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Supporting Information

Integration of Conductive MOF and MXene for High-Performance Supercapacitor

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Characterization

XRD patterns were examined on a Bruker D8 Advance X-ray diffractometer (Cu-Kα radiation: λ=0.15406 nm). XPS measurement was carried out using an Axis Ultra X-ray photoelectron spectrometer (Kratos Analytical Ltd., UK) equipped with Al-Kα source (hv = 1486.6 eV). The morphological characteristics of the sample were observed using a field emission scanning electron microscope (Zeiss_Supra55) at an acceleration voltage of 5.0 KV. TEM images, SAED images, and EDS mapping images were captured on a Tecnai G2 F30 transmission electron microscope with an acceleration voltage of 300 kV.

Electrochemical measurement

All electrochemical measurements were conducted in a typical three-electrode electrochemical cell, which contained a 3 M KOH aqueous solution as the electrolyte. The working electrode (WE) consisted of nickel foam with active materials. The Hg/HgO electrode served as the reference electrode (RE), and the counter electrode (CE) was a Pt electrode. Cyclic voltammetry (CV) measurements were performed on a CHI760e electrochemical workstation. The working electrode was made by mixing the as-prepared sample powder, acetylene black, and polytetrafluoroethylene at a weight ratio of 80:15:5, respectively. Then, a piece of nickel foam size of approximately 1 × 1 cm was coated by above powder. Then, the nickel foam was pressed into a thin foil at a pressure of 8 MPa. The mass loading of the active material on the electrodes is about 2 mg. The electrochemical capacitive performance of the electrodes can be measured by cyclic voltammetry (CV), galvanostatic charge/discharge (GDC) curves and stability test. The specific capacity can be calculated from the GCD curves through equations:

$$C_m = \frac{I\,\Delta t}{m\,\Delta V}$$

Asymmetric supercapacitor assembly and measurements

For asymmetric supercapacitor (ASC) device, the as-synthesized MXene@Ni-HHTP-*x* and activated carbon (AC) used as positive and negative electrodes, respectively, which was investigated in 3 M KOH. The negative electrode was prepared by using a similar procedure with positive electrode. The AC was produced by Shenzhen Naxin Material Co., Ltd whose type is YEC-8. The specific surface area and bulk density of AC (YEC-8) are about 2000 m^2/g and 0.4 g/mL, respectively. Similar as before, the negative electrode was made by mixing the as-prepared AC, acetylene black, and polytetrafluoroethylene at a weight ratio of 80:15:5, respectively. To balance the charges between the positive and negative electrodes, the load-bearing ratio of MXene@Ni-HHTP-2 to AC on nickel foam is about 2 : 5.4. Then, the above powder was coated on a piece of nickel foam, approximately 1×1 cm^2. Then, the nickel foam was pressed into a thin foil at a pressure of 8 MPa. The mass loading of the active material on the electrodes is about 2 mg. Then, the nickel foam was pressed into a thin foil at a pressure of 8 MPa. The mass loading of the active material on the electrodes is about 2 mg and the mass ratio of the positive electrode and negative electrode was about 1:1. The energy density (E, W h kg^{-1}) and power density (P, W kg^{-1}) were calculated through equations:

$$E = \frac{C\,\Delta V^2}{7.2}$$

$$P = \frac{E \times 3600}{\Delta t}$$

Table S1. Experimental reaction formula of MXene@cMOF-*x*

Name	MXene (mg)	HHTP (mg)	$Ni(OAc)_2 \cdot 4H_2O$ (mg)
M@cMOF-1	5	3.5	5
M@cMOF-2	10	3.5	5
M@cMOF-3	20	3.5	5
M@cMOF-4	40	3.5	5
M@cMOF-5	100	3.5	5
M@cMOF-6	10	1.7	2.5
M@cMOF-7	10	7	10
M@cMOF-8	10	7	0

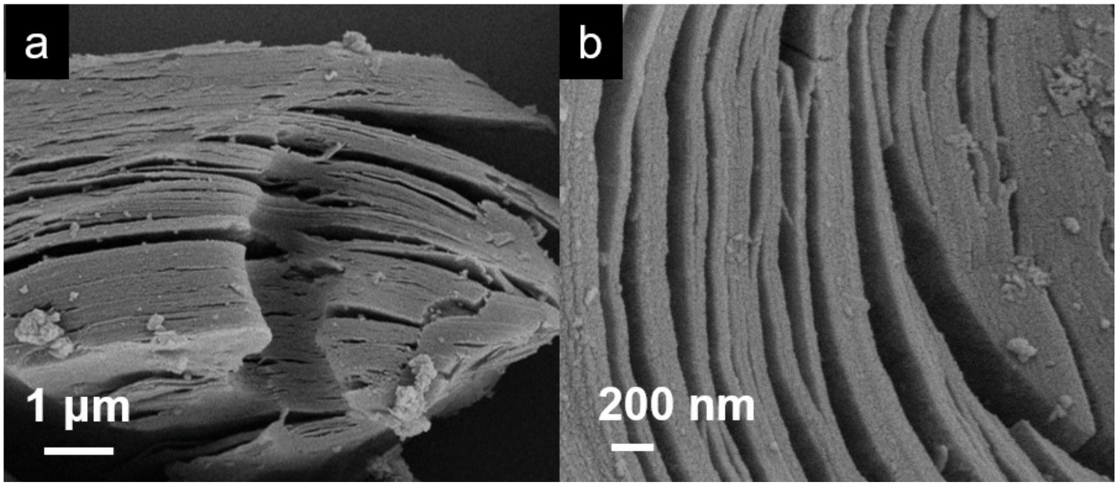

Fig. S1. (a-b) SEM images of MXene with different magnifications.

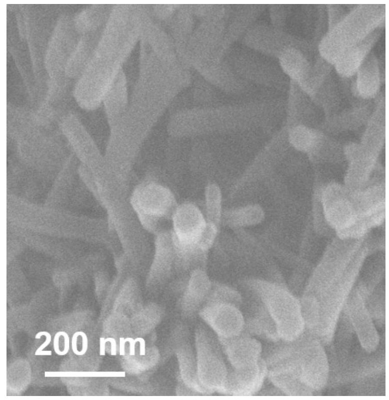

Fig. S2. SEM image of Ni-HHTP.

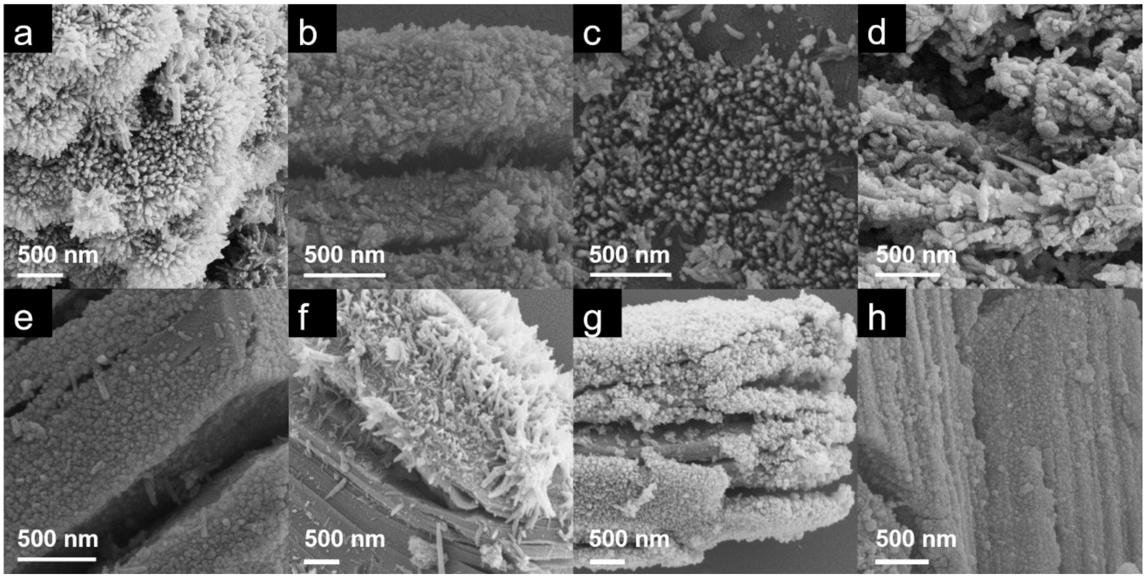

Fig. S3. (a-h) SEM images of M@cMOF-1~8.

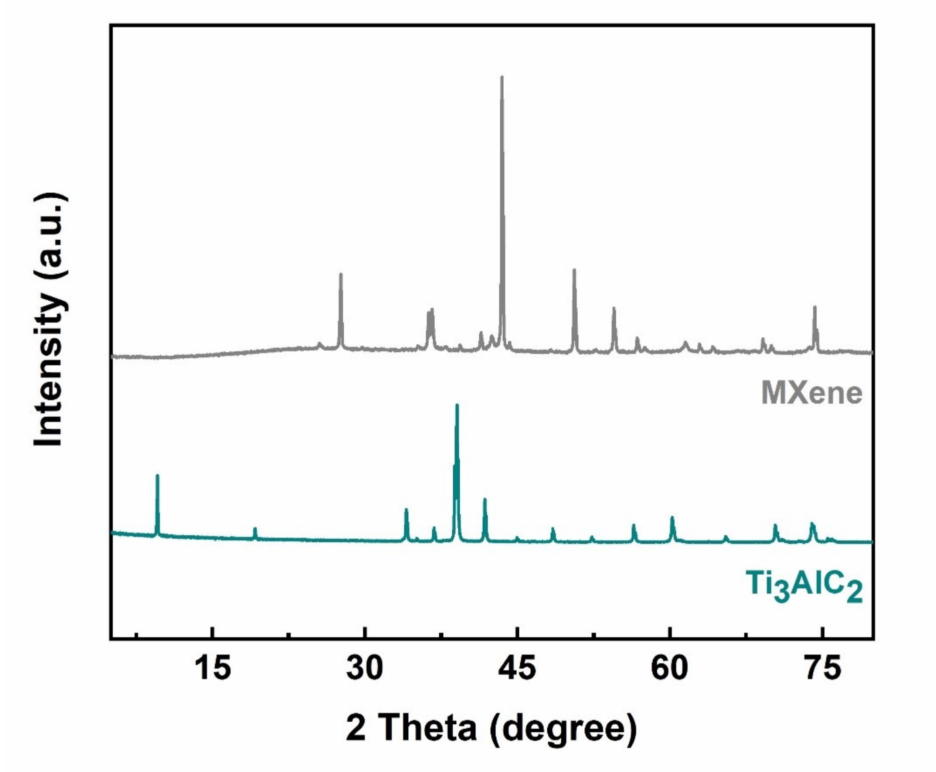

Fig. S4. XRD patterns of Ti_3AlC_2 and MXene.

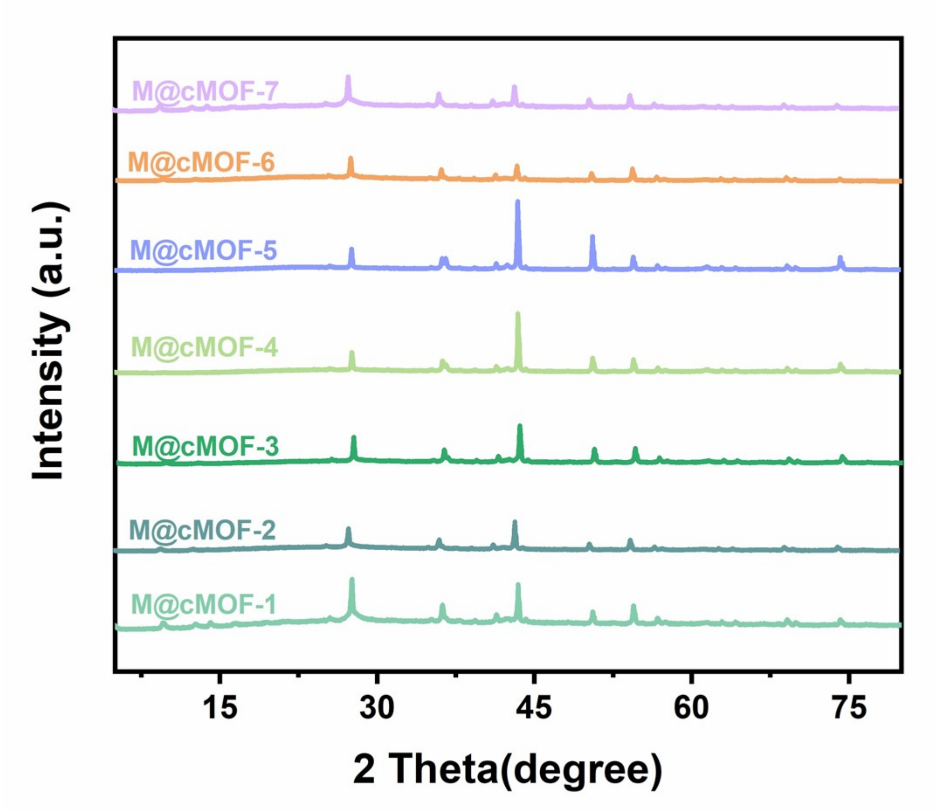

Fig. S5. XRD patterns of M@cMOF-1~7.

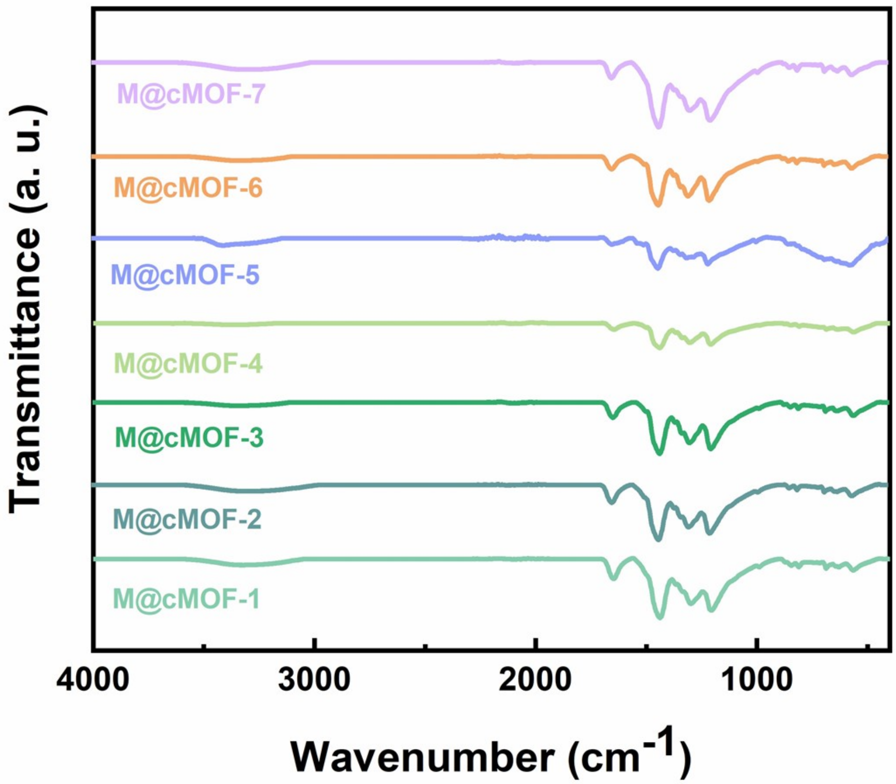

Fig. S6. FT-IR spectra of M@cMOF-1~7.

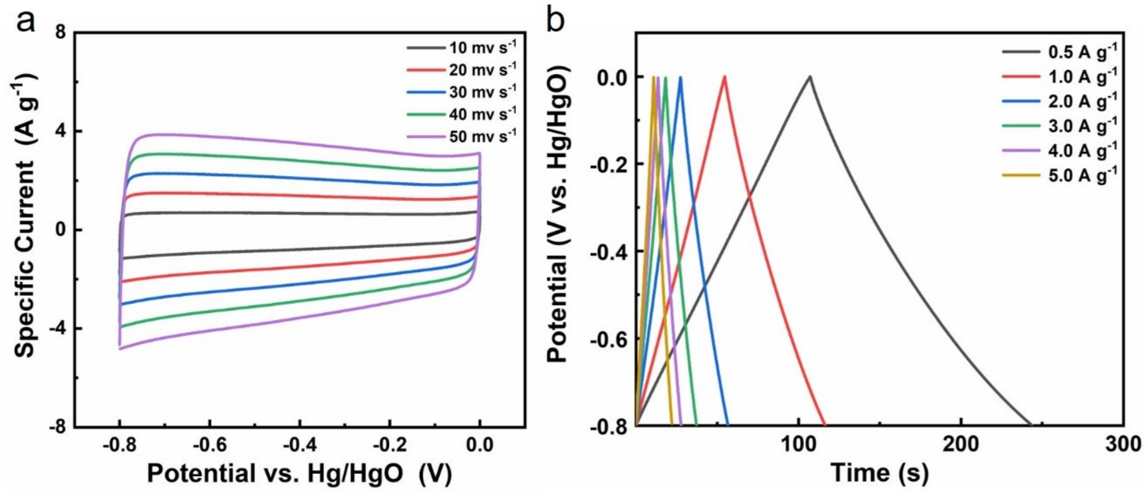

Fig. S7. CV and GCD curves of activated carbon.

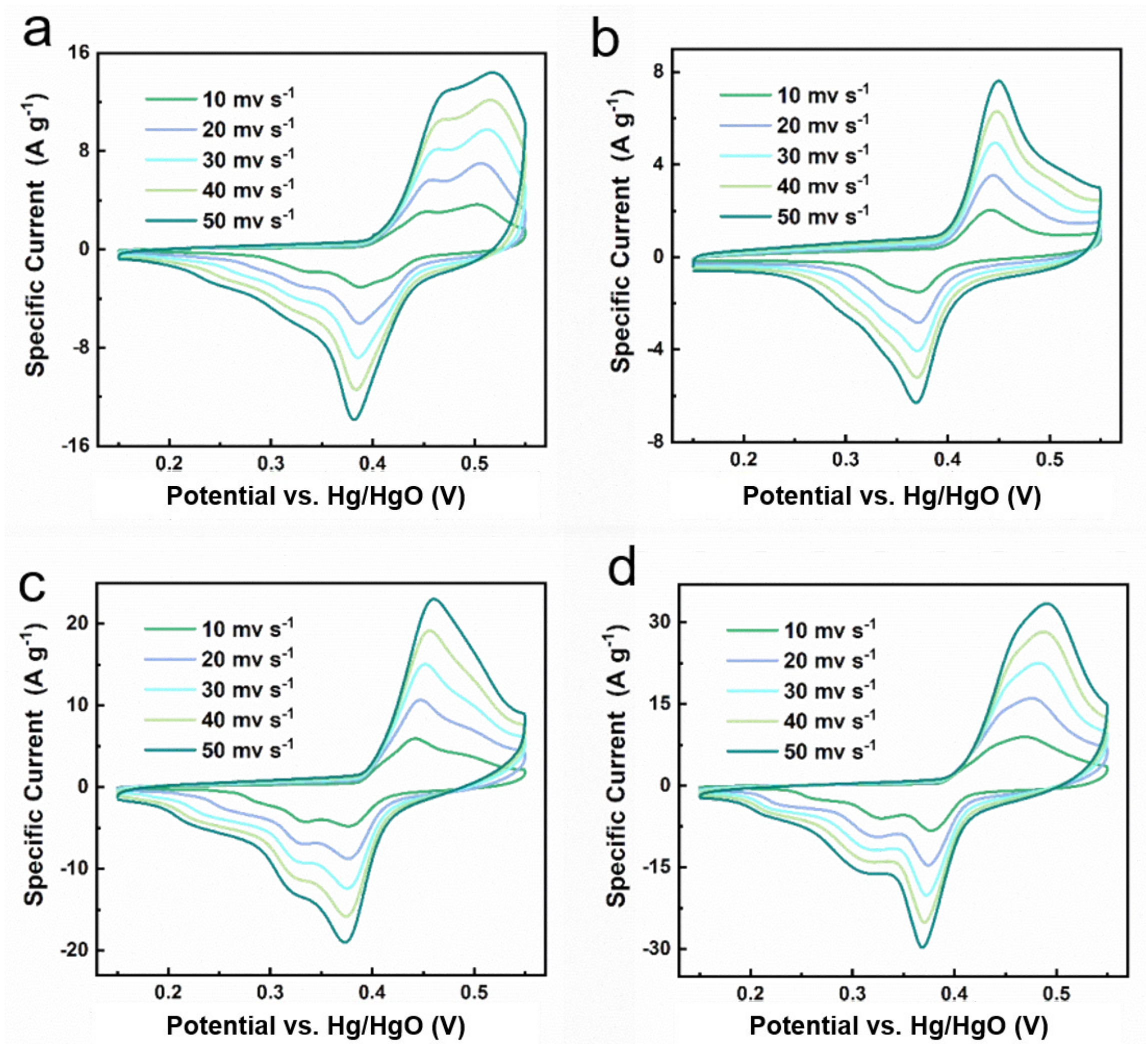

Fig. S8. CV curves of (a) MXene and (b-d) M@cMOF-1~3 at different scan rates in a three-electrode system.

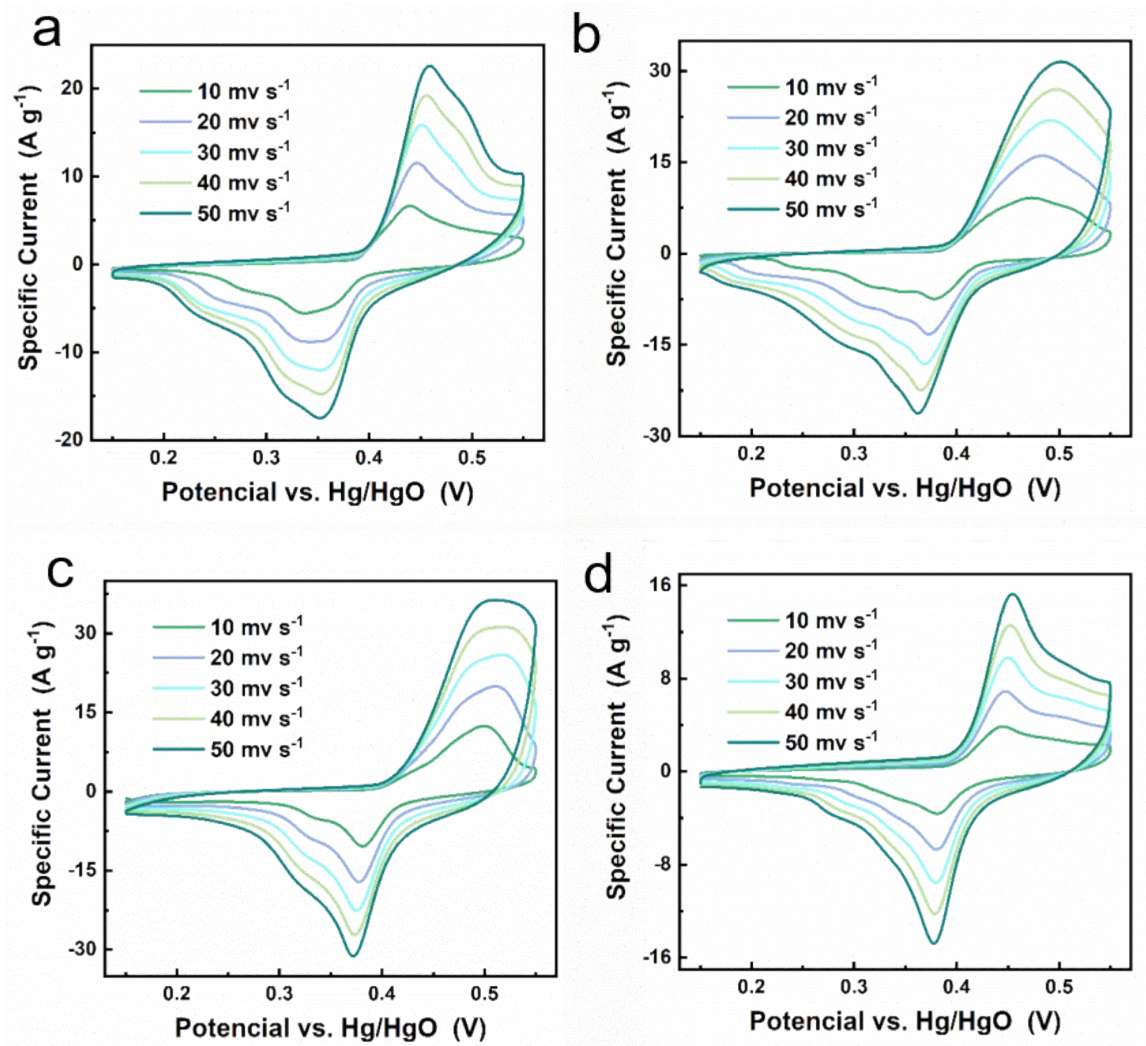

Fig. S9. CV curves of (a-d) M@cMOF-4~7 at different scan rates in a three-electrode system.

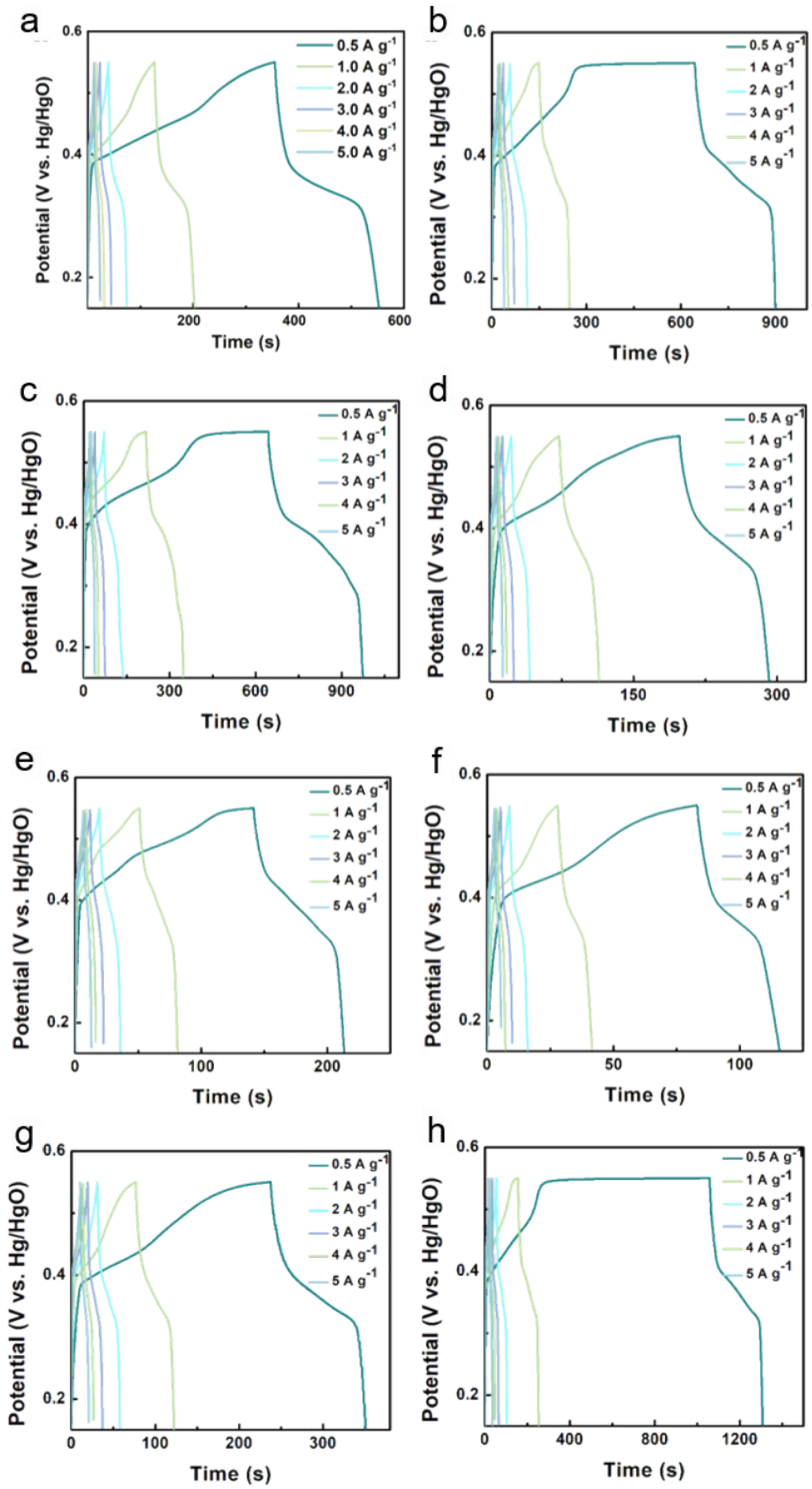

Fig. S10. GCD curves of (a) MXene and (b-f) M@cMOF-1~7 at different current densities in a three-electrode system.

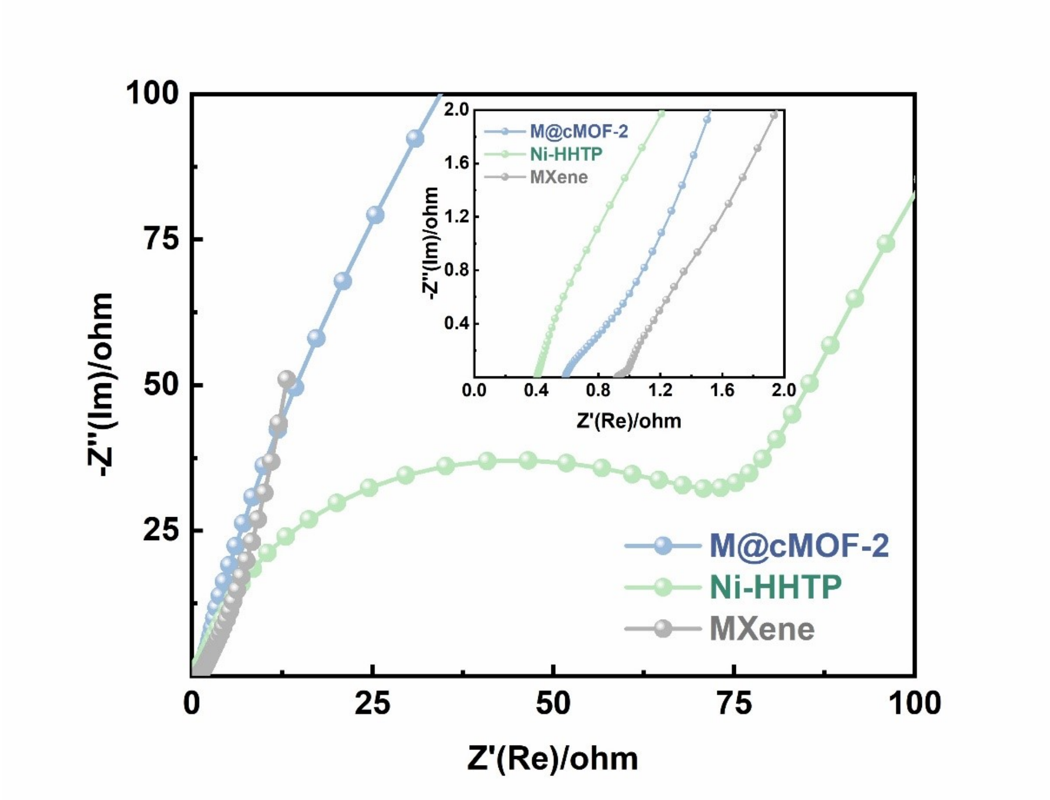

Fig. S11. Nyquist plots of MXene, Ni-HHTP and M@cMOF-2. Insets: magnified high-frequency region.

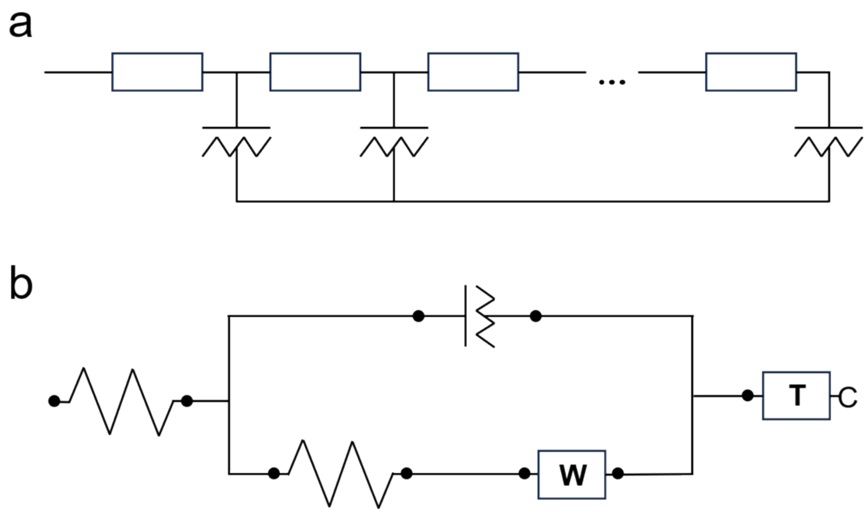

Fig. S12. The fitted equivalent circuits of (a)MXene, M@cMOF-2 and (b) Ni-HHTP.

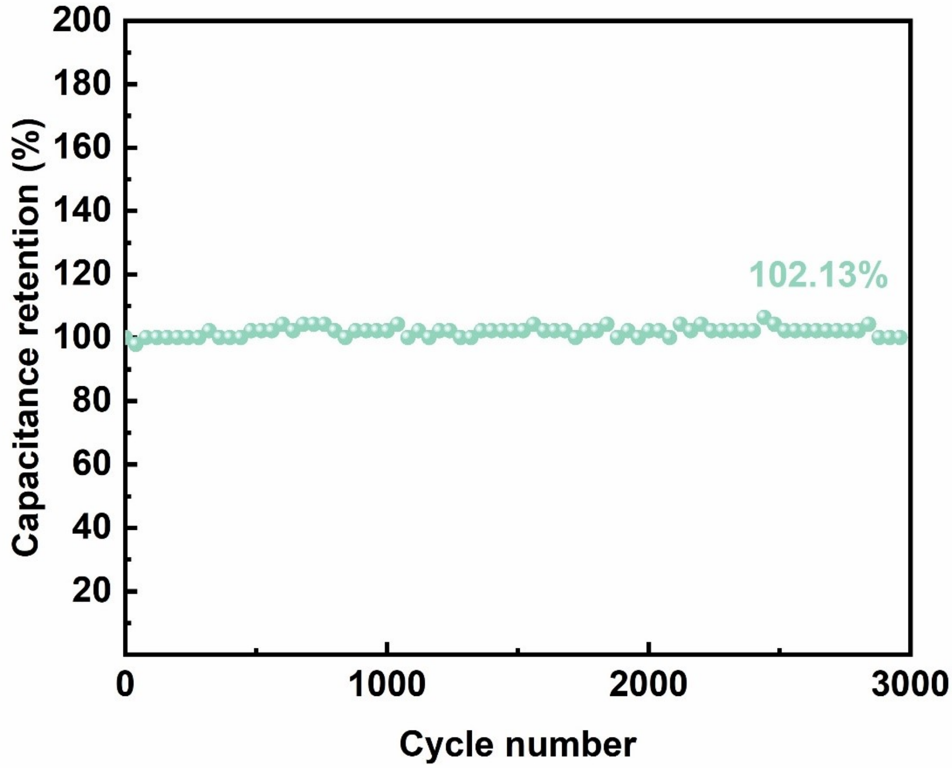

Fig. S13. Cycling stability of M@cMOF-2 at 3 A g^{-1} for 3000 cycles.

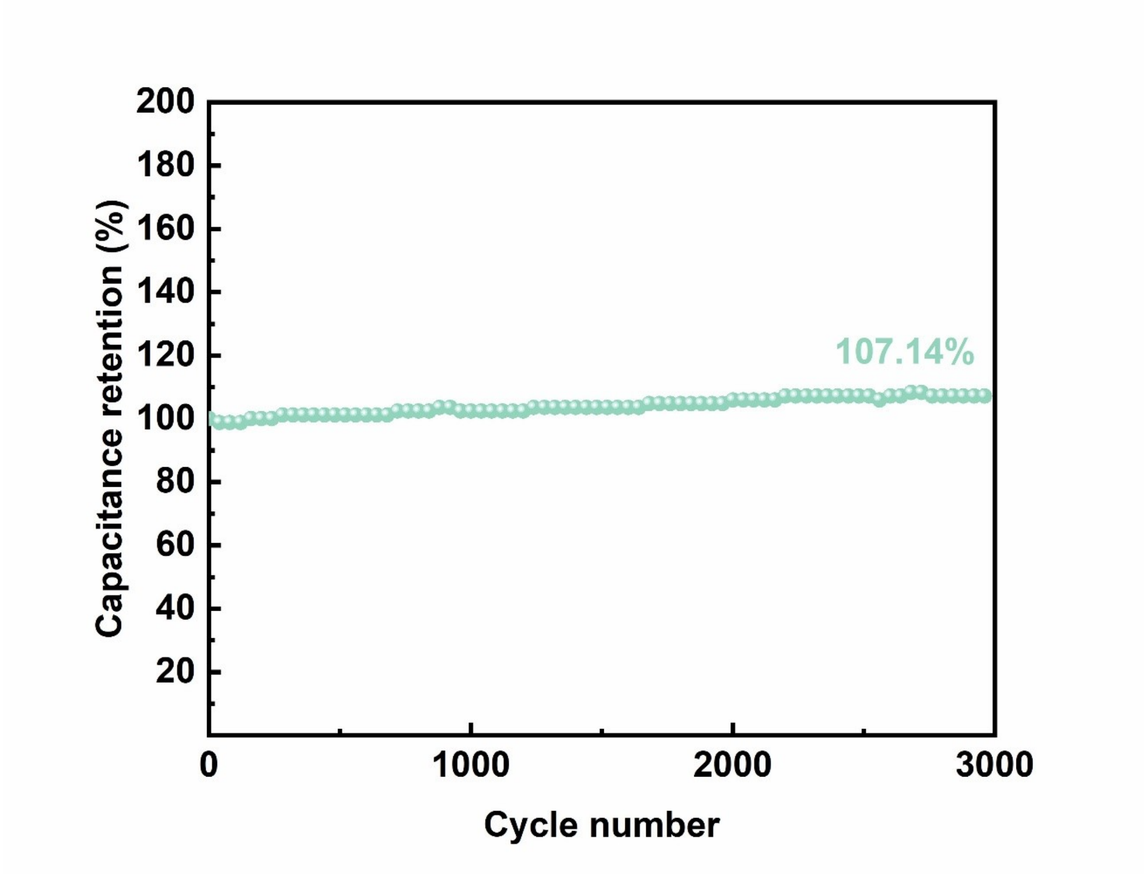

Fig. S14. Cycling stability of M@cMOF-2//AC aqueous asymmetric supercapacitor at 3 A g^{-1} for 3000 cycles.