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

Supporting Information for

Synergistically coupling of NiVAl layered double hydroxide with few-layer $Ti_3C_2T_x$-MXene nanosheets for superior asymmetric supercapacitor

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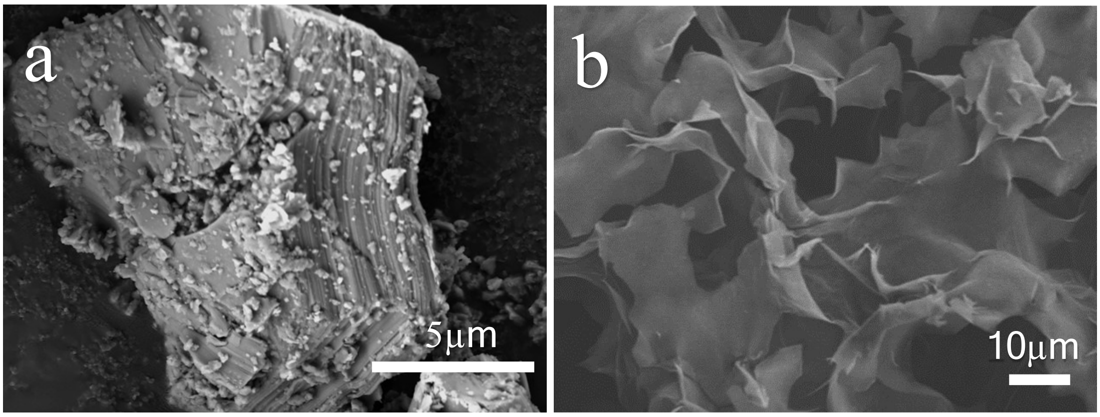

Fig. S1. SEM images of (a) Ti_3AlC_2, (b) $Ti_3C_2T_x$-MXene.

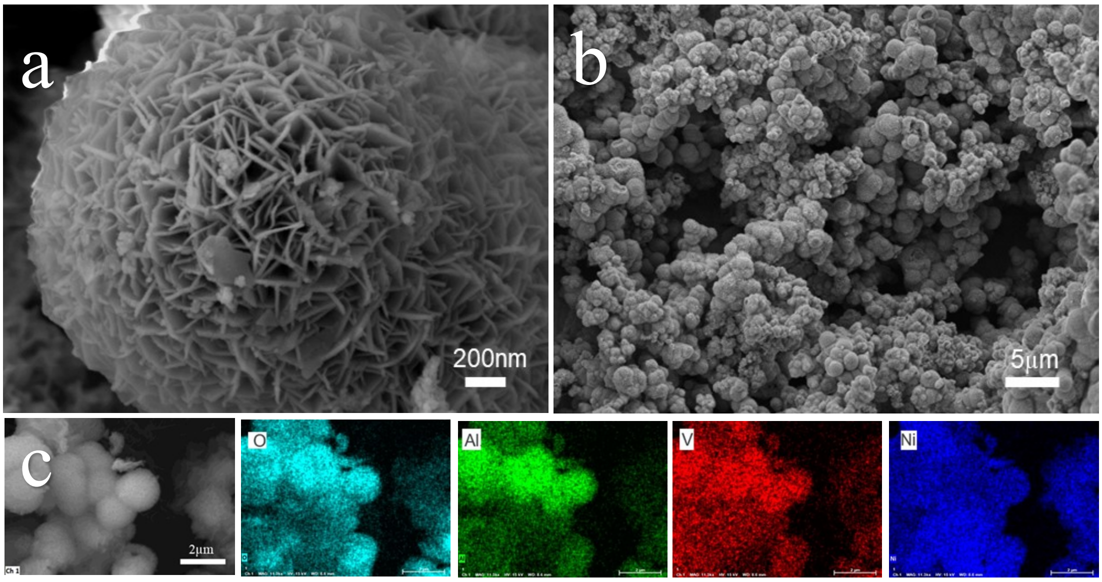

Fig. S2. SEM images of (a) NiVAl-LDH at high magnification, (b) NiVAl-LDH at low magnification, (c) EDS mapping of O, Al, V and Ni.

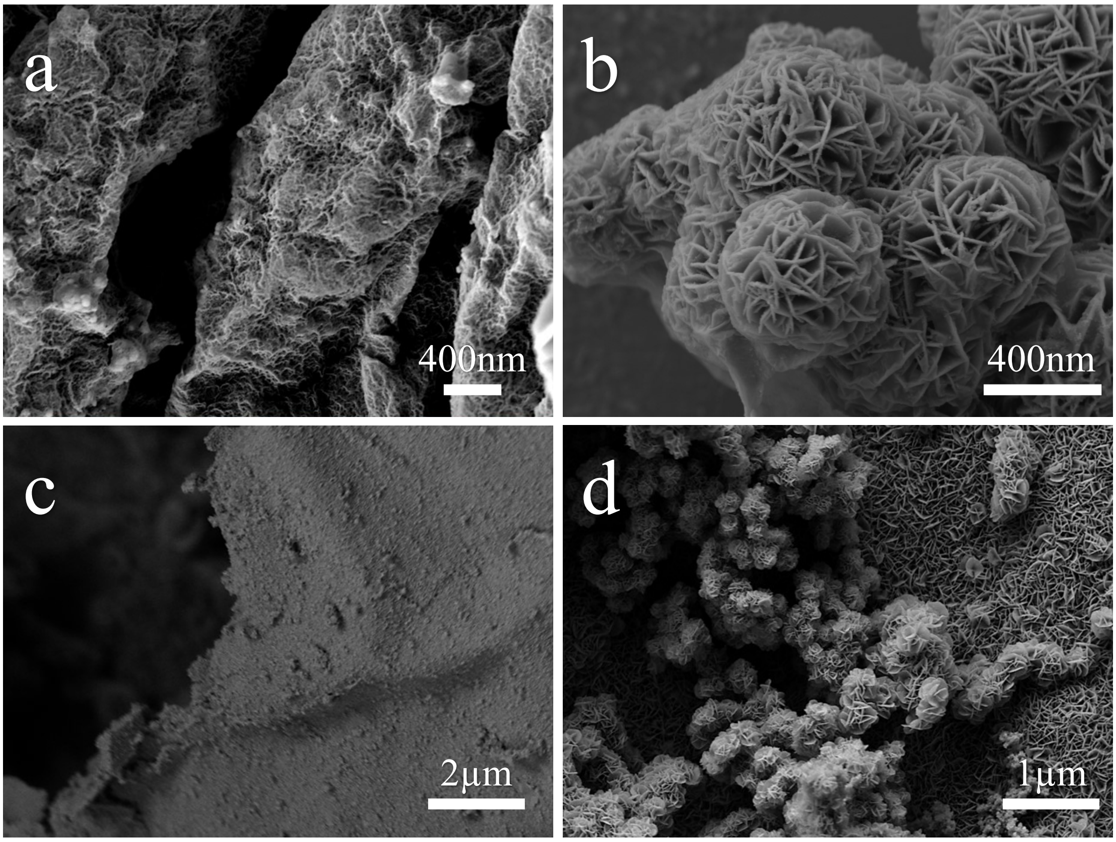

Fig. S3. SEM images of (a) $Ti_3C_2T_x$-MXene/NiVAl-LDH(1:1) at high magnification, (b) $Ti_3C_2T_x$-MXene/NiVAl-LDH(1:8) at high magnification, (c) $Ti_3C_2T_x$-MXene/NiVAl-LDH(1:1) at high magnification, (d) $Ti_3C_2T_x$-MXene/NiVAl-LDH(1:8) at low magnification.

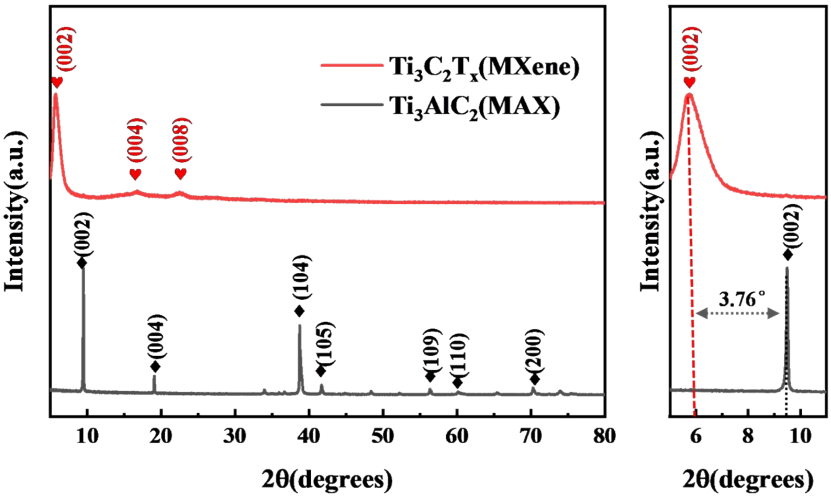

Fig. S4. The XRD pattern of Ti_3AlC_2 and $Ti_3C_2T_x$-MXene.

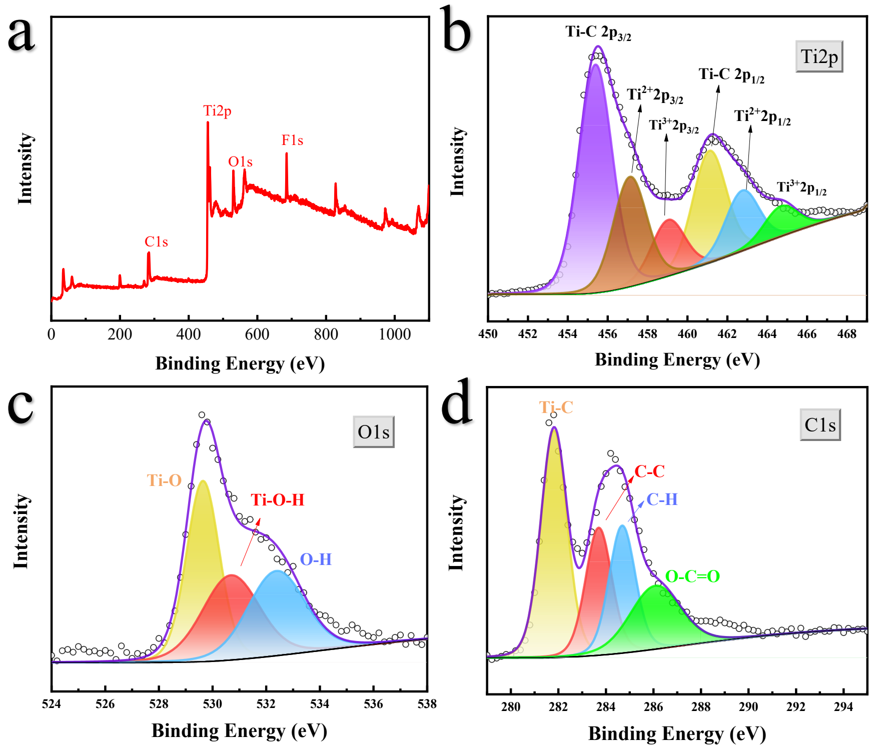

Fig. S5. (a) The XPS survey spectrum of $Ti_3C_2T_x$-MXene, (b) Ti 2p, (c) O 1s and (d) C 1s high-resolution XPS spectra of $Ti_3C_2T_x$-MXene.

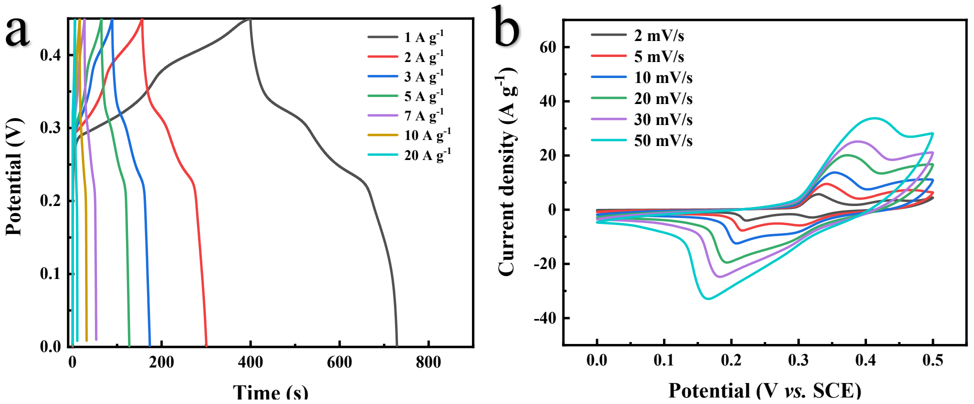

Fig. S6. (a) CV curves of NiVAl-LDH at different scan rates, (b) GCD curves of NiVAl-LDH at different current densities.

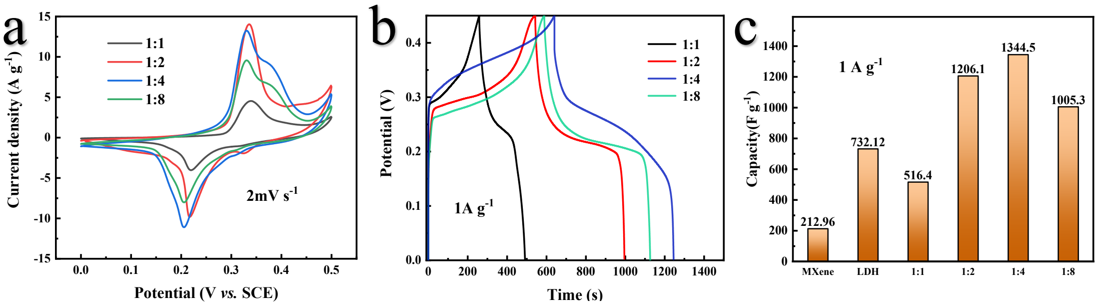

Fig. S7. (a) CV curves of different samples at scan rate of 2 mV s^{-1}. (d) GCD curves of different samples at current density of 1 A g^{-1}. (c) Histogram of the specific capacitance of different samples.

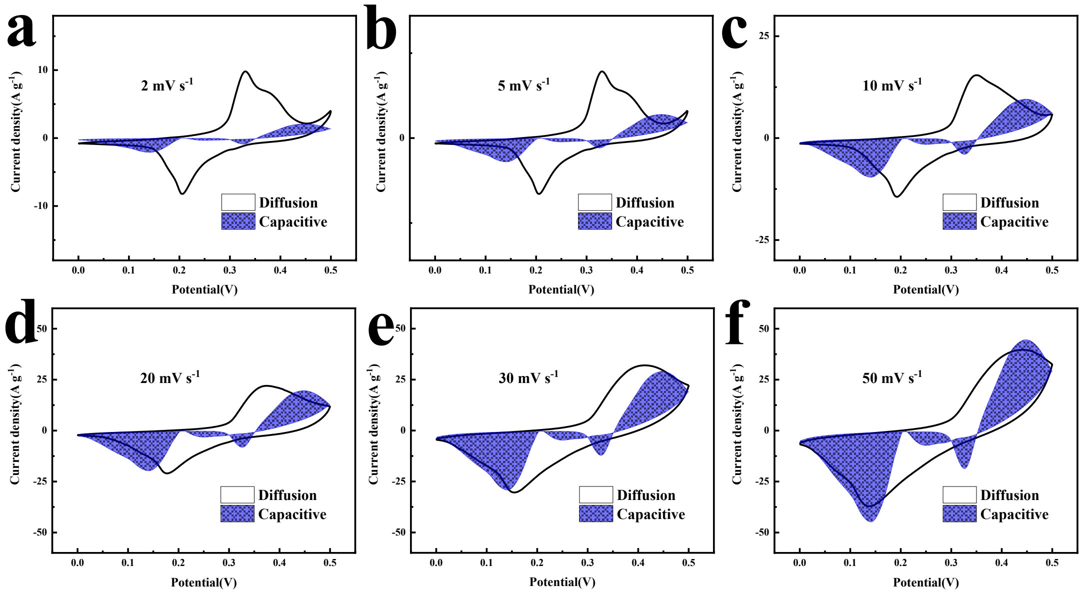

Fig. S8. CV of capacitive-controlled and diffusion-controlled contributions for $Ti_3C_2T_x$-MXene/NiVAl-LDH at different scanning rates.

Table. S1. The specific R_s and R_{ct} values (Ω) of $Ti_3C_2T_x$-MXene, NiVAl-LDH and $Ti_3C_2T_x$-MXene/NiVAl-LDH

Samples	R_s	R_{ct}
$Ti_3C_2T_x$-MXene	1.01	0.56
NiVAl-LDH	2.01	0.98
$Ti_3C_2T_x$-MXene/NiVAl-LDH	1.29	0.49

Table. S2. Electrochemical performances of $Ti_3C_2T_x$-MXene/NiVAl-LDH and relevant electrode materials

Electrode materials	KOH electrolyte	Specific capacitance	Cycle retention	Ref.
$Ti_3C_2T_x$-MXene/NiVAl-LDH	1 mol L^{-1}	186.7 mAh g^{-1} (1 A g^{-1})	84.7% (5000 cycles, 10 A g^{-1})	This work
NiMn-LDH	6 mol L^{-1}	527 F g^{-1} (1 A g^{-1})	91.2% (5000 cycles, 2 A g^{-1})	1
C-NiMn-1	1 mol L^{-1}	870 F g^{-1} (1 A g^{-1})	89.9% (5000 cycles, 0.5 A g^{-1})	2
MXene/NiCoFe-LDH	1 mol L^{-1}	1305 F g^{-1} (1 A g^{-1})	85.7% (6000 cycles, 10 A g^{-1})	3
CNTs@NiCo-LDH//ZIF-8	1 mol L^{-1}	176 mAh g^{-1} (1 A g^{-1})	90.22% (5200 cycles, 10 A g^{-1})	4
NiCoAl-LDH/$V_4C_3T_x$	1 mol L^{-1}	627 C g^{-1}(1 A g^{-1})	98.0% (10000 cycles, 20 A g^{-1})	5
G-NiMnLDH	2 mol L^{-1}	1108 F g^{-1} (1 A g^{-1})	78% (3000 cycles, 15 A g^{-1})	6
FeNi-LDH/$Ti_3C_2T_x$	1 mol L^{-1}	922.6 F g^{-1} (1 A g^{-1})	88% (10000 cycles, 3 A g^{-1})	7
$NiMoO_4$/NiCo-LDH	1 mol L^{-1}	153.7 mAh g^{-1} (1 A g^{-1})	80% (5000 cycles, 1 A g^{-1})	8
$CoNi_2S_4$/CoNi-LDH	1 mol L^{-1}	184 mAh g^{-1} (2 A g^{-1})	95.9% (10000 cycles, 1 A g^{-1})	9
NiCo-LDH@AgNW	1 mol L^{-1}	115 mAh g^{-1} (0.2 A g^{-1})	75.9% (5000 cycles, 1 A g^{-1})	10

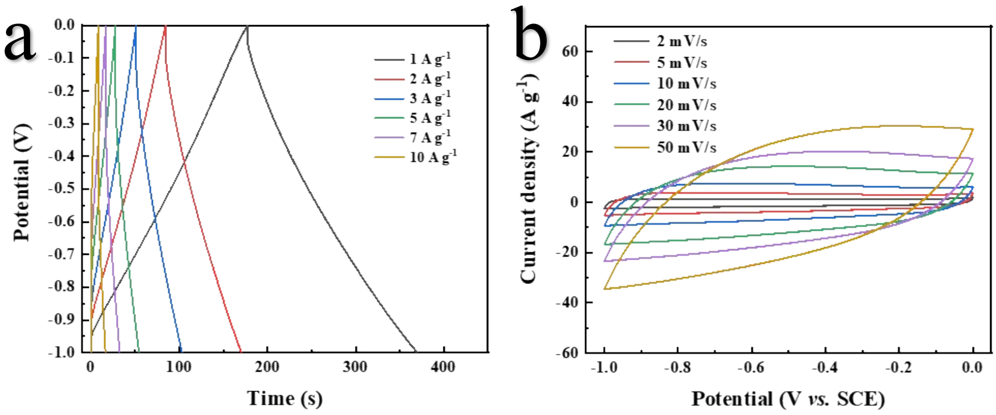

Fig. S9. (a) CV curves of AC at different scan rates, (b) GCD curves of AC at different current densities.

References

1. M. M. Baig, I. H. Gul, R. Ahmad, S. M. Baig, M. Z. Khan and N. Iqbal, *J. Mater. Sci.*, 2021, **56**, 18636-18649.
2. Q. Shan, W. Huo, M. Shen, C. Jing, Y. Peng, H. Pu and Y. Zhang, *Chin. Chem. Lett.*, 2020, **31**, 2245-2248.
3. T. Yang, J. Ye, S. Chen, S. Liao, H. Chen, L. Yang, X. Xu and F. Wang, *Electrochim. Acta*, 2020, **362**, 137081.
4. F. Zhu, W. Liu, Y. Liu and W. Shi, *Chem. Eng. J.*, 2020, **383**, 123150.
5. X. Wang, H. Li, H. Li, S. Lin, J. Bai, J. Dai, C. Liang, X. Zhu, Y. Sun and S. Dou, *J. Mater. Chem. A*, 2019, **7**, 2291-2300.
6. Y. Yang, X. Xu, W. Li, Y. Huang, J. Jiang, L. He, M. Jing, Y. Bai, T. Wu, G. Fang, Y. Yang and X. Wang, *Appl. Surf. Sci.*, 2023, **611**, 155562.

7. R. Zhang, J. Dong, W. Zhang, L. Ma, Z. Jiang, J. Wang and Y. Huang, *Nano Energy*, 2022, **91**, 106633.
8. S. Cui, Q. Hu, K. Sun, X. Wang, F. Wang, H. A. Hamouda, H. Peng and G. Ma, *ACS Appl. Nano Mater.*, 2022, **5**, 6181-6191.
9. A. Siddiqa, N. D. H and M. Padaki, *Energy Fuels*, 2022, **36**, 13286-13295.
10. X. Xuan, M. Qian, L. Pan, T. Lu, Y. Gao, L. Han, L. Wan, Y. Niu and S. Gong, *J. Energy Chem.*, 2022, **70**, 593-603.