Title: **Oxidation stability of $Ti_3C_2T_x$ MXene nanosheets in solvents and composite films**

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Supporting Information

	Day 0	Day 14
Color	Black	Black
ζ Potential (mV)	-32.0	-25.1
TiO_2 content (atomic %)	11.06	55.8
Concentration (mg ml^{-1})	1	0.2

Figure S1: $Ti_3C_2T_x$ colloidal dispersion in water on the 0^{th} day and the 14^{th} day.

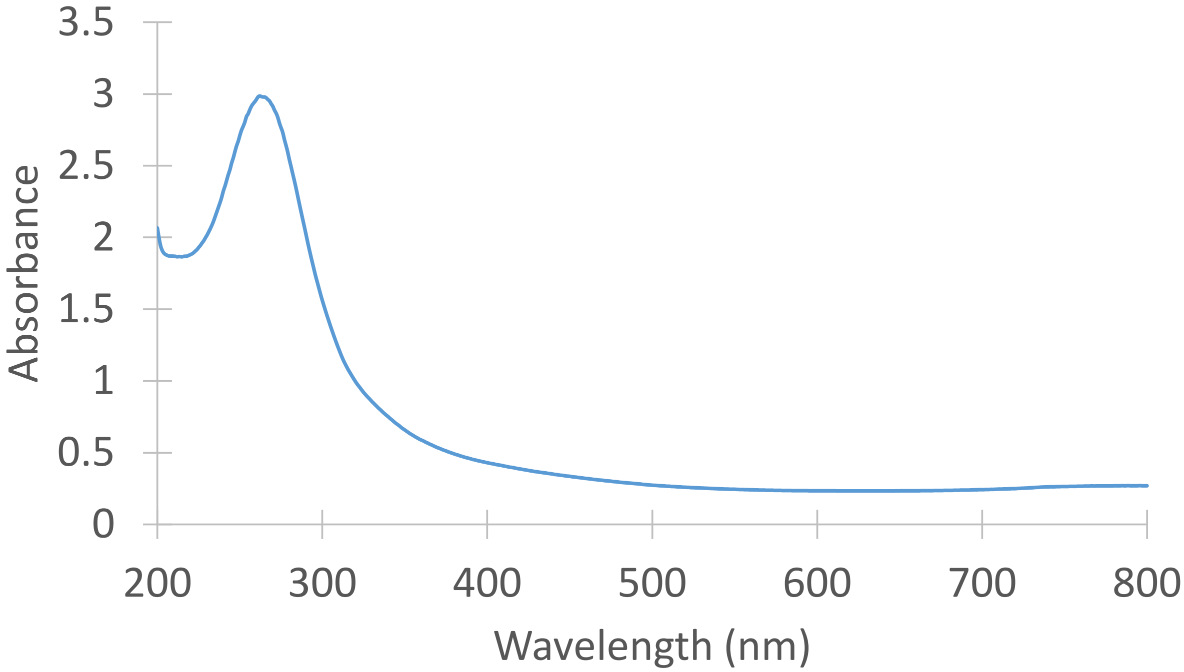


Figure S2: UV-vis spectra of $Ti_3C_2T_x$/water dispersion at 14 days. The sample has been diluted 1/10. The absorbance at 580 nm is 0.236 and the extinction coefficient at the same wavelength is 1167.2 ml mg^{-1} m^{-1}. Using Beer-Lambert's Law, the concentration was calculated to be 0.202 mg ml^{-1}.

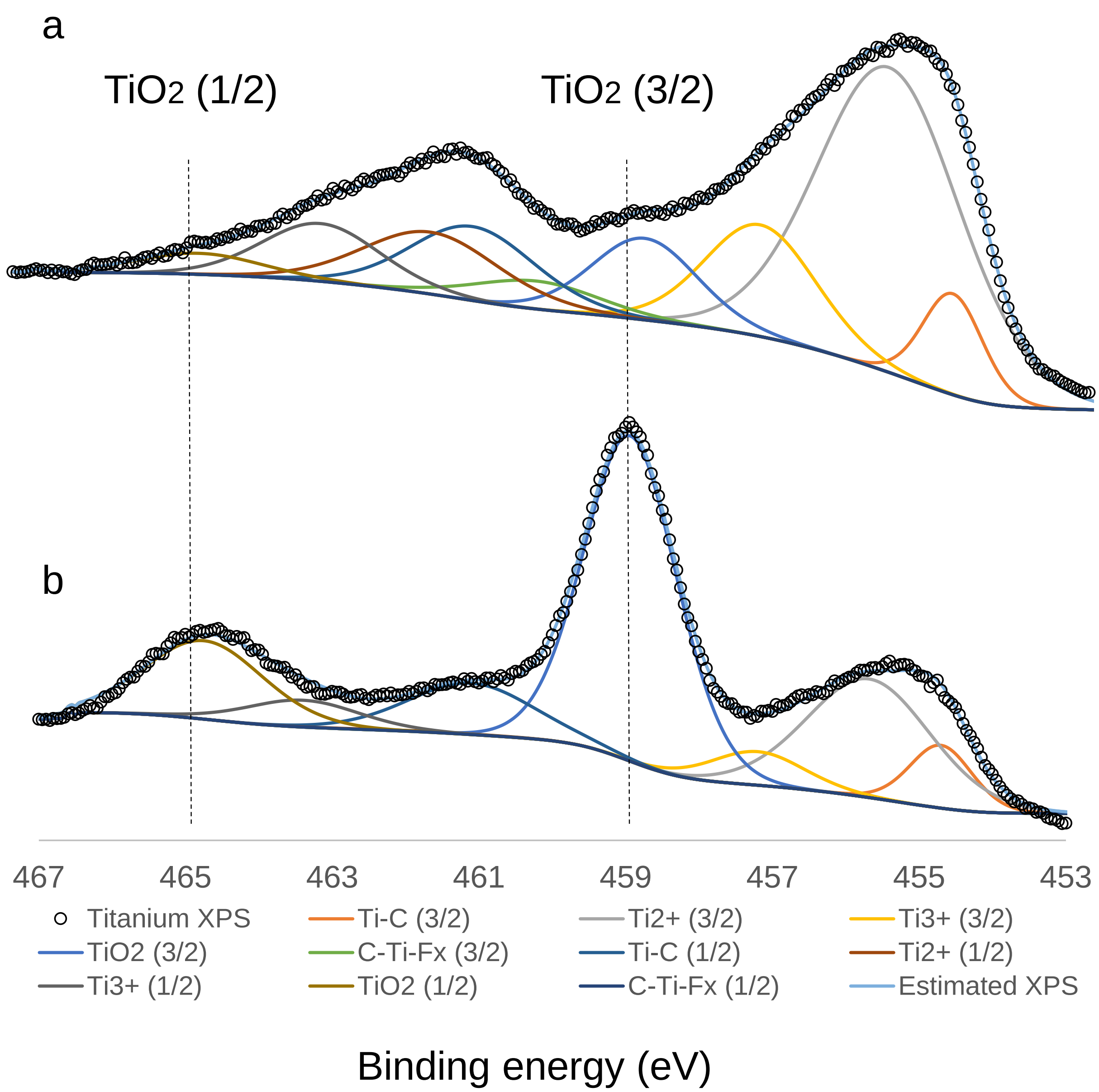


Figure S3: XPS of a) vacuum filtered film drawn from fresh (Day 0) $Ti_3C_2T_x$ colloidal dispersion; the TiO_2 content in this sample was 11.06% and b) vacuum filtered film drawn from the same $Ti_3C_2T_x$ colloidal dispersion on the 14th day; the TiO_2 content was 55.80%.

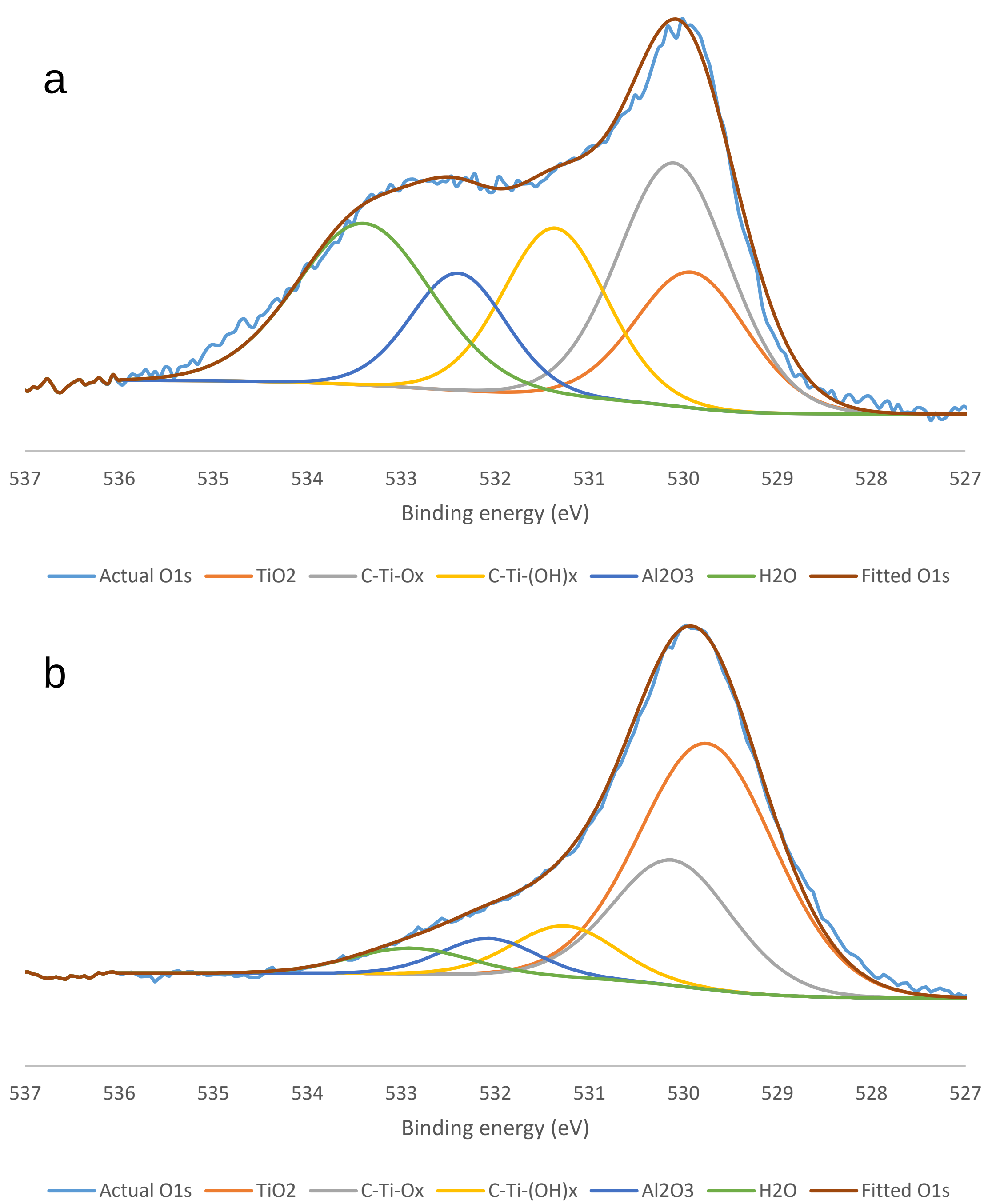


Figure S4: XPS of O 1s orbital of a) vacuum filtered Ti_3C_2 before freeze drying (Day 0 sample); the TiO_2 content in this sample was 16.32% and b) $Ti_3C_2T_x$/water dispersion on the 14th day; the TiO_2 content was 55.29%.

We soaked non-delaminated $Ti_3C_2T_x$ MXene "clay" (this is MXene obtained after washing away the DMSO intercalants) in various organic solvents (as presented in **Figure S5 and S6**) and recorded their conductivity and TiO_2 content. These clays are designated as "NDM" for "non-delaminated MXenes;" After soaking them for eight months in five different organic solvents, only NDM in acetonitrile and acetone had measurable conductivity values as seen in **Figure S5**. The conductivity was measured by vacuum filtering NDM into films. The data from **Figure S5** also suggests that TiO_2 content directly affects conductivity; NDM with high TiO_2 content were less conductive. Additionally, **Figure S6** displays the conductivity NDM soaked in acetone and acetonitrile at various times and an expected trend line of decreasing conductivity with increasing TiO_2 content.

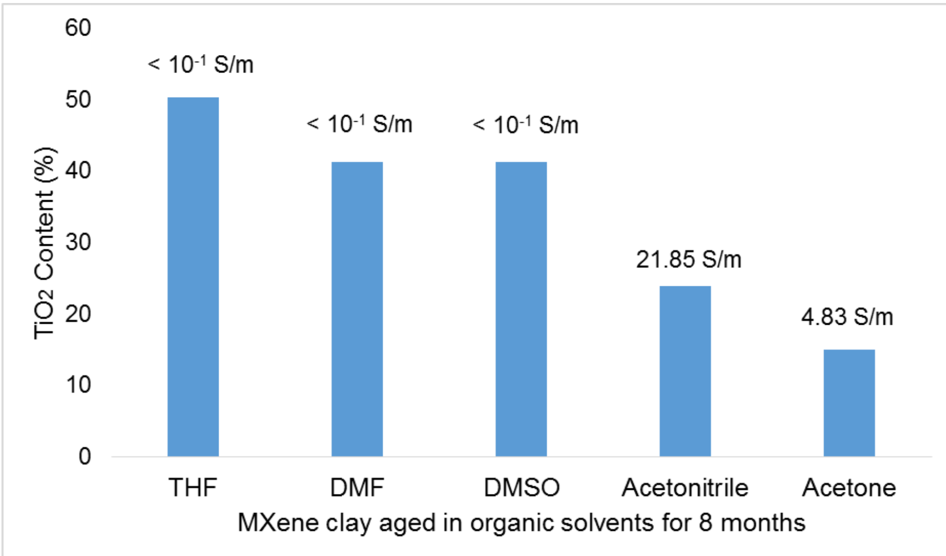


Figure S5: MXene clay aged in various organic solvents for 8 months. After 8 months, the MXenes were vacuum filtered into films then their conductivity was measured. Films made from aged MXenes in acetone and acetonitrile possessed measurable conductivity than other solvents.

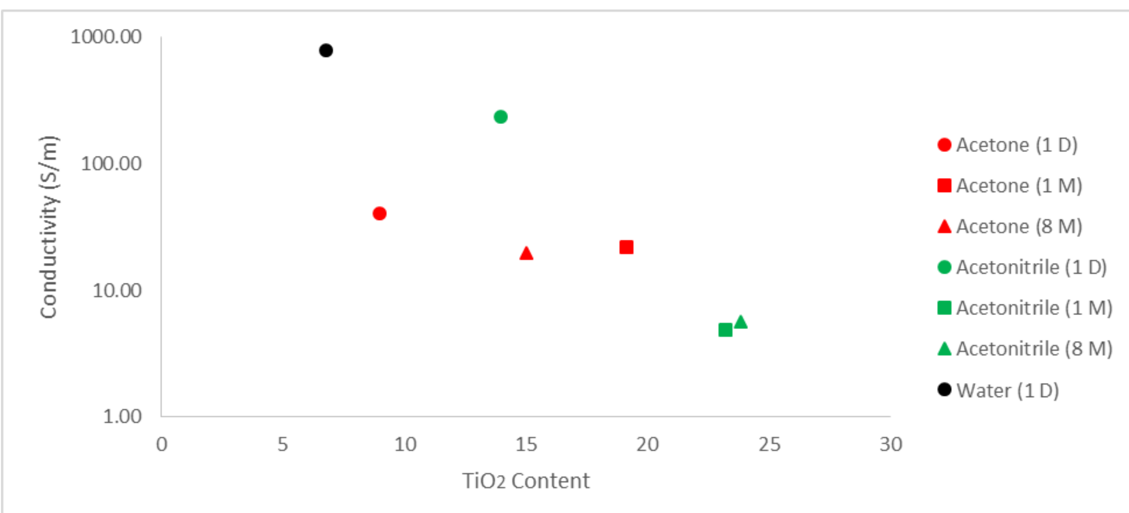
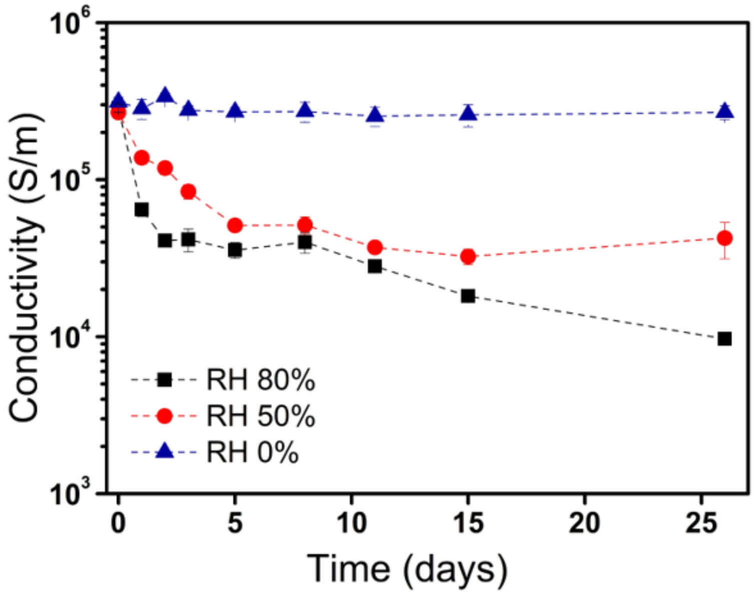


Figure S6: Decrease in conductivity with increasing TiO_2 in MXene clay that were aged in various solvents. 1 D is one day, 1 M is 1 month, and 8 M is 8 months.



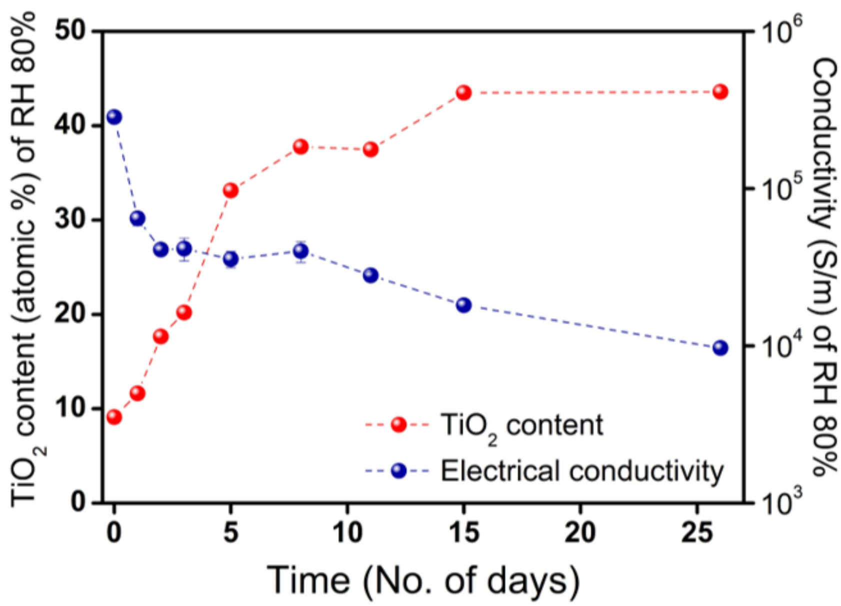


Figure S7: (top) Conductivity as a function of time for samples stored in humid and dry environments. (bottom) Ti^{4+} (TiO_2) content of RH 80% sample with time.

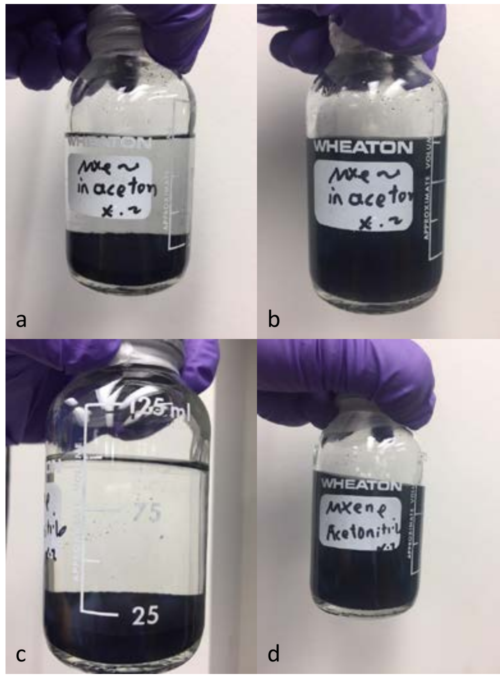


Figure S8: a) $Ti_3C_2T_x$ in acetone; $Ti_3C_2T_x$ powder sedimented to the bottom b) $Ti_3C_2T_x$ in acetone after vortex mixing which form a temporary colloidal solution; this was vacuum filtered to obtain vacuum filtered film c) $Ti_3C_2T_x$ in acetonitrile; $Ti_3C_2T_x$ powder sedimented to the bottom d) $Ti_3C_2T_x$ in acetonitrile after vortex mixing which form a temporary colloidal solution; this was vacuum filtered to obtain vacuum filtered film

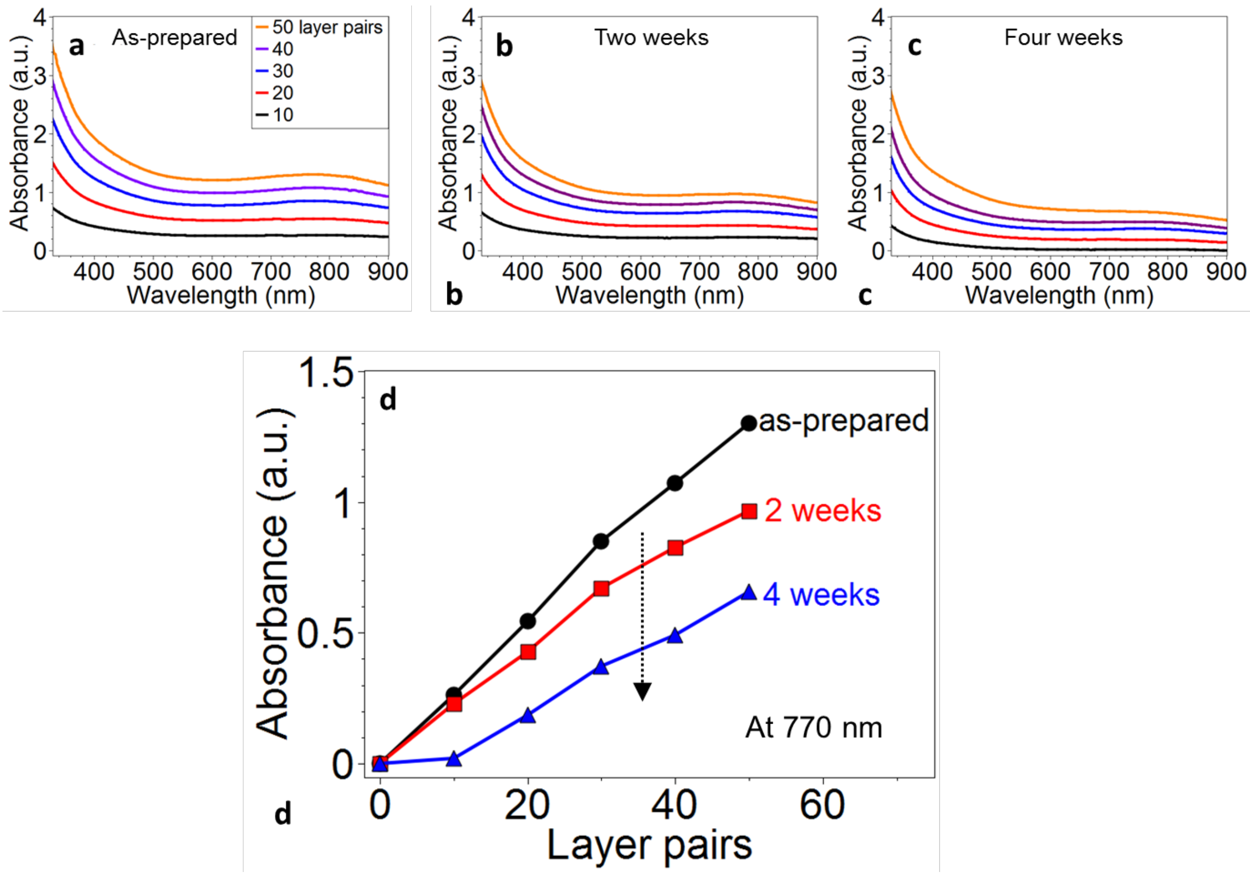


Figure S9: UV absorbance of various layer pair (LP) LBL films: a) as-prepared, b) after 2 weeks, c) after 1 month (four weeks), and d) UV absorbance (at 770 nm) of all of LP LBL films at various times

Table S1: $Ti_3C_2T_x$ film conductivity vs UV exposure time data

UV exposure time (hours)	Conductivity (S m^{-1})
0	$5.94\times10^{2} \pm 1.42\times10^{2}$
1	$3.96\times10^{2} \pm 9.89\times10^{1}$
2	$3.51\times10^{2} \pm 1.37\times10^{2}$
3	$2.93\times10^{2} \pm 6.43\times10^{1}$
4	$2.91\times10^{2} \pm 6.68\times10^{1}$
5	$2.76\times10^{2} \pm 8.15\times10^{1}$
6	$2.18\times10^{2} \pm 7.80\times10^{1}$
8	$1.73\times10^{2} \pm 5.85\times10^{1}$
24	$8.70\times10^{1} \pm 3.69\times10^{1}$

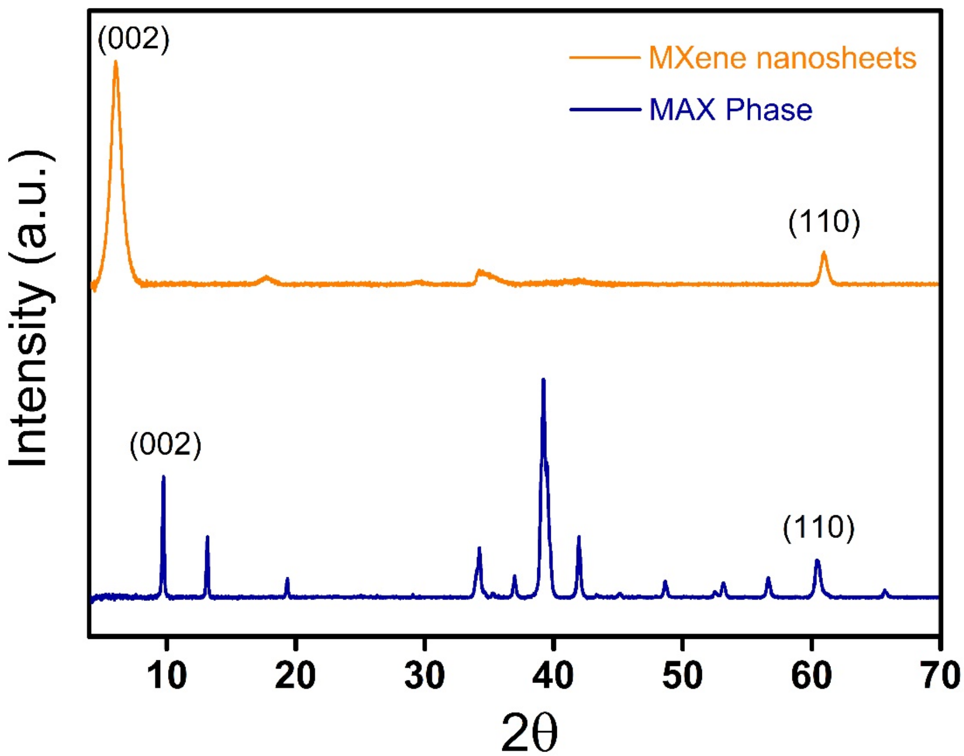


Figure S10: XRD pattern of Ti_3AlC_2 MAX phase and the corresponding etched $Ti_3C_2T_x$ MXene.

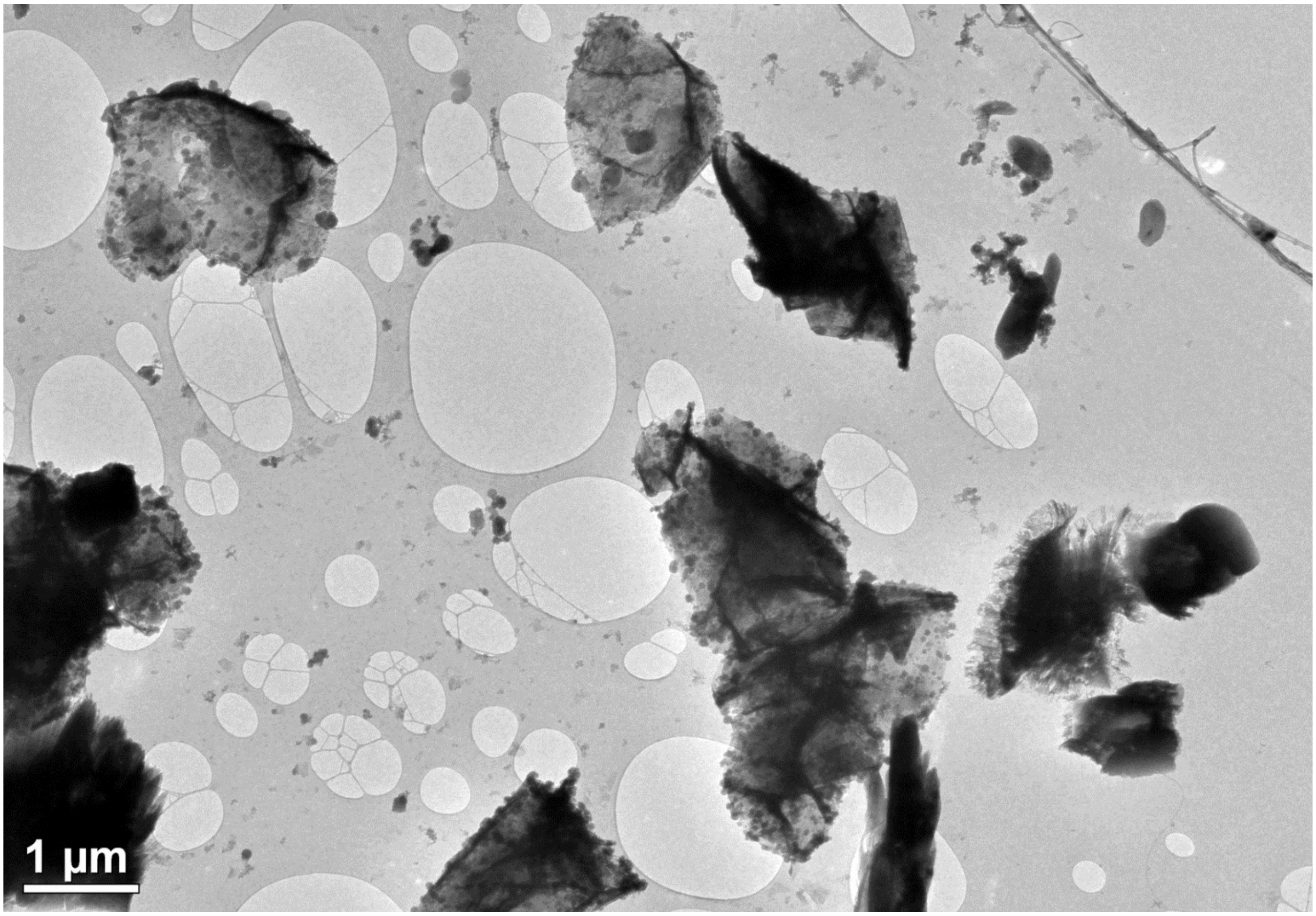


Figure S11: TEM image of oxidized MXenes

Table S2: Thickness of the various samples

Sample	Thickness (mm)
Air	0.03
Aged in water (day 0)	0.03
Aged in water (day 7)	0.01
Aged in water (day 14)	0.01
Aged in acetone (day 0)	0.72
Aged in acetone (day 7)	0.43
Aged in acetone (day 14)	1.08
Aged in acetonitrile (day 0)	0.75
Aged in acetonitrile (day 7)	0.40
Aged in acetonitrile (day 14)	0.67
Aged in Ice (day 7)	0.01
Aged in ice (day 14)	0.02
Aged in ice (day 21)	0.04
50/50 MXene-PVA sample	0.03
10/90 MXene-PVA sample	0.21
UV sample	0.03

Table S3: Electrical conductivities of buckypapers before and after being treated by acetone and acetonitrile

	Acetone (S/m)	Acetonitrile (S/m)
Before treatment	$1.7 \pm 0.2 \times 10^5$	$2.2 \pm 0.3 \times 10^5$
After treatment	$1.0 \pm 0.2 \times 10^5$	$9.4 \pm 0.9 \times 10^4$