One-step hydrothermal synthesis of porous $Ti_3C_2T_z$ MXene/rGO gels for supercapacitor applications

Sanjit Saha[1], Kailash Arole[2], Miladin Radovic,[2] Jodie L. Lutkenhaus,[1,2*] Micah J. Green[1,2*]

[1]Artie McFerrin Department of Chemical Engineering, Texas A&M University, College Station, TX 77843, USA

[2]Department of Materials Science and Engineering, Texas A&M University, College Station, TX 77843, USA

*Corresponding authors: micah.green@tamu.edu; jodie.lutkenhaus@tamu.edu

Supporting Information

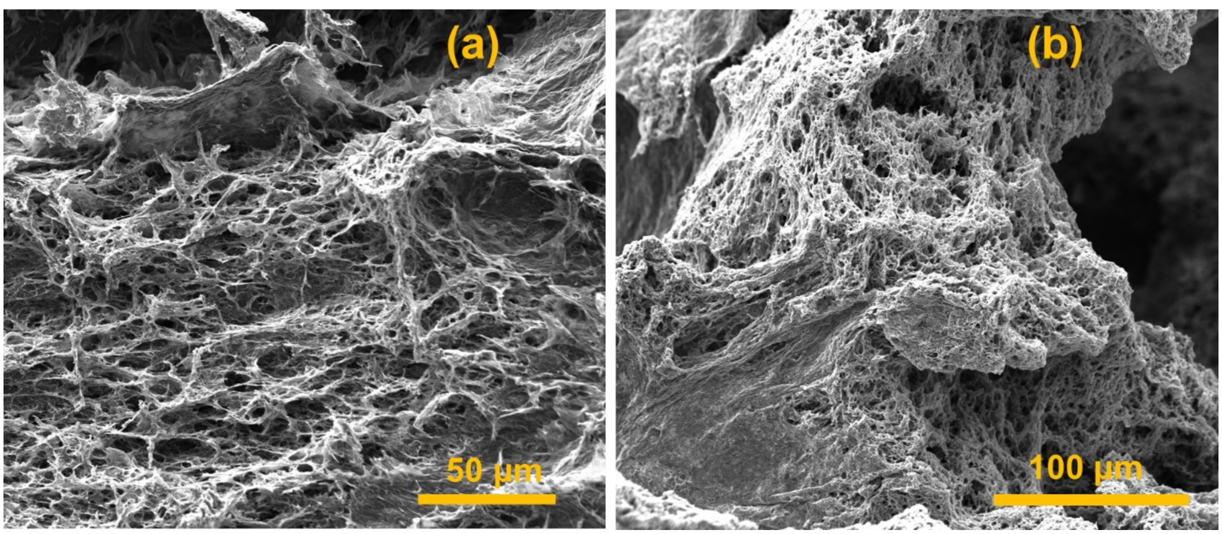

Figure S1. FE-SEM images of GM2 shows porous structure favorable for transportation of electrolyte ions

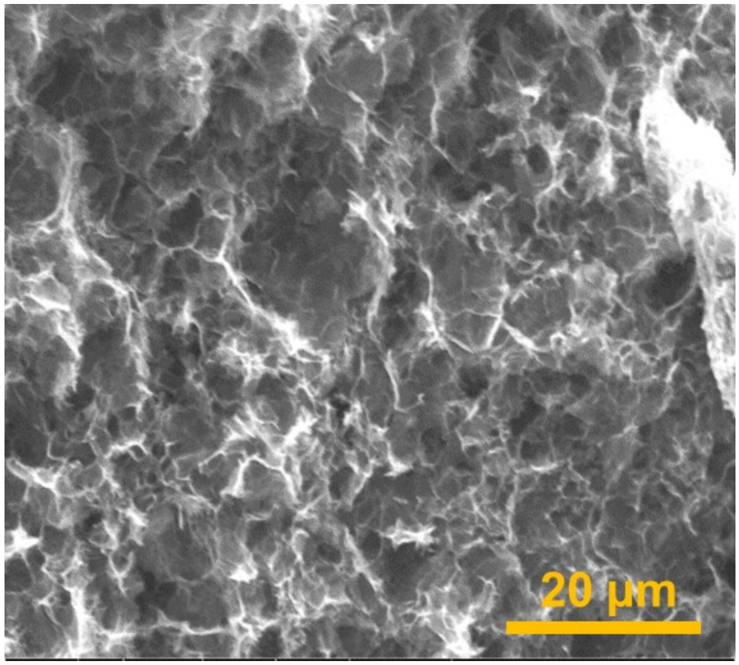

Figure S2. FE-SEM images of GM0

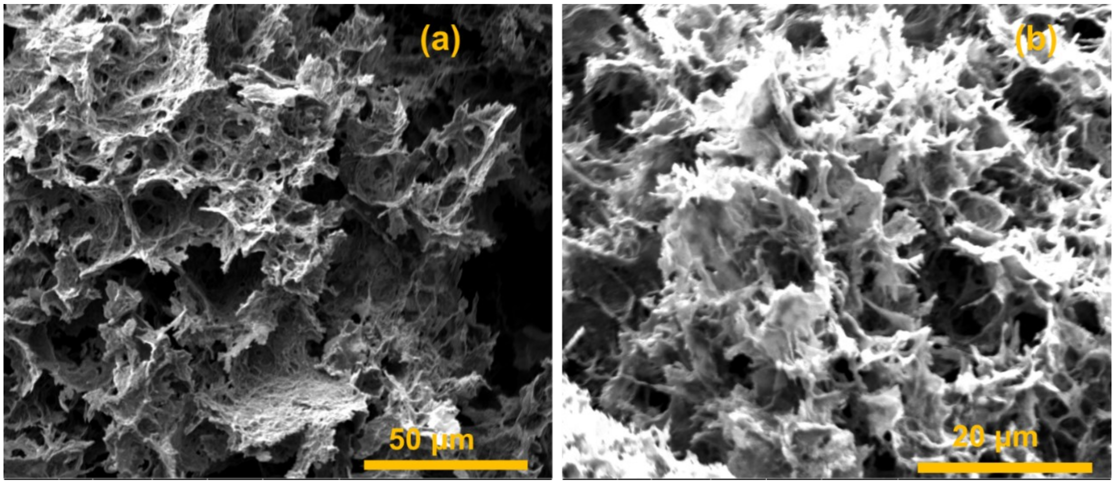

Figure S3. FE-SEM images of (a) GM1 and (b) GM3

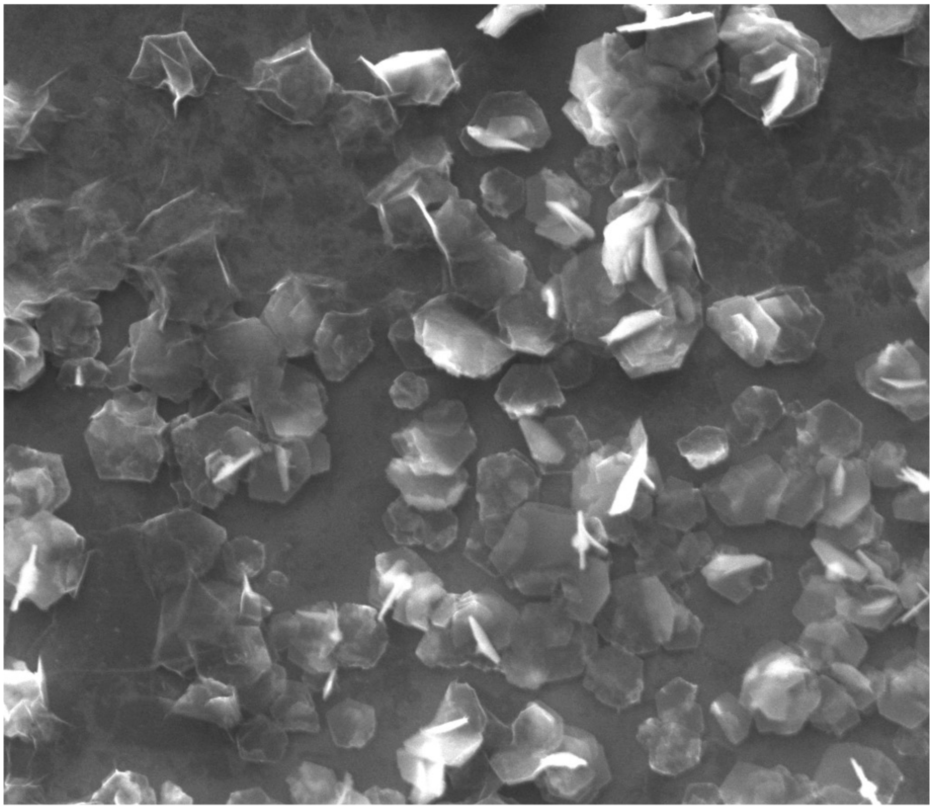

Figure S4. FE-SEM images of $Ti_3C_2T_z$ nanosheets

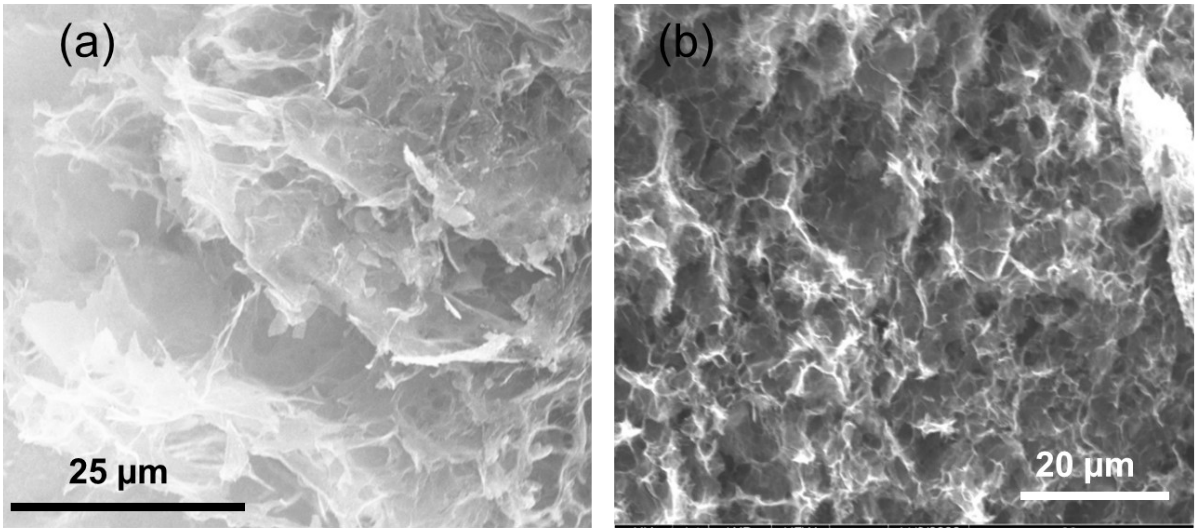

Figure S5. FE-SEM of GM2 and GM0 for EDS analysis

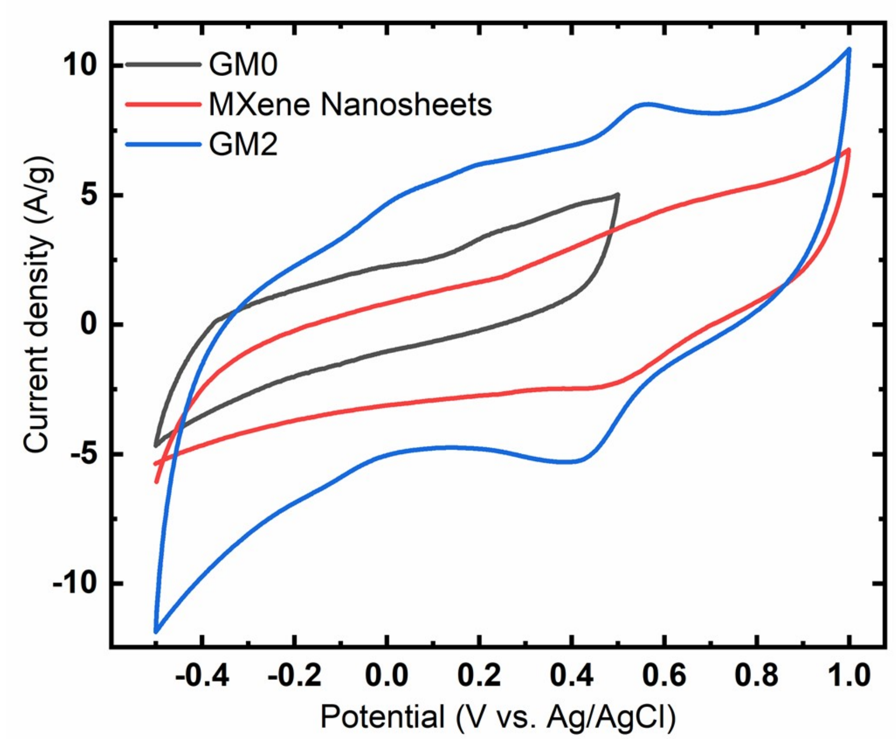

Figure S6. Three electrode CV of pure rGO gel (GM0), $Ti_3C_2T_z$ Nanosheets and $Ti_3C_2T_z$ /rGO gel (GM2) at 10 mV/s scan rate. The specific capacitance was calculated as 314, 402 and 920 F/g for GM0, $Ti_3C_2T_z$ nanosheets and GM2, respectively. The potential window of $Ti_3C_2T_z$ /rGO (1.5 V) is higher than pure rGO gel.

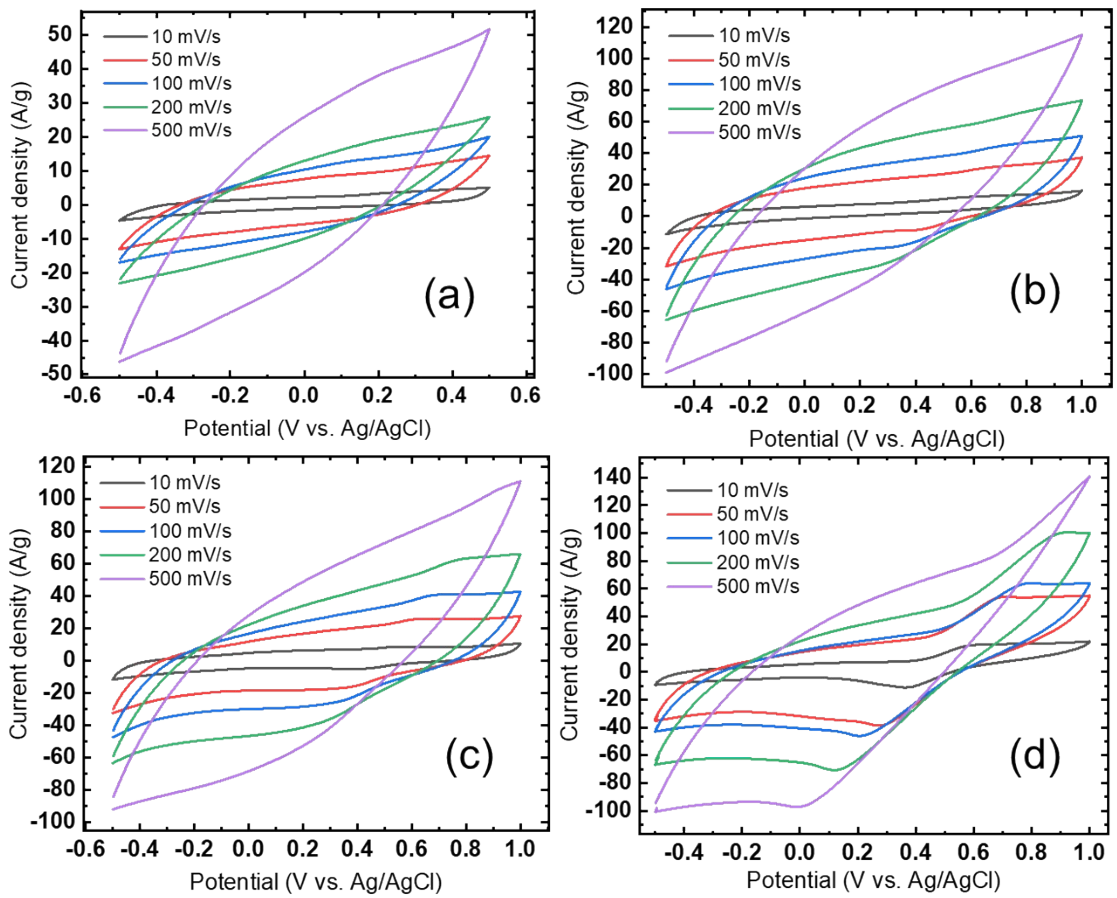

Figure S7. CV of (a) GM0, (b) GM1, (c) GM2, and (d) GM3 at different scan rates. The CV plots show appearance of redox peak with higher $Ti_3C_2T_z$ content (GM2 and GM3). At high scan rate the CV nature of GM2 is stable but GM3 got distorted due to excess $Ti_3C_2T_z$ content.

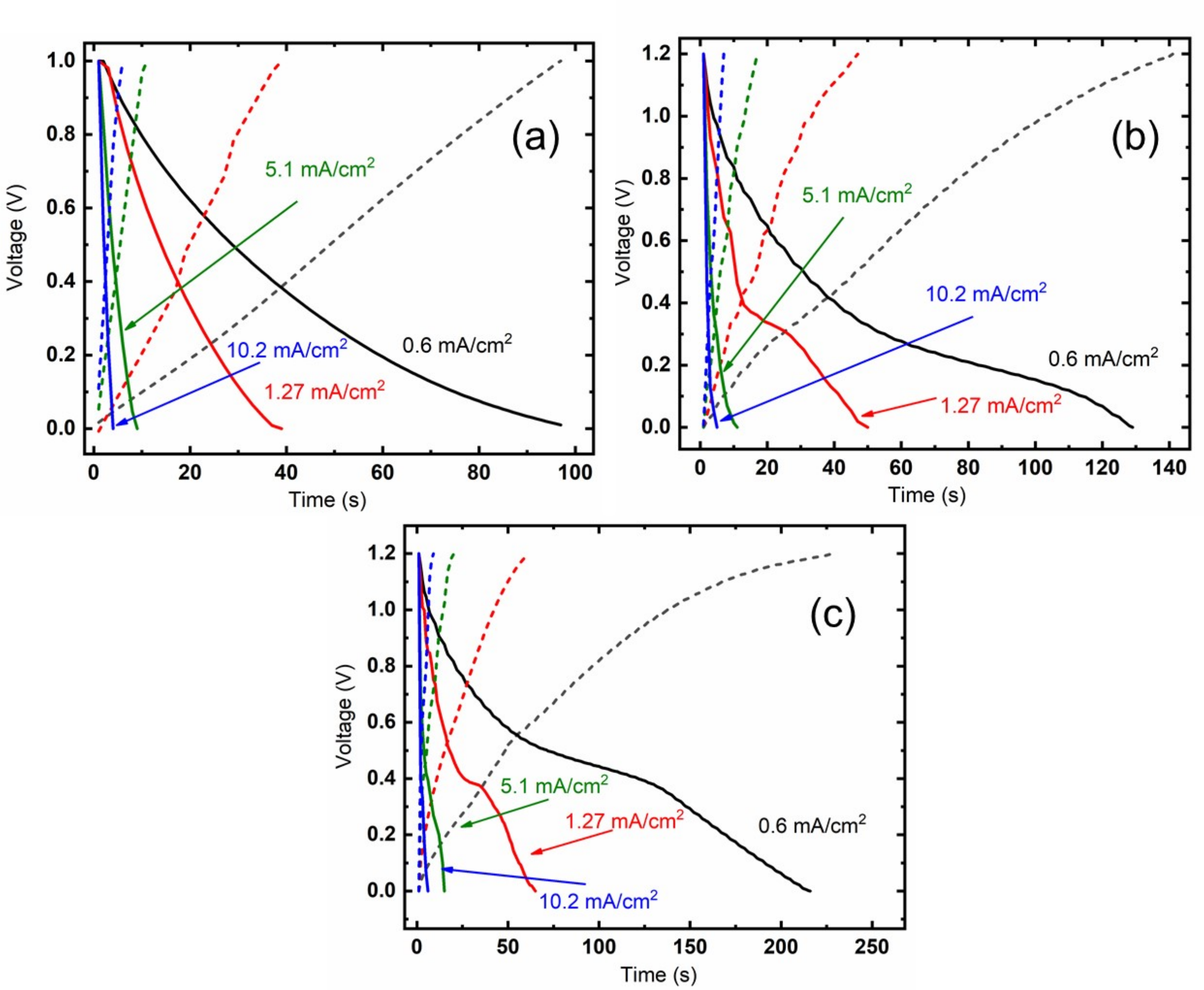

Figure S8. Two-electrode CD of (a) GM0, (b) GM1, and (c) GM3 at different current densities. The discharging time of the symmetric cells constructed with $Ti_3C_2T_z$ /rGO gels is significantly higher than the pure rGO symmetric cell.

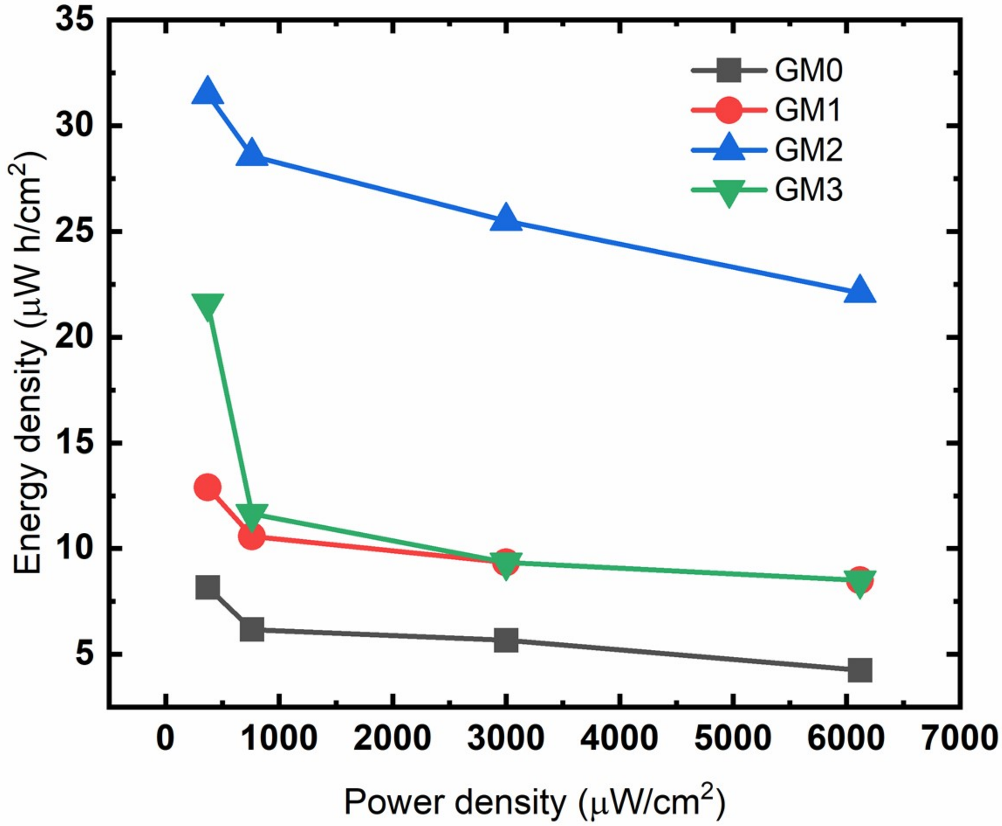

Figure S9. Ragone plot of GM0, GM1, GM2 and GM3 two electrode supercapacitor cell. GM2 shows higher energy density than both GM1 and GM3.

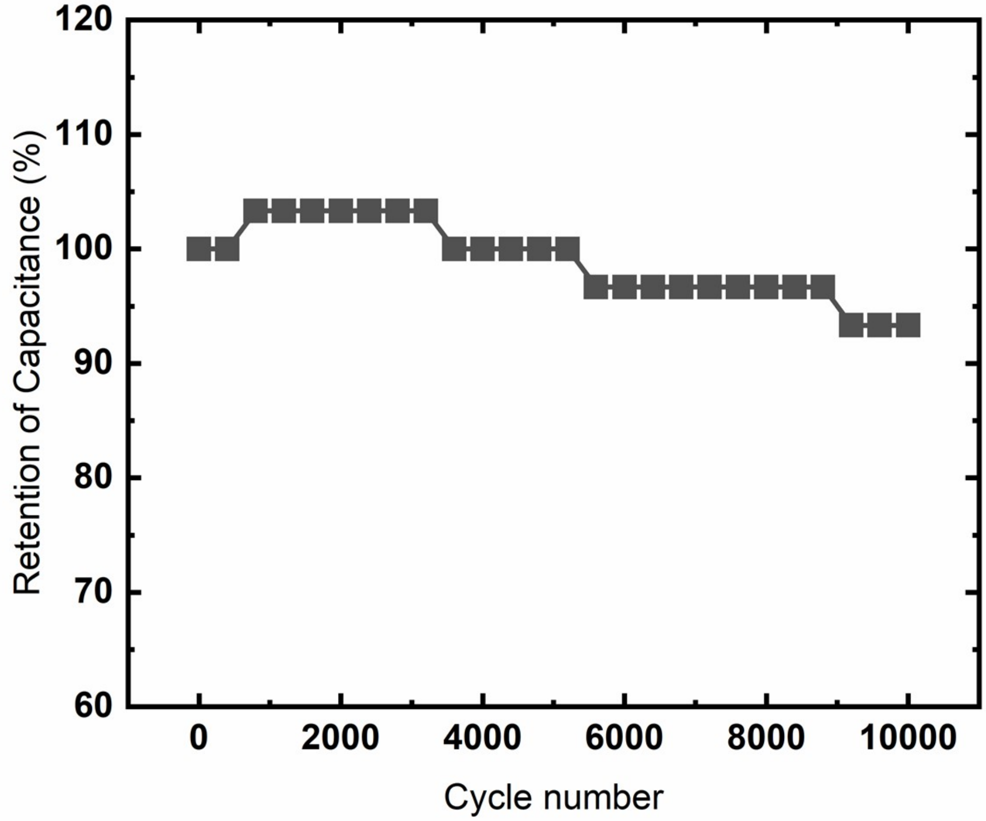

Figure S10. Stability study of GM2 two electrode supercapacitor at a current density of 5.1 mA/cm^2. GM2 (symmetric cell) shows ~93% retention after, 10,000 cycles.

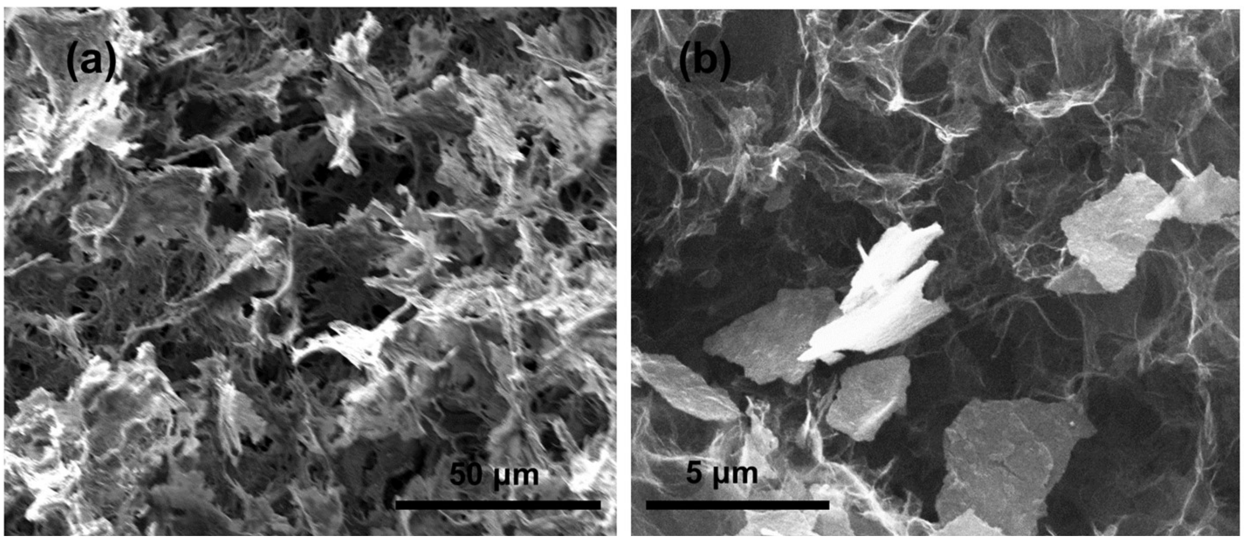

Figure S11. (a) Low- and (b) high-magnification FE-SEM image of $Ti_3C_2T_z$/rGO gel after charge discharge 10000 cycles. $Ti_3C_2T_z$/rGO gel after 10000 cycles shows a highly porous structure, similar to the un-used $Ti_3C_2T_z$/rGO.

Table S1. Comparison of the surface area of different graphene and graphene/MXene gel.

Material	**Surface area (m^2/g)**	**Reference**
MXene-Derived TiO_2@rGO	174	[1]
Ti_3C_2Tx/GO hydrogel	65	[2]
MXene/Graphene hydrogel	161.1	[3]
Graphene Aerogels	350	[4]
Graphene Aerogel	516	[5]
Graphene oxide Aerogel	745	[6]
N-doped graphene aerogel	446	[7]
CNT/Graphene Aerogel	435	[8]
MXene/rGO gel	224	Present work

Table S2. Comparison of the specific capacitance (three electrode) of graphene and MXene electrode with the present work. The specific capacitance of MXene/rGO gel is significantly higher than pure rGO and MXene electrode.

	Specific capacitance (F/g)	Scan rate (mV/s)	References
Few-layer graphene	180	60	[9]
Highly corrugated graphene	349	2	[10]
Graphene nano-platelet	214	10	[11]
KOH modified graphene	136	10	[12]
Graphene Aerogel	176	1 A /g	[13]
$Ti_3C_2T_X$ clay	246	2	[14]
$Ti_3C_2T_X$	67.7	1 A /g	[15]
Surface-modified 2D titanium carbide	325	2	[16]
MXene/rGO gel	920	10	Present work

Table S3. Comparison of the specific capacitance, energy density, power density and stability (two electrode) of graphene and MXene electrode with the present work

	Specific capacitance (mF/cm^2)	Energy density ($\mu W\ h/cm^2$)	Corresponding Power density ($\mu W/cm^2$)	Stability (after 10,000 cycles)	References
3D graphene	18.70	2.59	230	93%	[17]
Hydrothermally reduced GO	38.2	5.3			[18]
rGO/CNT	269	5.91	20		[19]
3D MXene	2.1	24.4	640	90%	[20]
Additive-free MXene	562 F/cm^3	0.32	11.4	97%	[21]
Carbon//MXene	52	2.62	1620	86% (after 5,000 cycles)	[22]
Co-Al-LDH/MXene	40	8.84	230	92%	[23]
3D vanadium nitride (VN) nanowire/CNT	213.5	96	270	96.8% (after 5,000 cycles)	[24]
Graphene/titanium carbide aerogel	171.4	2.1	301.2	93%	[25]
3D MXene–Graphene Aerogel	34.6	2.18	60	91% (after 15,000 cycles)	[26]
MXene/rGO gel	158	31.5	360	93%	Present work

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