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Ion-Assisted Self-Assembly of Macroporous MXene Film as supercapacitor electrodes

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Methods for calculation of specific capacitance

1. Three-electrode system

CV test

The gravimetric capacitances were calculated according to the following equations:

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

$$C_a = \frac{C_g m}{S} \quad (2)$$

Where C_g (F g^{-1}) is the specific 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, C_a (mF cm^{-2}) is the areal capacitance of the electrode, S (cm^2) denotes the area of the electrode.

2. Capacitive contribution

The distinguish and quantify the capacitive contribution to the overall current response, it used the following formula (3):

$$C = K_1 + K_2 V^{-0.5} \quad (3)$$

Since the current response at a fixed potential is attributed to two separate mechanisms, i.e surface capacitive effects (surface capacitive effects: from EDLC and pseudocapacitance), and intercalation pseudocapacitance (from diffusion-controlled insertion processes), formula (3) demonstrates that the total capacitance C on the basis of CV experiment contain scan be divided into a rate-independent component K_1, and a diffusion-limited component $K_2V^{-0.5}$ that controlled by scanning rate (intercalation pseudocapacitance).

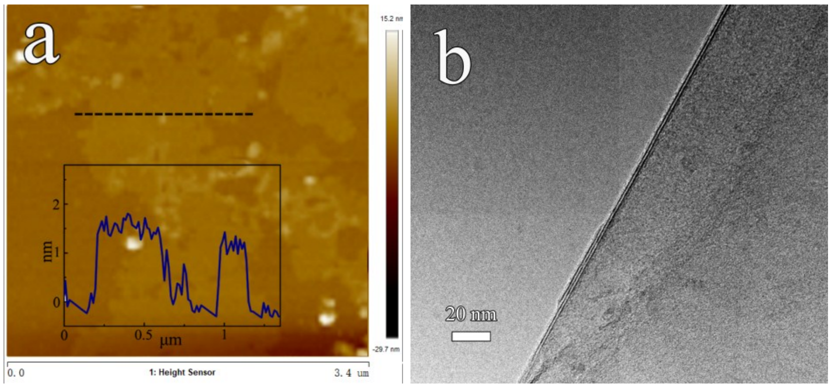

Fig.S1 TEM and AFM image of as-prepared $Ti_3C_2T_x$ nanosheets and (a) TEM image, (b)AFM images

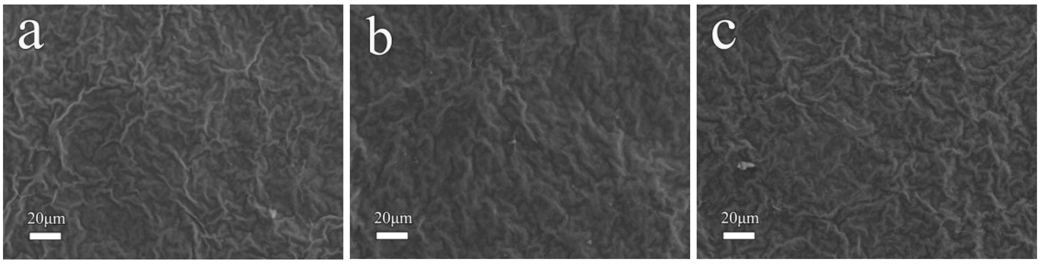

Fig.S2 Top-view SEM images of (a) $Ti_3C_2T_x$-A, (a) $Ti_3C_2T_x$-H and $Ti_3C_2T_x$-K

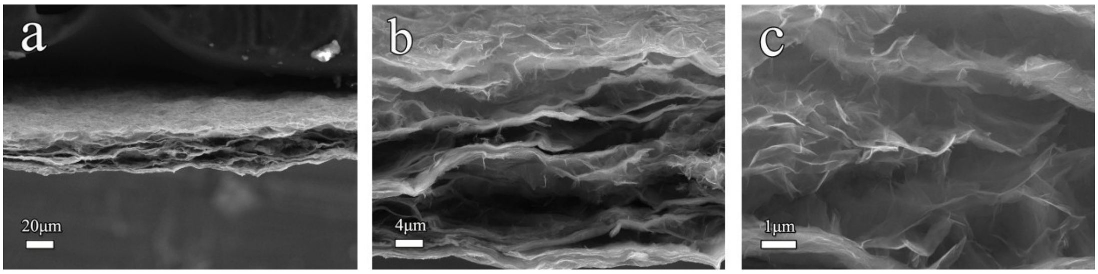

Fig.S3 (a) , (b) and (c) Cross-sectional SEM images of $Ti_3C_2T_x$-H

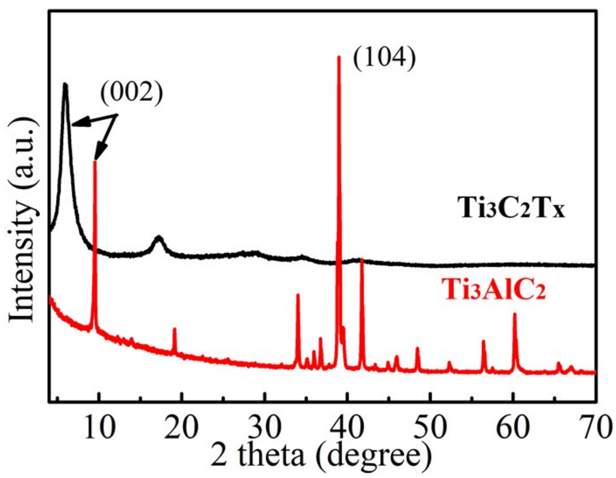

Fig.S4 XRD patterns of $Ti_3AlC_2T_x$ and $Ti_3C_2T_x$

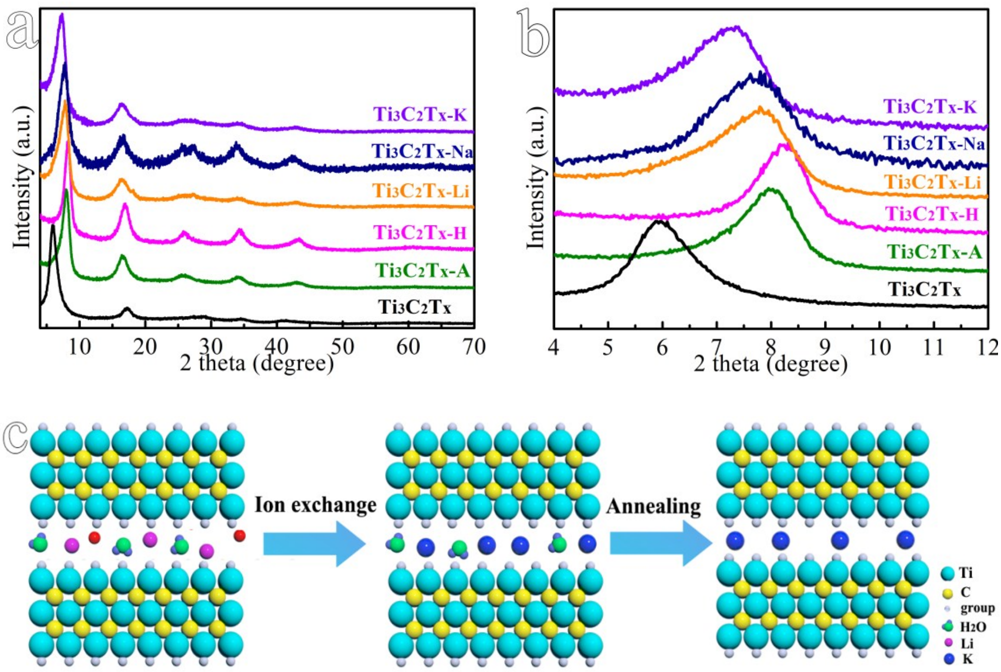

Fig.S5 (a) XRD patterns of $Ti_3C_2T_x$, $Ti_3C_2T_x$-A, $Ti_3C_2T_x$-H , $Ti_3C_2T_x$-Li, $Ti_3C_2T_x$-Na and $Ti_3C_2T_x$-K, (b) detailed XRD patterns showing (002) peaks, (c)A schematic illustration of the change of interlayer spacing.

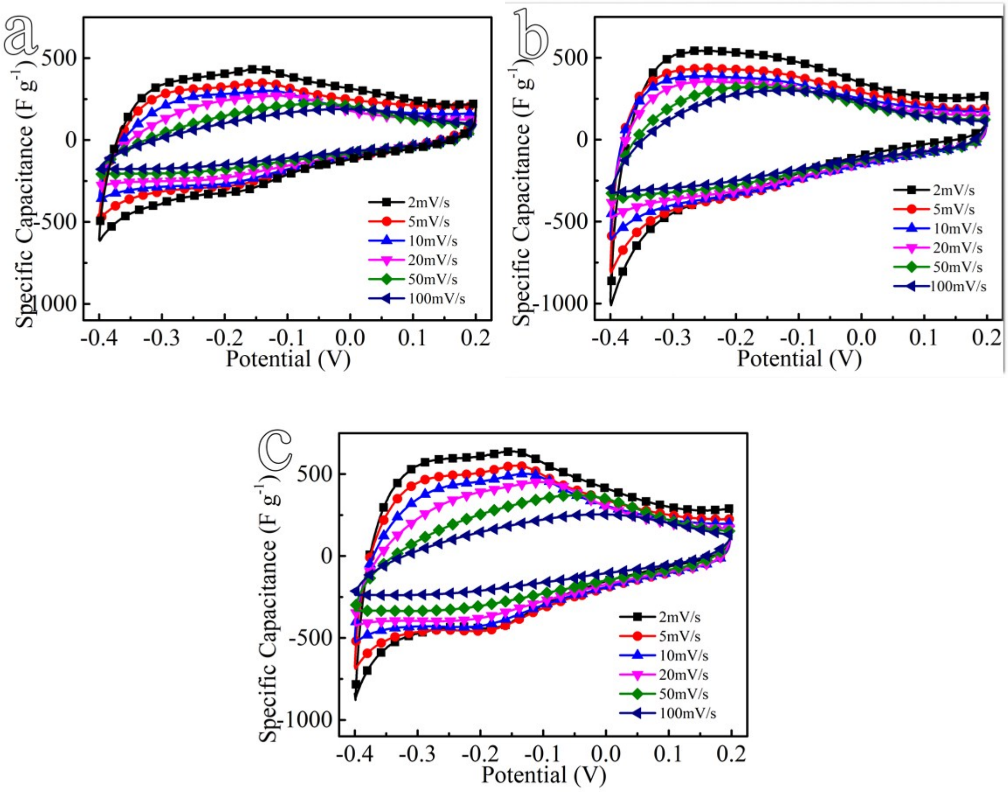

Fig.S6 CV curves at various scan rates for (a) $Ti_3C_2T_x$-A, (b) $Ti_3C_2T_x$-H and (c) $Ti_3C_2T_x$-K

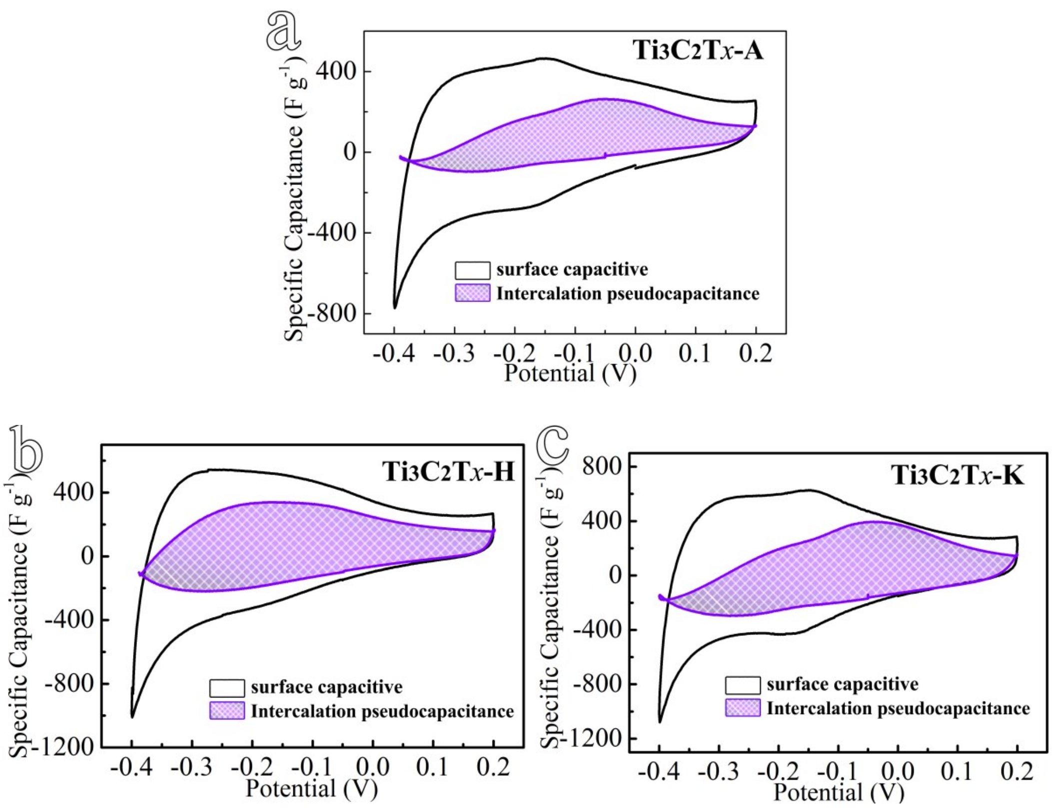

Fig.S7 Cyclic voltammetry profiles collected at 1mV/s (a) $Ti_3C_2T_x$-A, (b) $Ti_3C_2T_x$-H and (c) $Ti_3C_2T_x$-K

Table S1 EDS result of the Ti_3AlC_2, $Ti_3C_2T_x$-A, $Ti_3C_2T_x$-H and $Ti_3C_2T_x$-K

Element (at.%)	Ti	C	O	F	Al	Cl	K
Ti_3AlC_2	47.7	37.1	-	-	15.2	-	-
$Ti_3C_2T_x$-A	38.2	30	18.5	11.6	-	1.7	-
$Ti_3C_2T_x$ -H	35	29.8	20.5	12.1	-	2.6	-
$Ti_3C_2T_x$-K	34.1	31	19.4	11	-	3	1.5

Table S2 Comparison of specific capacitance for different electrode materials

Electrodes	Electrolyte	Mass loading (mg cm^{-2})	Scan rate or current density	Specific capacitance (F g^{-1})	Areal capacitance (F cm^{-2})	Ref.
$Ti_3C_2T_x$ Aerogel	1M KOH	15	2 mV s^{-1}	67	1012	10
$Ti_3C_2T_x$ / CF	1M H_2SO_4	2.6	10 mV s^{-1}	200	416	31
$Ti_3C_2T_x$	1M KOH	7.6	2mV s^{-1}	78	579	32
$Ti_3C_2T_x$ /Ag NP film	1M Na_2SO_4	15	5mA cm^{-2}	78	1173	33
$Ti_3C_2T_x$ @Al	0.5M Na_2SO_4	20	1m A cm^{-2}	54	1087	34
RGO/MnO_2 hybrid paper	1M Na_2SO_4	3.7	0.1 A g-1	243	897	35
$Ti_3C_2T_x$ /NF	1M KOH	4.8	5mV s^{-1}	115	246	36
RGo/Ni foam	1M H_2SO_4	3.5	0.5 m A cm^{-2}	-	323	37
$Ti_3C_2T_x$-A	**1M H_2SO_4**	**2.5**	**2mV s^{-1}**	**307**	**768**	**this work**
$Ti_3C_2T_x$-H	**1M H_2SO_4**	**2.5**	**2mV s^{-1}**	**374**	**935**	**this work**
$Ti_3C_2T_x$-K	**1M H_2SO_4**	**2.4**	**2mV s^{-1}**	**425**	**1025**	**this work**