_2 nanosheet on Mo foil	Hydrothermal	192.7 F/g (1 mA/cm^2)	1 M Na_2SO_4	7
MoS_2 nanosheet	Solvothermal	231 F/g (1 A/g)	1 M Na_2SO_4	8
MoS_2 nanosheet	Solvothermal	348 F/g (1 A/g)	1 M H_2SO_4	This work

Table S3 Synthesis conditions and specific capacitances comparisons of various metal disulfides reported from references with our obtained 1T- MoS_2.

Materials	**Synthesis Method**	**Specific Capacitance**	**Electrolyte**	**Ref.**
CoS_2	Microwave-mediated	119 F/g (1 A/g)	1 M $LiPF_6$-based	9
CoS_2	Hydrothermal	236.5 F/g (1A/g)	2 M KOH	10
NiS_2/NiS	Hydrothermal	717 F/g (0.6 A/g)	3 M KOH	11
NiS_2	Microwave-assisted	695 F/g (1.25 A/g)	3 M KOH	12
NiS_2/graphene	Solvothermal	426 F/g (1A/g)	6 M KOH	13
MnS_2	Hydrothermal	471 F/g (0.5 mA/cm^2)	-	14
SnS_2	Solvothermal	216 F/g (0.38 A/g)	1 M KCl	15
WS_2	Hydrothermal	2813 µF/g (0.5 A/m^2)	1 M H_2SO_4	16
VS_2	Chemical exfoliating	4760 µF /cm^2 (0.1 A/m^2)	BM1MBF_4-PVA	17
VS_2	Hydrothermal	155 F/g (1 mA/cm^2)	6 M KOH	18
MoS_2 nanosheet	Solvothermal	348 F/g (1 A/g)	1 M H_2SO_4	This work

Supplementary References

1. K.-J. Huang, J.-Z. Zhang, G.-W. Shi and Y.-M. Liu, *Electrochim. Acta*, 2014, **132**, 397-403.
2. Y. Gao, Y. S. Zhou, M. Qian, X. N. He, J. Redepenning, P. Goodman, H. M. Li, L. Jiang and Y. F. Lu, *Carbon*, 2013, **51**, 52-58.
3. K. Krishnamoorthy, G. K. Veerasubramani, S. Radhakrishnan and S. J. Kim, *Mater. Res. Bull.*, 2014, **50**, 499-502.
4. X. Zhou, B. Xu, Z. Lin, D. Shu and L. Ma, *J. nanosci. nanotechnol.*, 2014, **14**, 7250-7254.
5. E. G. da Silveira Firmiano, A. C. Rabelo, C. J. Dalmaschio, A. N. Pinheiro, E. C. Pereira, W. H. Schreiner and E. R. Leite, *Adv. Energ. Mater.*, 2014, **4**.
6. R. Wang, C. Xu, J. Sun, Y. Liu, L. Gao, H. Yao and C. Lin, *Nano Energy*, 2014, **8**, 183-195.
7. K. Krishnamoorthy, G. K. Veerasubramani, P. Pazhamalai and S. J. Kim, *Electrochim. Acta*, 2016, **190**, 305-312.
8. H. Xiao, S. Wang, S. Zhang, Y. Wang, Q. Xu, W. Hu, Y. Zhou, Z. Wang, C. An and J. Zhang, *Mater. Chem. Phys.*, 2017, **192**, 100-107.
9. S. Amaresh, K. Karthikeyan, I.-C. Jang and Y. Lee, *J. Mater. Chem. A*, 2014, **2**, 11099-11106.
10. J.-C. Xing, Y.-L. Zhu, Q.-W. Zhou, X.-D. Zheng and Q.-J. Jiao, *Electrochim. Acta*, 2014, **136**, 550-556.
11. C. Wei, C. Cheng, Y. Cheng, Y. Wang, Y. Xu, W. Du and H. Pang, *Dalton Trans.*, 2015, **44**, 17278-17285.
12. H. Pang, C. Wei, X. Li, G. Li, Y. Ma, S. Li, J. Chen and J. Zhang, *Sci. Rep.*, 2014, **4**, 3577.
13. X. Li, J. Shen, N. Li and M. Ye, *Mater. Lett.*, 2015, **139**, 81-85.
14. T. Chen, Y. Tang, Y. Qiao, Z. Liu, W. Guo, J. Song, S. Mu, S. Yu, Y. Zhao and F. Gao, *Sci. Rep.*, 2016, **6**, 23289.
15. R. K. Mishra, G. W. Baek, K. Kim, H.-I. Kwon and S. H. Jin, *Appl. Surf. Sci.*, 2017, **425**, 923-931.
16. A. Khalil, Q. Liu, Q. He, T. Xiang, D. Liu, C. Wang, Q. Fang and L. Song, *RSC Adv.*, 2016, **6**, 48788-48791.
17. J. Feng, X. Sun, C. Wu, L. Peng, C. Lin, S. Hu, J. Yang and Y. Xie, *J. Am. Chem. Soc.*, 2011, **133**, 17832-17838.
18. T. M. Masikhwa, F. Barzegar, J. K. Dangbegnon, A. Bello, M. J. Madito, D. Momodu and N. Manyala, *RSC Adv.*, 2016, **6**, 38990-39000.