

High Volumetric Energy Density Annealed-MXene-Nickel Oxide/MXene Asymmetric Supercapacitor

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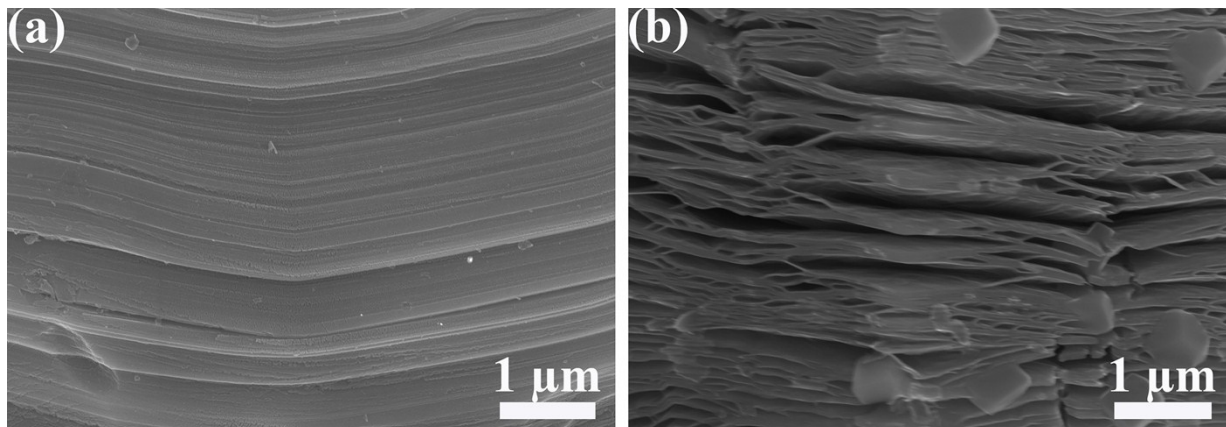


Figure S1. SEM images of the (a) as-obtained before HF treatment Ti_3AlC_2 MAX phase, and (b) after HF treatment $\text{Ti}_3\text{C}_2\text{T}_x$ MXene.

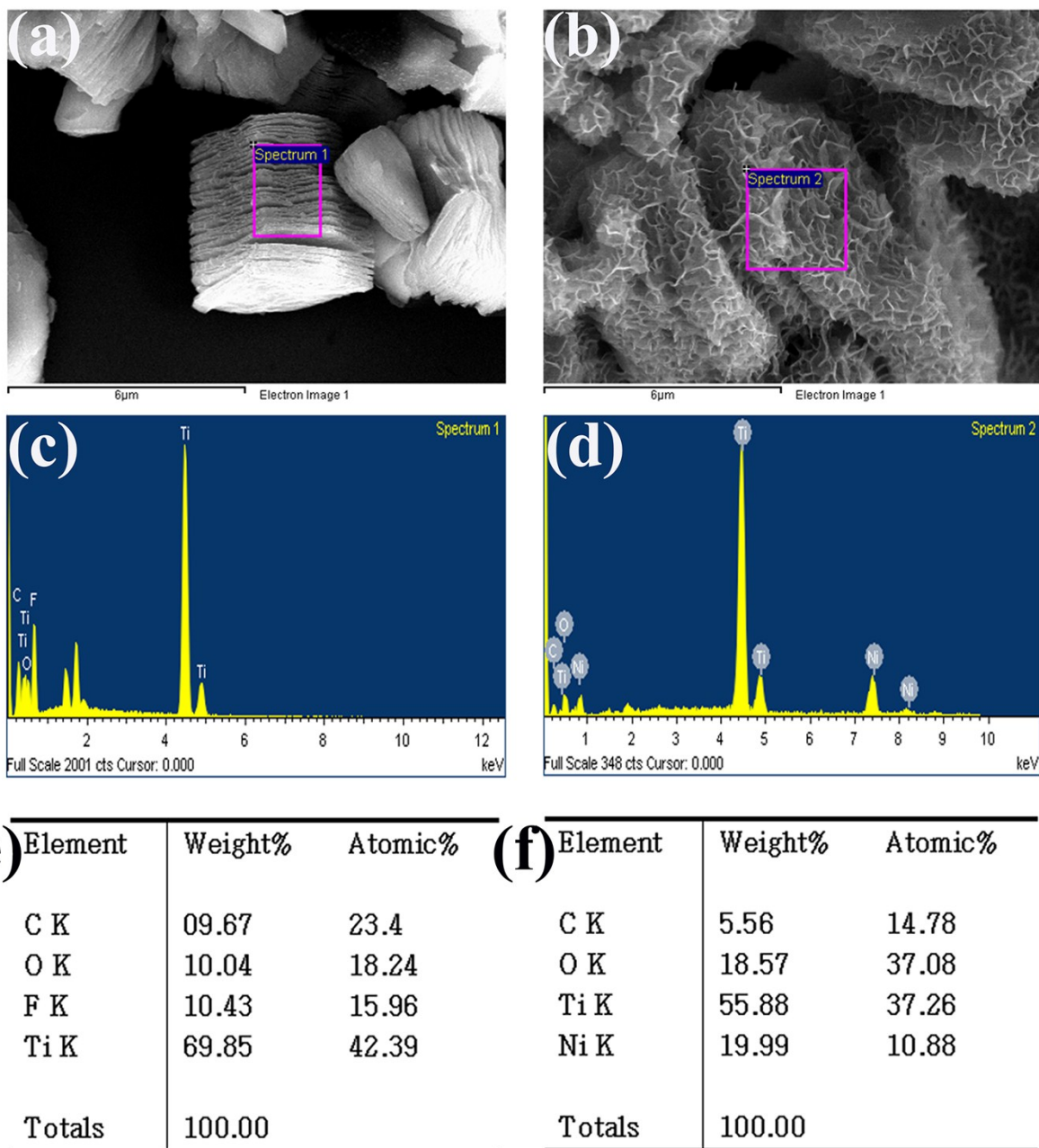


Figure S2. (a) SEM images of the $\text{Ti}_3\text{C}_2\text{T}_x$ MXene with corresponding selected-area EDX spectrum (c), and (e) corresponding elements content. (b) SEM images of the Ni-dMXNC with corresponding selected-area EDX spectrum (d), and (f) corresponding elements content.

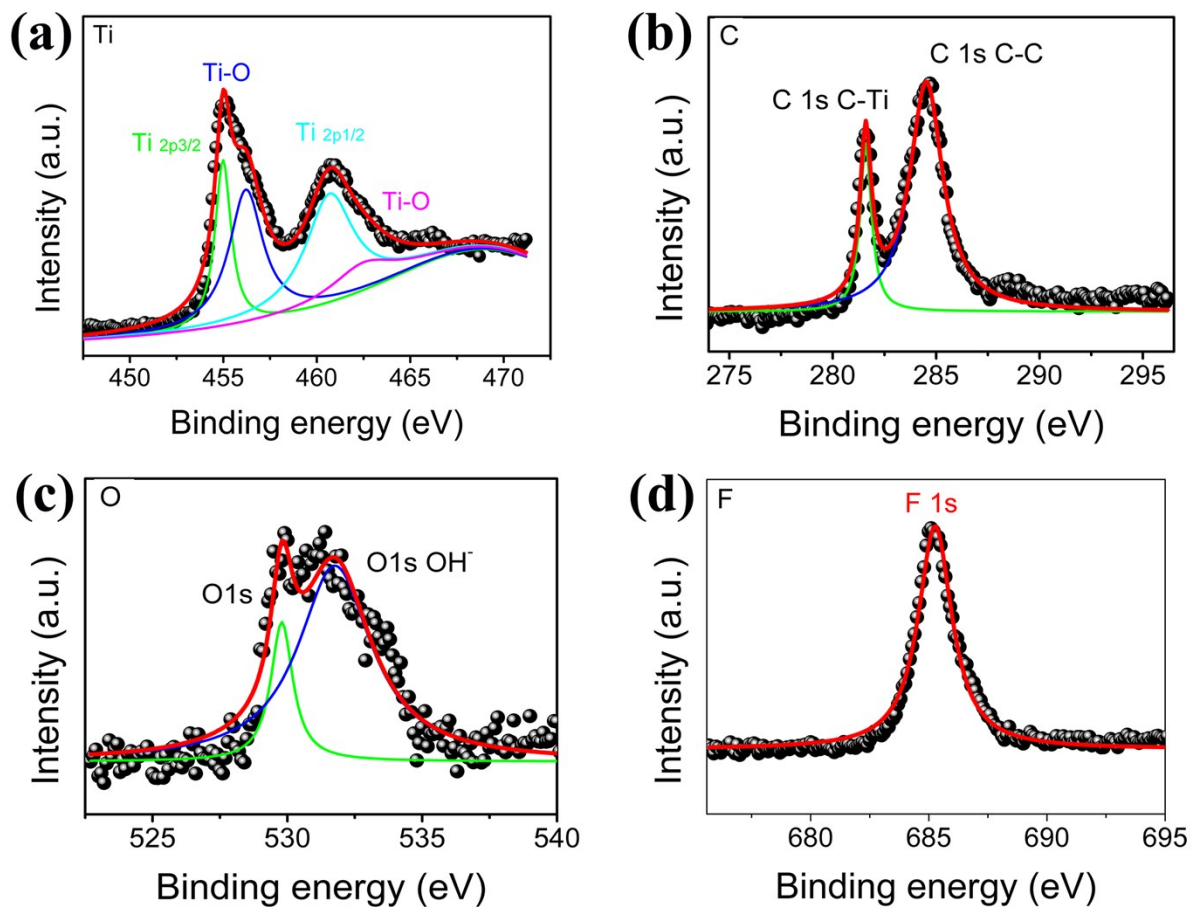


Figure S3. High-resolution XPS spectra (a) Ti 2p, (c) C 1s, (d) Ni 2p, (e) O 1s, and (f) F 1s spectra of $\text{Ti}_3\text{C}_2\text{T}_x$ MXene.

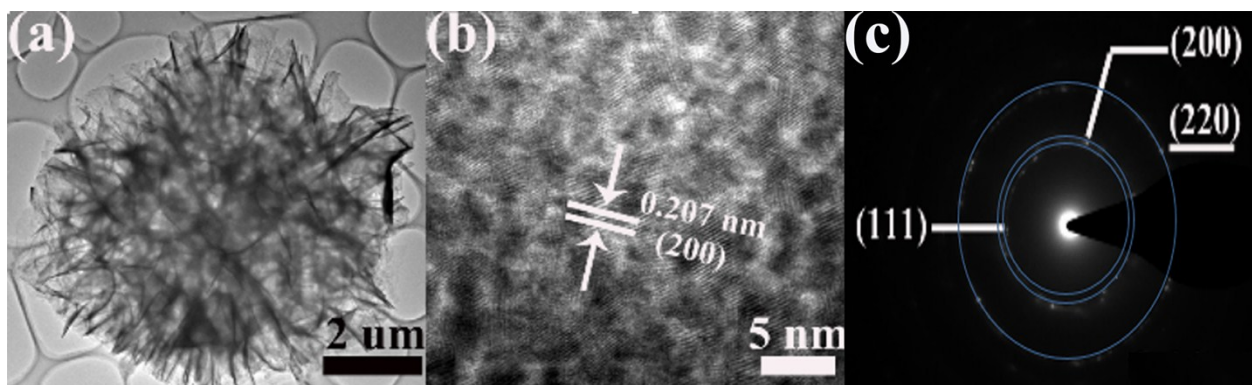


Figure S4. (a) Low magnification TEM image, (b) HRTEM image and (c) corresponding SAED pattern of the NiO nanosheets.

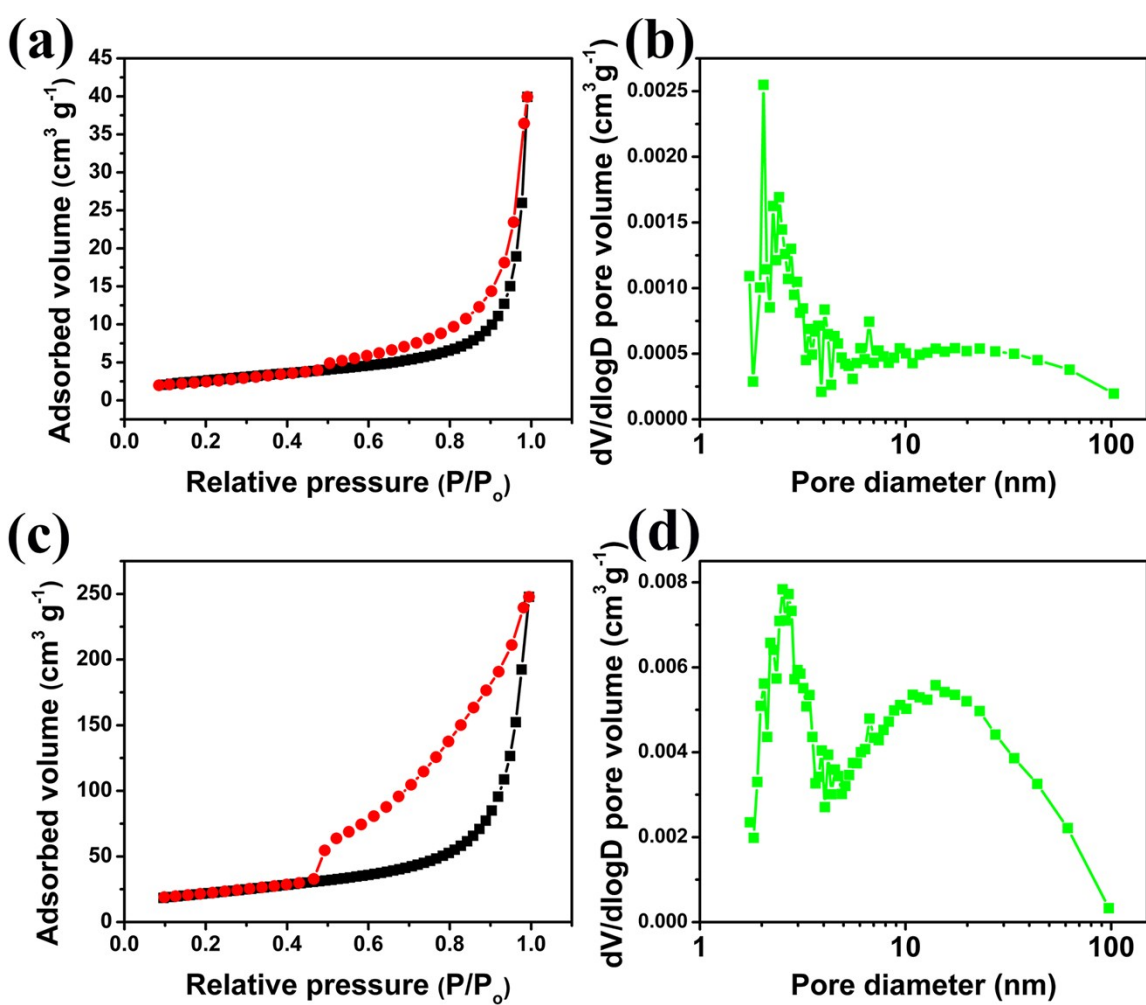


Figure S5. Pore structure of $\text{Ti}_3\text{C}_2\text{T}_x$ MXene and Ni-dMXNC (a) Nitrogen adsorption-desorption isotherms and (b) the BHJ pore-size distribution of the $\text{Ti}_3\text{C}_2\text{T}_x$ MXene; (c) Nitrogen adsorption-desorption isotherms and (d) the BHJ pore-size distribution of the Ni-dMXNC.

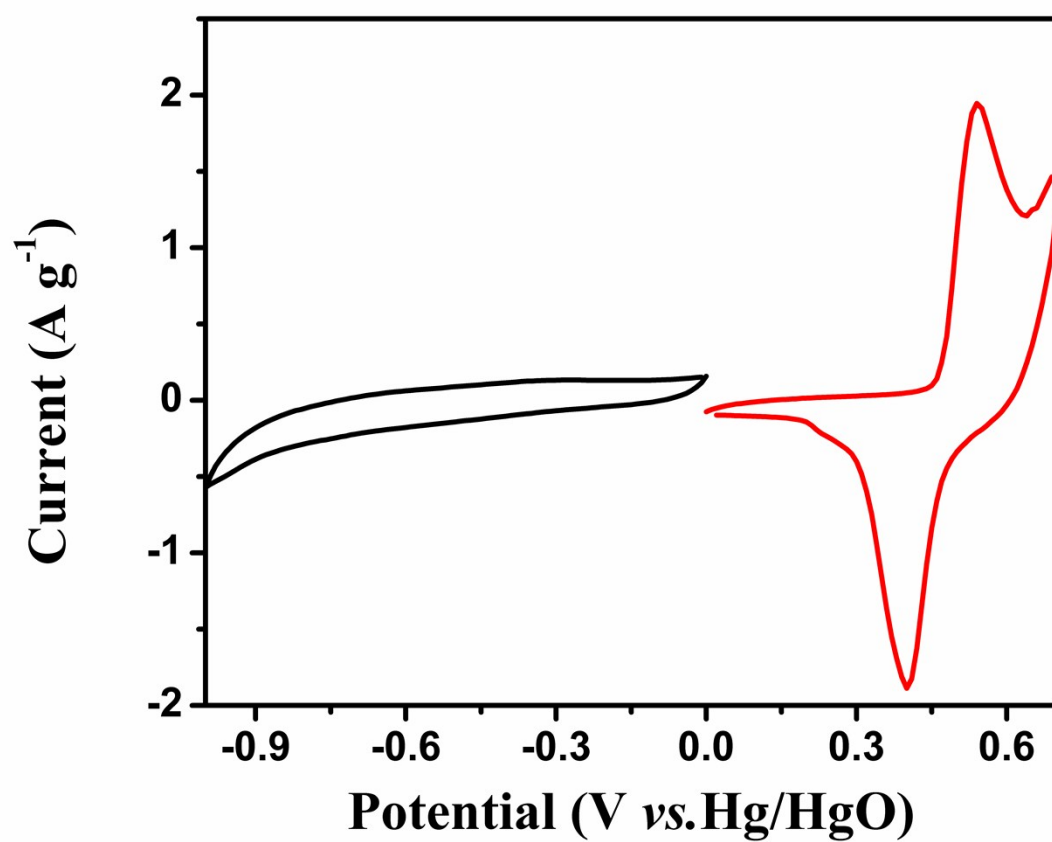


Figure S6. CV curves of the Ti₃C₂T_x MXene electrodes in different potential range at scan rate of 10 mV s⁻¹.

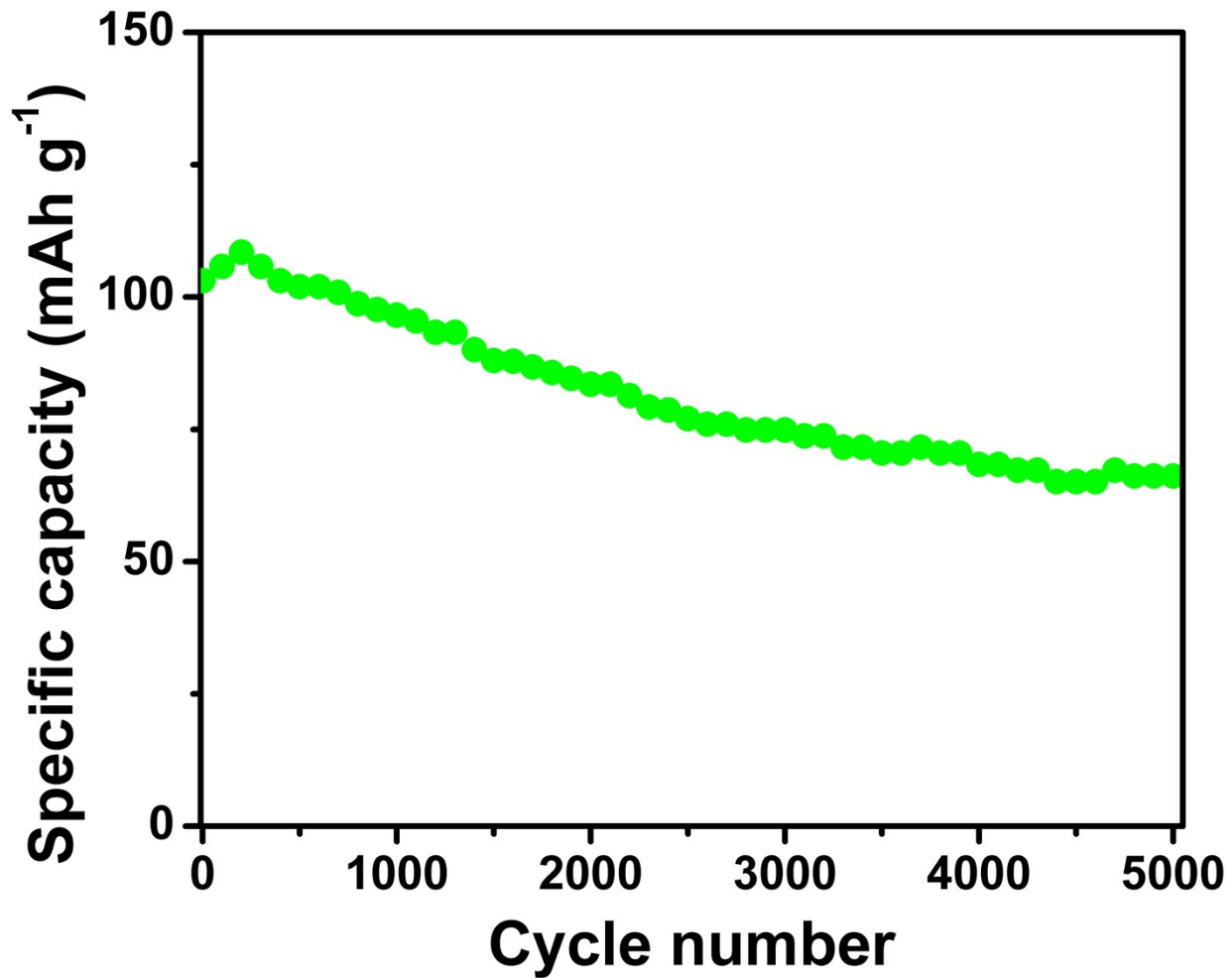


Figure S7. Cycling performance of the NiO electrode at a current density of 5 A g⁻¹.

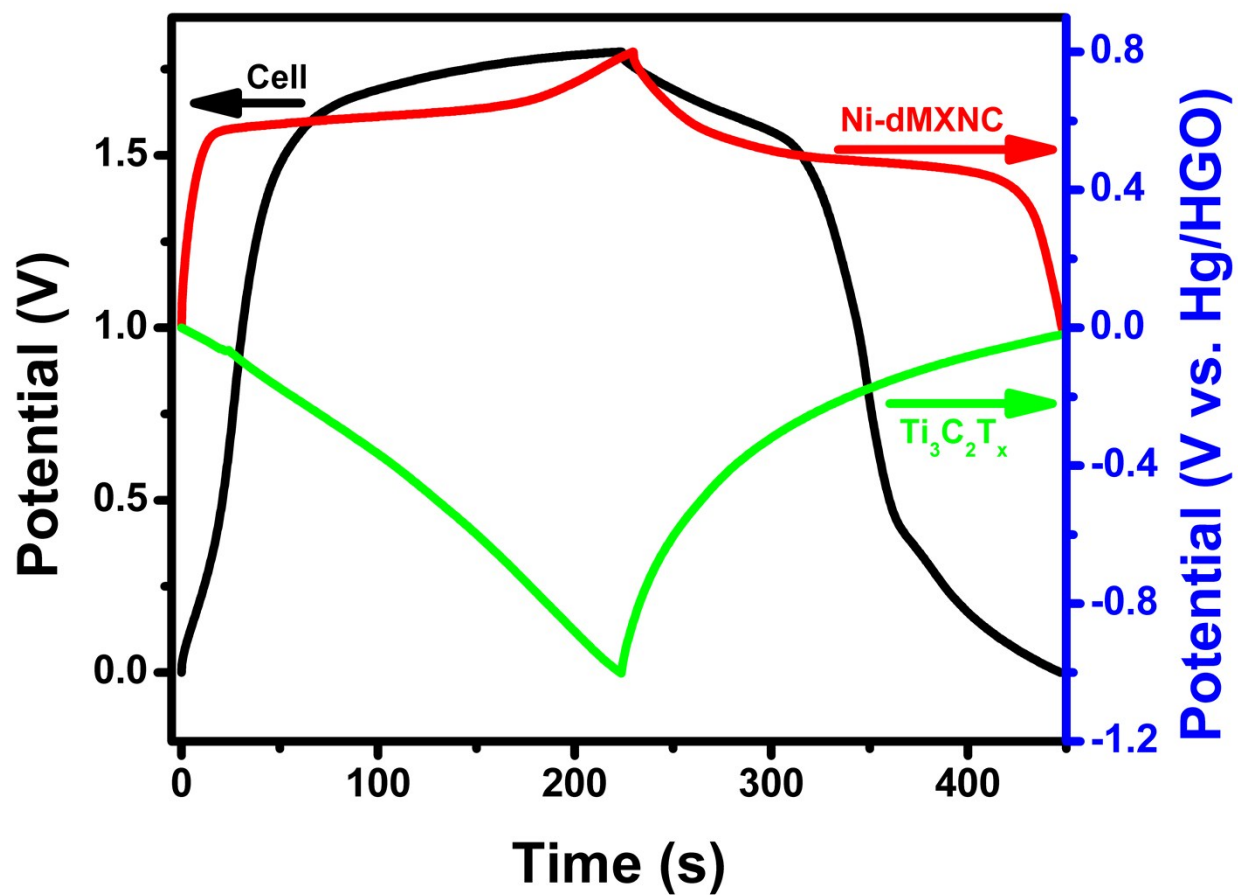


Figure S8. Galvanostatic charge-discharge curves of the asymmetric cell and the in situ tracked variation of the potential in each individual electrode.

Table S1. Resistivity of the $\text{Ti}_3\text{C}_2\text{T}_x$ MXene and Ni-dMXNC materials.

Sample	Resistivity (Ω/\square)	Resistivity ($\Omega \text{ m}$)
$\text{Ti}_3\text{C}_2\text{T}_x$	1.54E+4	6.76E+2
Ni-dMXNC	4.71E+3	3.30E+2

Table S2. Comparison of maximum gravimetric capacitance and volumetric capacitance of the reported MXene-based materials and the present work.

Positive electrodes	C_s (F g ⁻¹)	C_s (F cm ⁻³)	Electrolyte	Ref.
Ti ₃ C ₂ T _x		360 (2 mV s ⁻¹)	1 M MgSO ₄	[1]
Ti ₃ C ₂ T _x	53 (2 mV s ⁻¹)		0.05 M LiCl	[2]
Ti ₃ C ₂ T _x		49.6 (0.63 A cm ⁻³)	1 M H ₂ SO ₄	[3]
Ti ₃ C ₂	71.2 (2.5A/g)	119.8 (2.5A/g)	3 M KOH	[4]
Ti ₃ C ₂ -1.8	117 (2 mV s ⁻¹)		1 M KOH	[5]
Ti ₃ C ₂ T _x paper		442 (2 mV s ⁻¹)	1 M KOH	[6]
<i>d</i> -Ti ₃ C ₂		520 (2 mV s ⁻¹)	1 M H ₂ SO ₄	[7]
Ti ₃ C ₂ T _x -XAS	230 (1 mV s ⁻¹)		1 M H ₂ SO ₄	[8]
Ti ₃ C ₂ T _x hydrogel	70 (20 mV s ⁻¹)		Neat EMI-TFSI	[9]
Ti ₃ C ₂ T _x clay	245 (2 mV s ⁻¹)	900 (2 mV s ⁻¹)	1 M H ₂ SO ₄	[10]
Ti ₃ C ₂ T _x MXene film	499 (2 mV s ⁻¹)	226 (2 mV s ⁻¹)	1 M H ₂ SO ₄	[11]
Ti ₃ C ₂ /CNT	85 (2 mV s ⁻¹)	245 (2 mV s ⁻¹)	1 M EMITFSI	[12]
<i>d</i> -Ti ₃ C ₂ T _x /CNT	193.5 (5 mVs ⁻¹)	393 (5 mVs ⁻¹)	6 M KOH	[13]
Sandwich Ti ₃ C ₂ T _x /CNT		390 (2 mV s ⁻¹)	1 M MgSO ₄	[1]
Sandwich Ti ₃ C ₂ T _x /rGO		435 (2 mV s ⁻¹)	1 M MgSO ₄	[1]
Sandwich Ti ₃ C ₂ T _x /MWCNT		321 (2 mV s ⁻¹)	1 M MgSO ₄	[1]
Nb ₂ CT _x /CNT paper	165 (5 mVs ⁻¹)	325 (5 mVs ⁻¹)	1 M LiPF ₆	[14]
Mo ₂ CT _x	196 (2 mV s ⁻¹)	700 (2 mV s ⁻¹)	1 M H ₂ SO ₄	[15]
Ti ₂ CT _x //Ti ₂ CT _x symmetric SC	51 (1 mV s ⁻¹)		30 % KOH	[16]
V ₂ CT _x /hard carbon	100 (0.2 mV s ⁻¹)	170 (0.2 mV s ⁻¹)	1 M NaPE6	[17]
Ni-dMXNC	273.2 (1 A g ⁻¹)	819.6 (1 A g ⁻¹)	1 M KOH	This work

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