Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Fabrication of amorphous Co/Mo–$MnSe_x$ electrode materials for high-performance hybrid supercapacitors

Qian Zhang [a], *Guoxiang Wang* [a, *], *Taipu Chen* [b, c] *Hao Wu* [a], *Rui Yuan* [a], *Boyan Ai* [a], *Pengchao Liang* [a], *Dahui Fang* [b], *Qingwang Min* [a, *]

[a] School of Light Industry & Chemical Engineering, Dalian Polytechnic University, Dalian 116034, China.

[b] Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Dalian 116023, China

[c] University of Chinese Academy of Sciences, Beijing 100039, China

---

Author Contributions

*Corresponding author.
E-mail address: wanggx1000@126.com (G.X. Wang)
E-mail address: minqw@dlpu.edu.c

The specific capacitance (C, F g^{-1}) is calculated from the GCD curve according to Equation (1).

$$C = \frac{I \times \Delta t}{m \times \Delta v} \quad (1)$$

Specific capacitances derived from GCD curves in the two electrode (C, F g^{-1}) system were counted by formula (2):

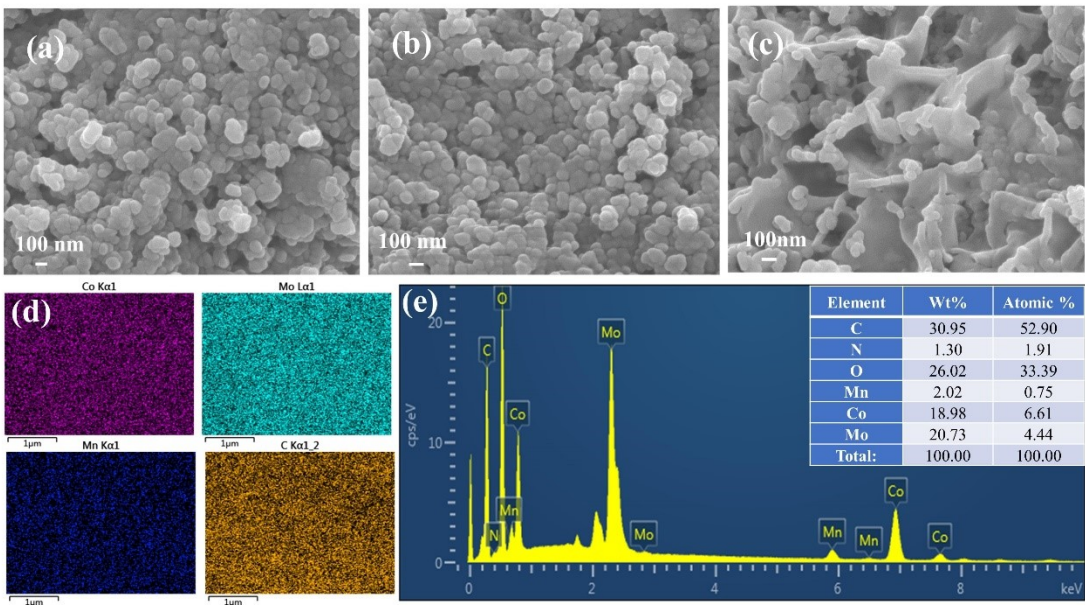
$$C = \frac{2 i_m \int V dt}{V_1^2 - V_0^2} \quad (2)$$

The energy density (E, Wh kg^{-1}) and power density (P, W kg^{-1}) in the two electrodes were calculated using the following two formulas.

$$E = \frac{1/2 C (\Delta V)^2}{3.6} \quad (3)$$

$$P = \frac{E \times 3600}{\Delta t} \quad (4)$$

Where t denotes the discharge time (s), m is the quality of active material (g), I is the discharge current (A), V is the potential change during the discharge process (V) and i_m is the current density (A g^{-1}).



Element	Wt%	Atomic %
C	30.95	52.90
N	1.30	1.91
O	26.02	33.39
Mn	2.02	0.75
Co	18.98	6.61
Mo	20.73	4.44
Total:	100.00	100.00

Fig. S 1. SEM images of (a) Co/Mo–MOF, (b) Co/Mo–MOF–Mn, (c) Co/$MoSe_x$, (d) Elemental mapping and (e) EDS image of Co/Mo–MOF–Mn.

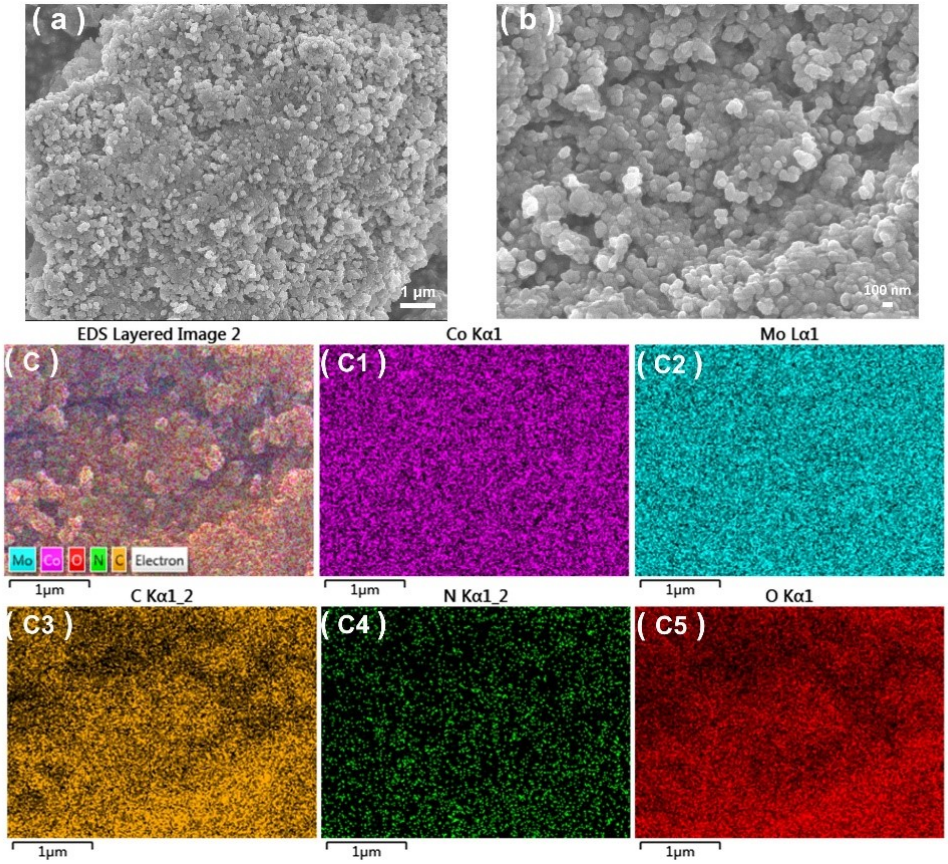


Fig. S 2. (a, b) SEM images and (c) EDS mapping distribution of Co/Mo–MOF.

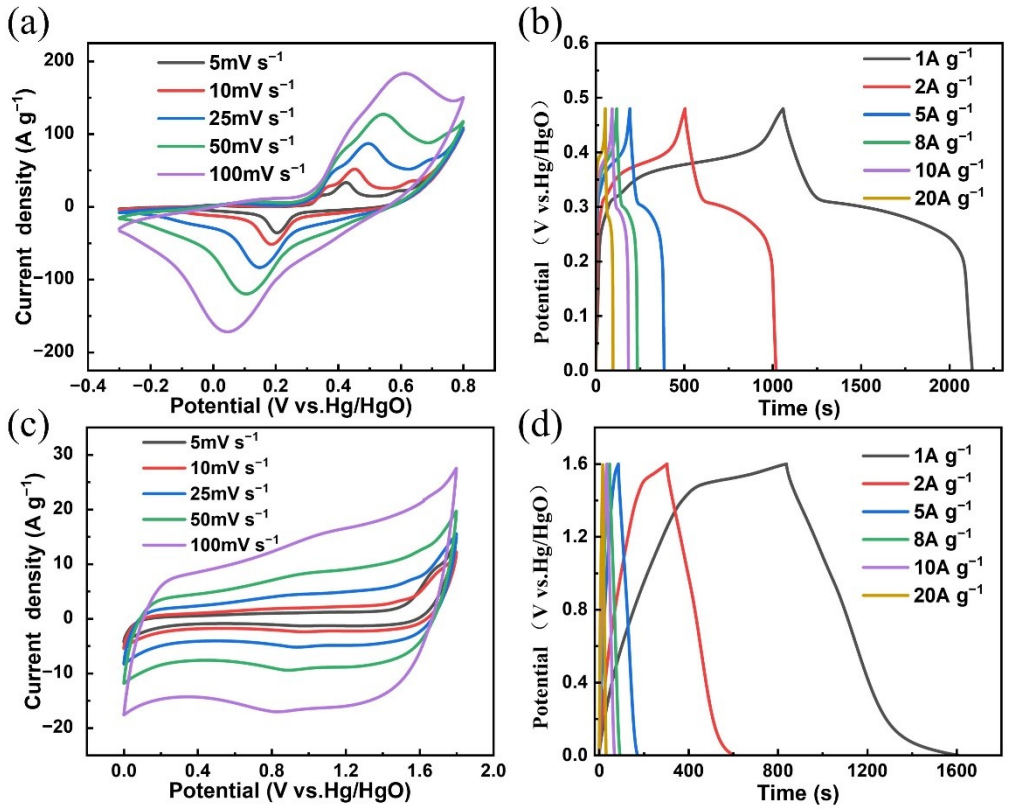


Fig. S 3. (a, c) CV curves at various scan rates and (b, d) GCD curves at various densities of Co/Mo–MOF and Co/Mo–MOF//AC.

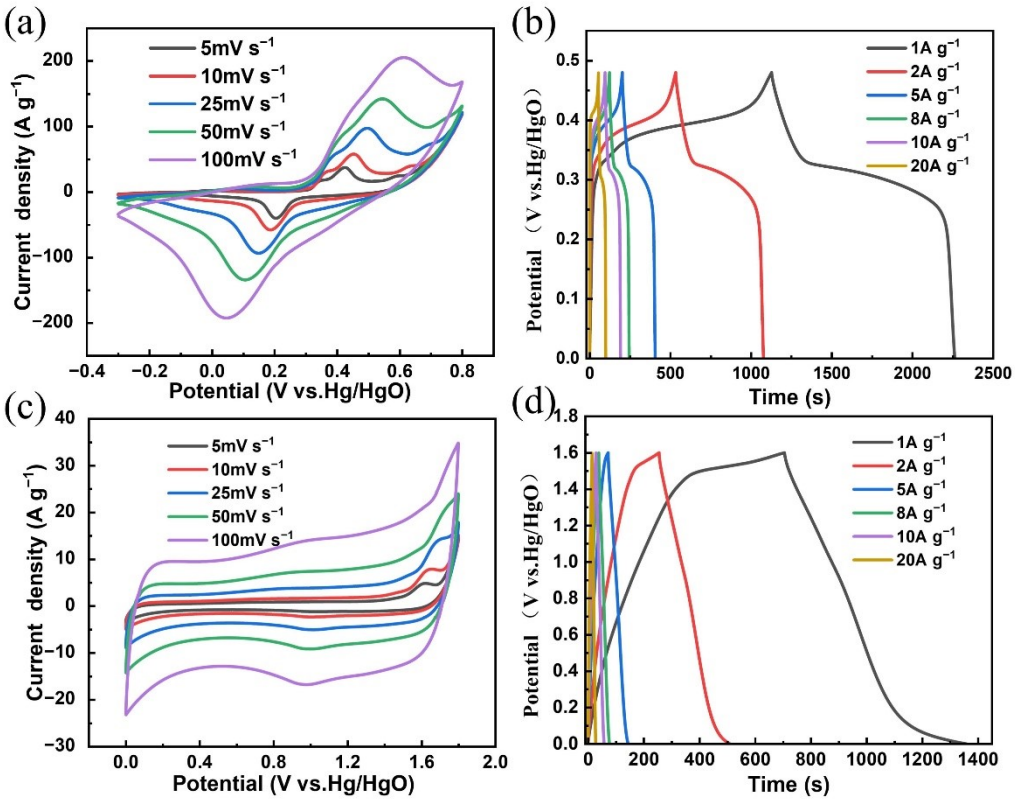


Fig. S 4. (a, c) CV curves at various scan rates and (b, d) GCD curves at various densities of Co/Mo–Mn and Co/Mo–Mn//AC.

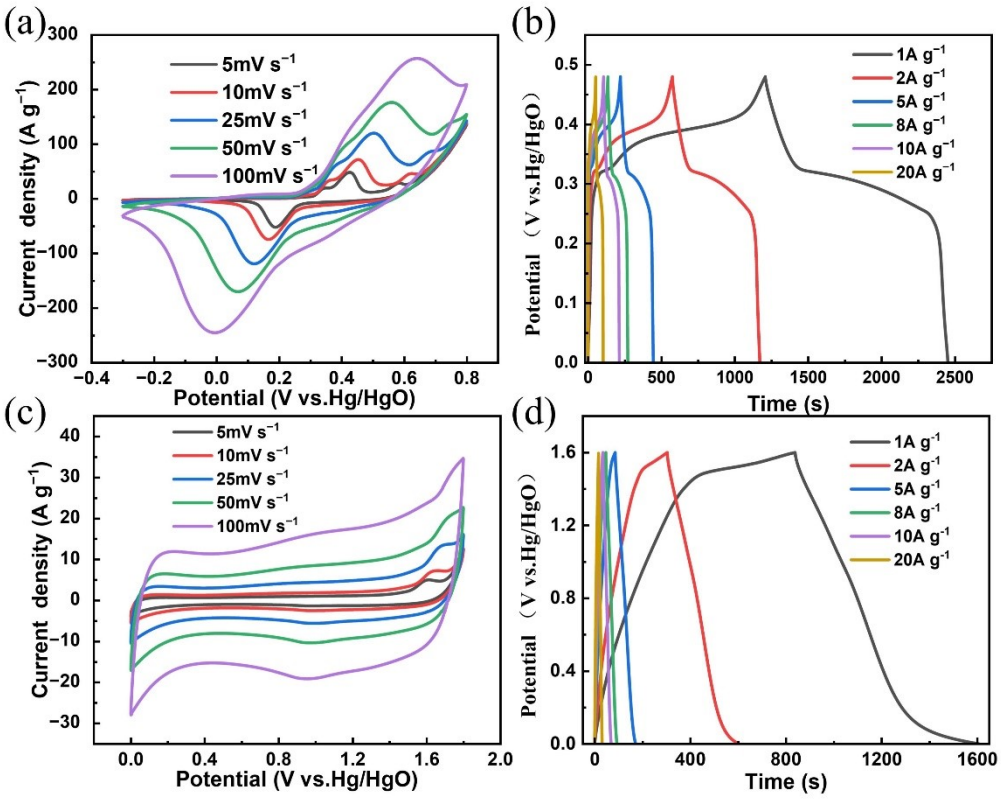


Fig. S 5. (a, c) CV curves at various scan rates and (b, d) GCD curves at various densities of Co/$MoSe_x$ and Co/$MoSe_x$ //AC.

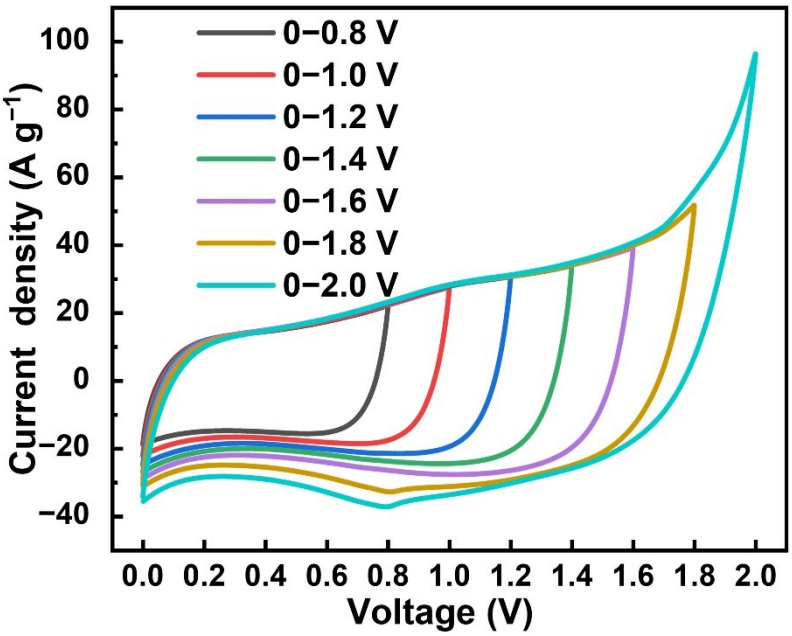


Fig. S 6 CV curves of CO/Mo–$MnSe_x$//AC at different potential ranging from 0.8 to 2.0 V at 100 mV·s^{-1}.

Table. S 1 Results of EIS fitting for four samples.

Sample	R_s/Ω	R_{ct}/Ω
CO/Mo–MOF	0.67	3.14
CO/Mo–MOF–Mn	0.67	4.05
CO/MoSex	0.62	6.32
CO/Mo–$MnSe_x$	0.59	1.88

Table. S 2 Energy density of Co/Mo–$MnSe_x$//AC compared with other reported high-performance HBS.

Devices	Power density （W kg^{-1})	Energy density (Wh kg^{-1})	Reference
Co–Mo–Se//AC	1094.0	44.7	1
$CoSe_2$//AC	387.0	18.9	2
$MnSe_2$@$MoSe_2$//AC	747.0	75.0	3
$CuSe_2$@$MoSe_2$//AC	746.0	113.0	4
MCSe-3h/rGO//AC	853.1	45.8	5
NMSe/rGO-140//AC	800.7	51.4	6
MNSe@NF//AC@NF	858.4	66.0	7
This work	496.0	141.3	This work

References

1. C. Miao, C. Zhou, H.-E. Wang, K. Zhu, K. Ye, Q. Wang, J. Yan, D. Cao, N. Li and G. Wang, *Journal of Power Sources*, 2021, **490**, 229532.
2. S. Liu, S. Sarwar, J. Wang, H. Zhang, T. Li, J. Luo and X. Zhang, *Journal of Materials Chemistry C*, 2021, **9**, 228-237.
3. M. S. Vidhya, R. Yuvakkumar, P. S. Kumar, G. Ravi and D. Velauthapillai, *Topics in Catalysis*, 2021, **65**, 615-622.
4. M. S. Vidhya, R. Yuvakkumar, P. S. Kumar, G. Ravi, D. Velauthapillai and P. N. Asrami, *Topics in Catalysis*, 2022, **65**, 668-676.
5. H. Xuan, G. Zhang, X. Han, R. Wang, X. Liang, Y. Li and P. Han, *Journal of Alloys and Compounds*, 2021, **863**, 158751.
6. G. Zhang, H. Xuan, J. Yang, R. Wang, Z. Xie, X. Liang, P. Han and Y. Wu, *Journal of Power Sources*, 2021, **506**, 230255.
7. B. Ameri, A. Mohammadi Zardkhoshoui and S. S. Hosseiny Davarani, *Dalton Trans*, 2021, **50**, 8372-8384.