Supplementary Information

Synthesis of Ultra-high Specific Surface Area Aerogels with Nitrogen enriched $Ti_3C_2T_x$ nanosheets as High Performance Supercapacitor Electrodes

Xudong Liu, Yong Liu, Shangli Dong, Xuefeng Zhang, Shida Hou*

Corresponding authors: Prof. Yong Liu E-mail: liuy@hit.edu.cn.

Methods for calculation of specific capacitance

CV test

The gravimetric capacitances were calculated according to the following equations:

$$Cg = \frac{\int Idv}{\upsilon \times V \times m} \qquad (1)$$

Where C_g (F g^{-1}) is the gravimetric capacitance of the electrode, I (A) is the charge-discharge current, υ(V/s) scan rate, m(g) is the mass of the working electrode. V (V) is voltage window.

GCD test

The v gravimetric capacitances were calculated according to the following equations:

$$Cg = \frac{I\Delta t}{\Delta V \times m} \qquad (2)$$

Where C_g (F g^{-1}) is the gravimetric capacitance of the electrode, I (A) is the charge-discharge current,

Δt (s) is the discharge time, ΔV (V) represents voltage drop on discharging (excluding the IR drop) , m (g) is the mass of the working electrode.

Energy (E) and power densities (P) of the ASC device were calculated as follows:

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

$$P = \frac{E}{\Delta t} \qquad (4)$$

Where C (F g^{-1}) is the gravimetric capacitance of the electrode, ΔV (V) is voltage window，Δt (s) is the discharge time.

The mass ratio of the positive electrode to the negative electrode was calculated based on charge balance theory according to the following equation:

$$\frac{m_+}{m_-} = \frac{C_- \times V_-}{C_+ \times V_+} \qquad (5)$$

Where m_+ / m_- are the mass of positive electrode/negative electrode, V_+ / V_- (V) are the voltage window of electrode/negative electrode, C_+/C_- (F g^{-1}) are the gravimetric capacitance of positive electrode/negative electrode.

The mass ratio for the positive to negative electrodes is calculated to be 1:2.

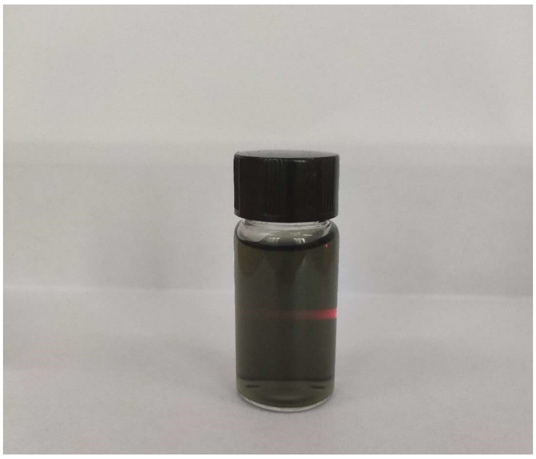

Figure S1 Tyndall effect of $Ti_3C_2T_x$ suspension

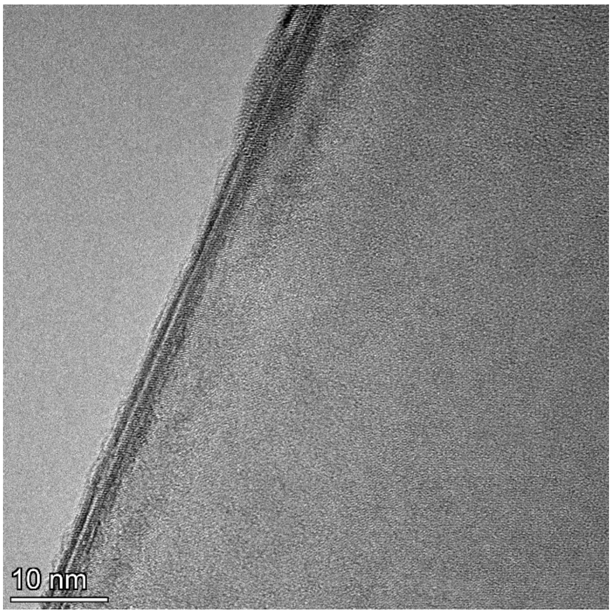

Figure S2. The morphology of single layer MXene nanosheets under TEM.

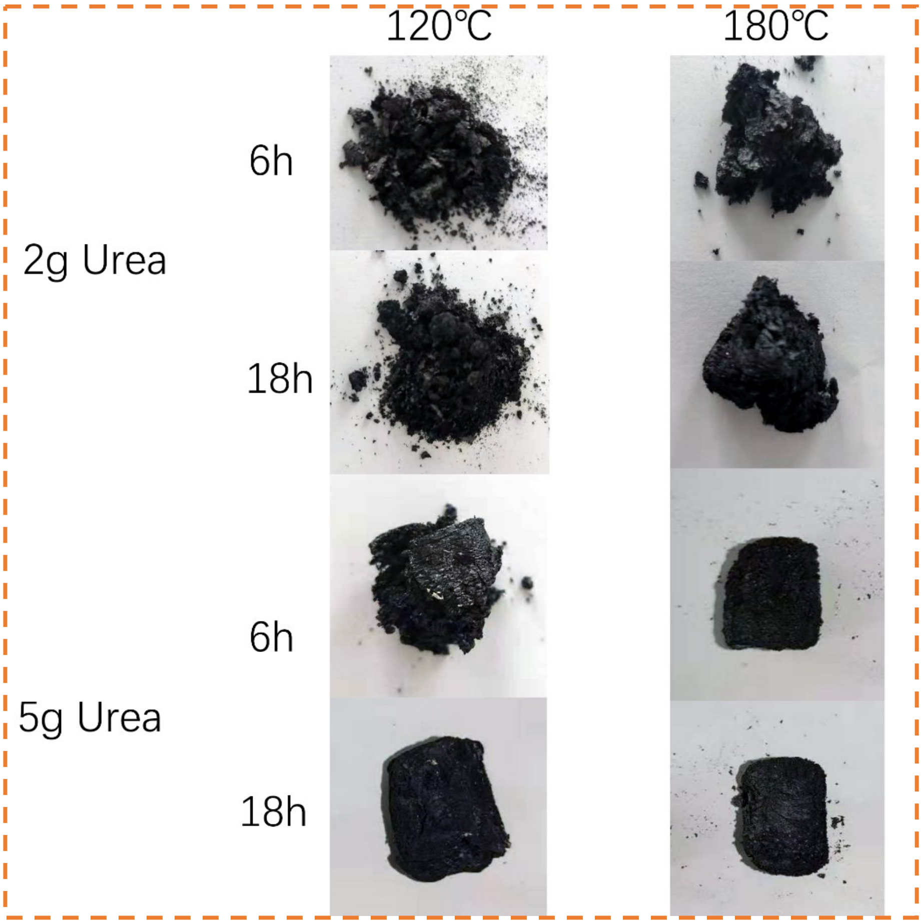

Figure S3 Optical topography of products under different hydrothermal reaction conditions.

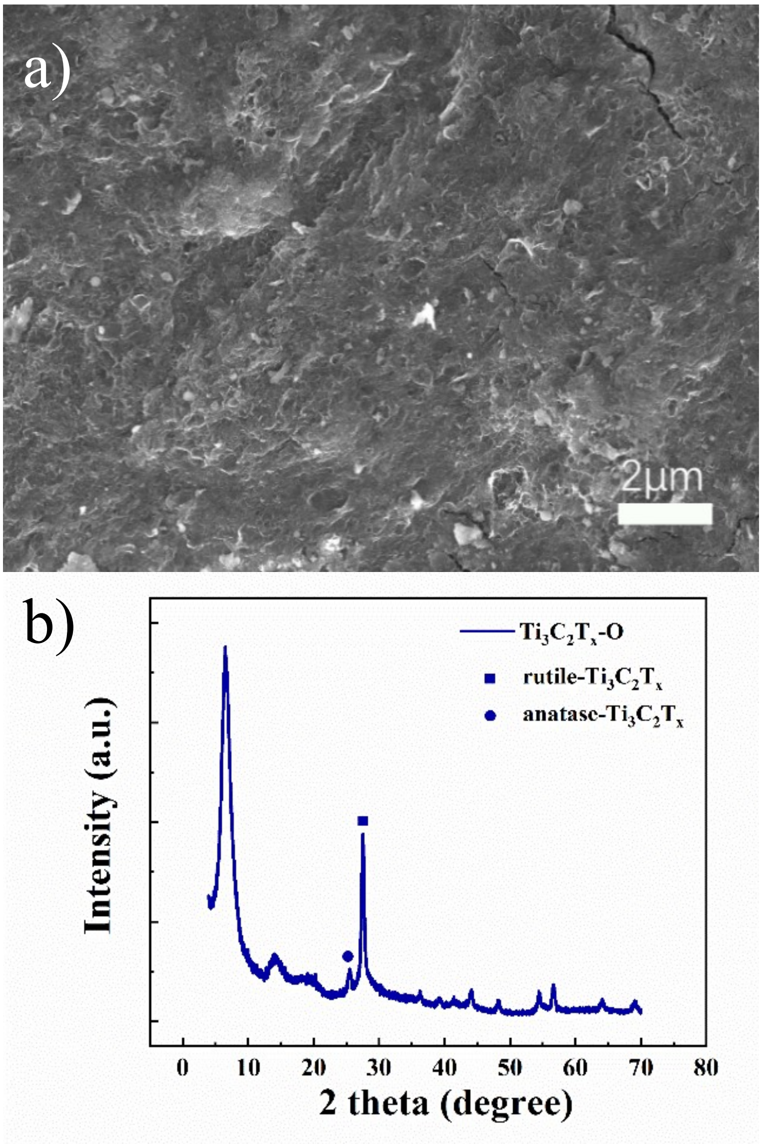

Figure S4 a) SEM morphology of $Ti_3C_2T_x$-O. b) XRD patterns of $Ti_3C_2T_x$-O.

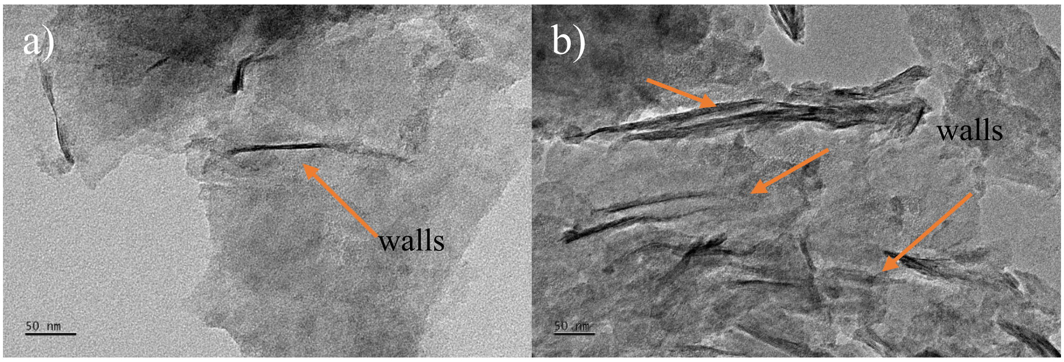

Figure S5 TEM morphology of a) N-$Ti_3C_2T_x$-2 b) N-$Ti_3C_2T_x$-aerogel.

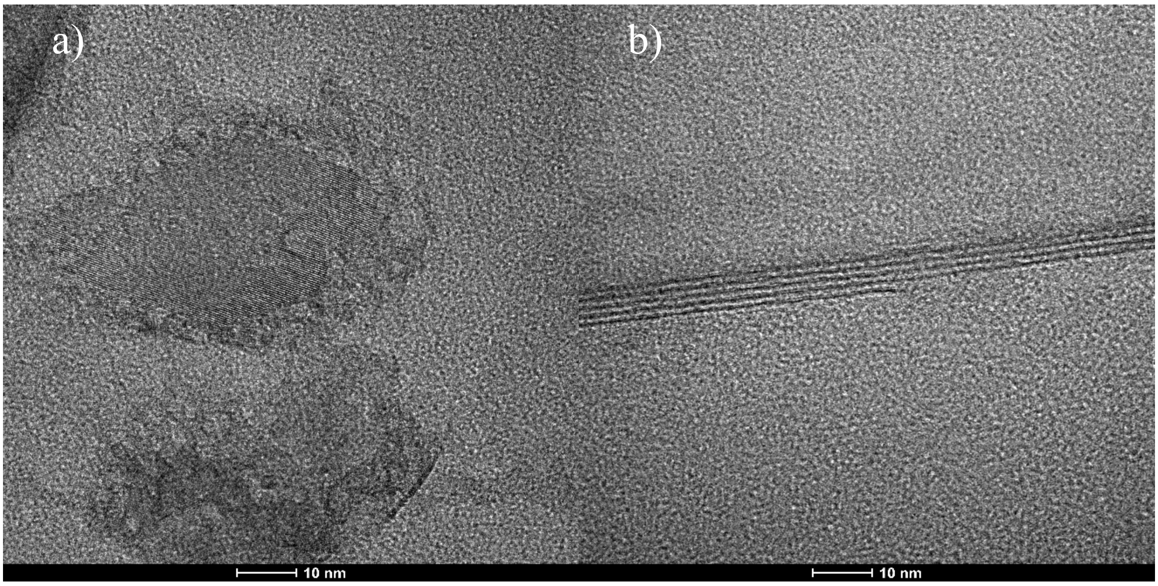

Figure S6 HRTEM of a) N-$Ti_3C_2T_x$-2 b) N-$Ti_3C_2T_x$-aerogel.

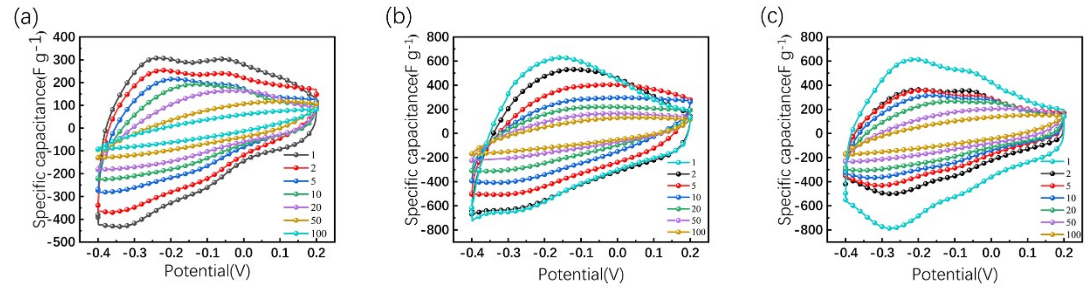

Figure S7 CV curves from 1-100 mVs^{-1} a) $Ti_3C_2T_x$-film b) N-$Ti_3C_2T_x$-2 c) N-$Ti_3C_2T_x$-aerogel.

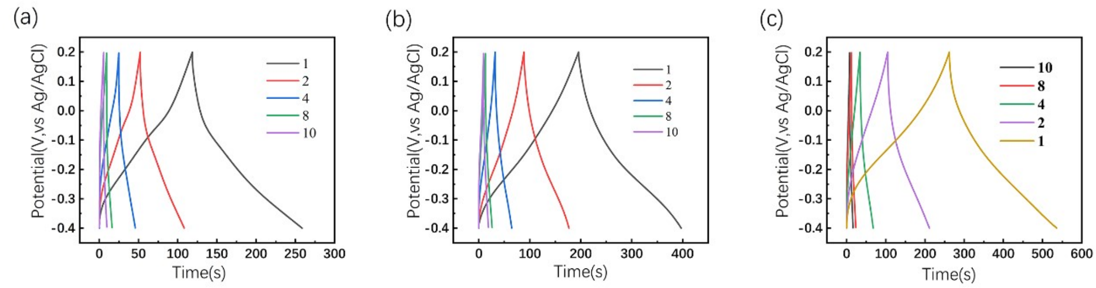

Figure S8 GCD curves from 1-100 A g^{-1} a) $Ti_3C_2T_x$-film b) N-$Ti_3C_2T_x$-2 c) N-$Ti_3C_2T_x$-aerogel.

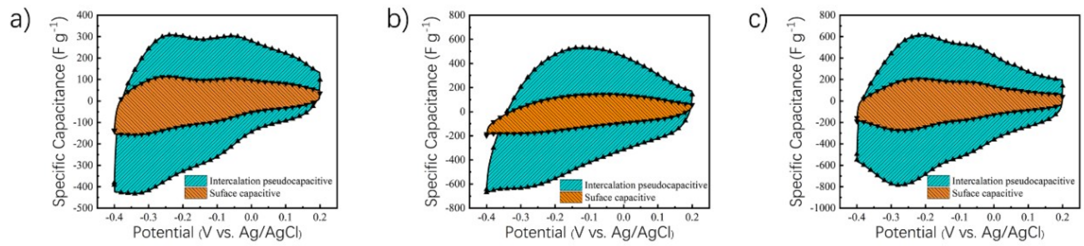

Figure S9 Pseudocapacitance contribution at 1 mVs^{-1} a) $Ti_3C_2T_x$-film b) N-$Ti_3C_2T_x$-2 c) N-$Ti_3C_2T_x$-aerogel.

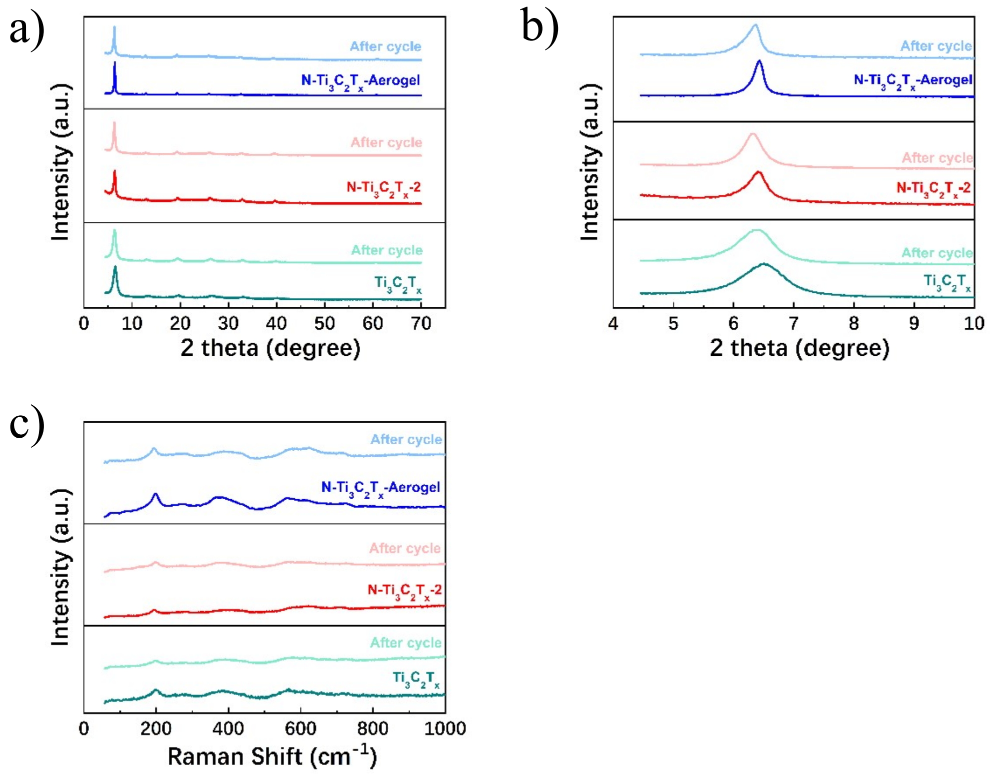

Figure S10 a,b) XRD patterns, c) Raman peaks of the prepared electrodes before and after 5000 charge-discharge cycles

Table S1 The comparison with other reported ASCs.

Materials	Energy density(Wh kg^{-1})	Power density(W kg^{-1})	Cycling performance	Reference
CF/MnO_2//MXene/CF	6.4	1107	84%(3000 cycles)	[1]
RuO2//h-WO3	16.92	540	171.75%(6500 cycles)	[2]
Bi2O3//graphite	8	2040	80%(5000 cycles)	[3]
Bi2O3//graphite	13	793	80%(2000 cycles)	[4]
AC//MnO2@NH4MnF3	11.2	10000	98%(1000 cycles)	[5]
NiCo2Se4//AC	25	490	93%(5000 cycles)	[6]
N-$Ti_3C_2T_x$-aerogel // AC	21.7	6000	85%(5000 cycles)	**This work**

1. Y. Wei, M. Zheng, W. Luo, B. Dai, J. Ren, M. Ma, T. Li and Y. Ma, *Journal of Energy Storage*, 2022, **45**.
2. S.-H. Ji, N. R. Chodankar and D.-H. Kim, *Electrochimica Acta*, 2019, **325**.
3. N. M. Shinde, Q. X. Xia, J. M. Yun, P. V. Shinde, S. M. Shaikh, R. K. Sahoo, S. Mathur, R. S. Mane and K. H. Kim, *Electrochimica Acta*, 2019, **296**, 308-316.
4. P. V. Shinde, B. G. Ghule, N. M. Shinde, Q. X. Xia, S. Shaikh, A. V. Sarode, R. S. Mane and K. H. Kim, *New Journal of Chemistry*, 2018, **42**, 12530-12538.
5. B. Li, X. Zhang, J. Dou and P. Zhang, *Electrochimica Acta*, 2020, **347**.
6. S. Li, Y. Ruan and Q. Xie, *Electrochimica Acta*, 2020, **356**.