Multifunctional MXene-Fe_3O_4-carbon nanotube composite electrodes for high active mass asymmetric supercapacitors

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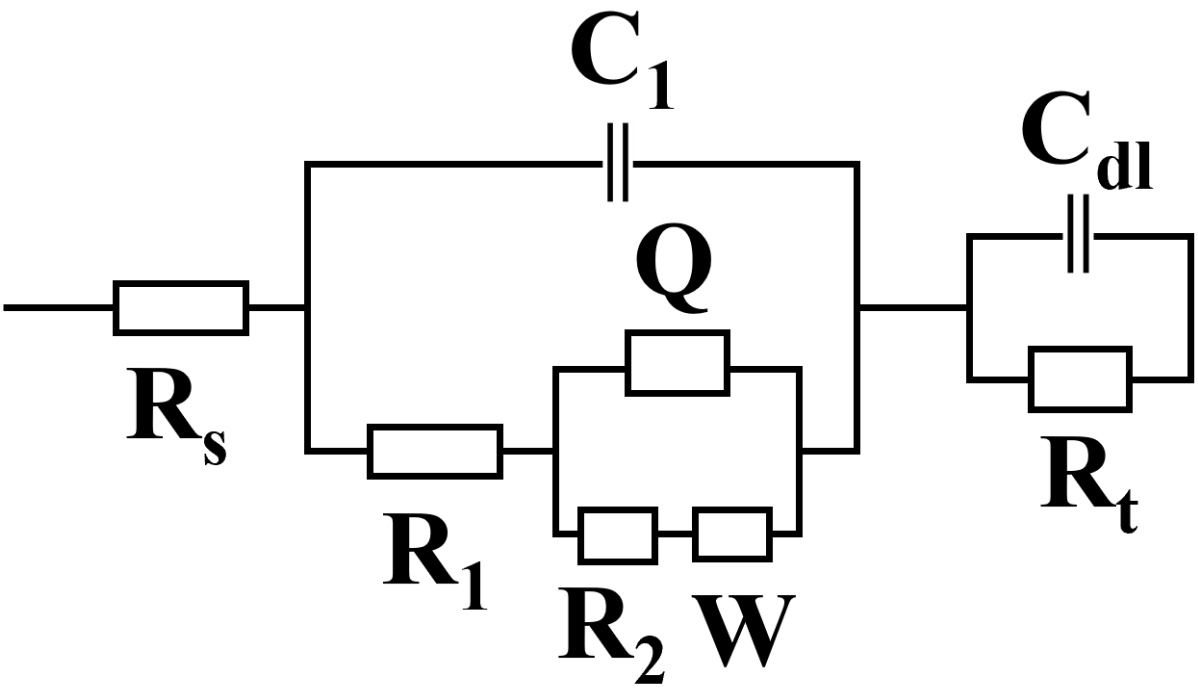

Figure S1. Equivalent circuit developed from high active mass loading electrodes. R-C(Q) transmission line was combined in series with solution resistance R_s. R_n elements represented electrolyte resistance. Q was related to the constant phase elements and W stood for Warburg impedance. Double layer capacitance C_{dl} was in parallel with the charge transfer resistance R_t.

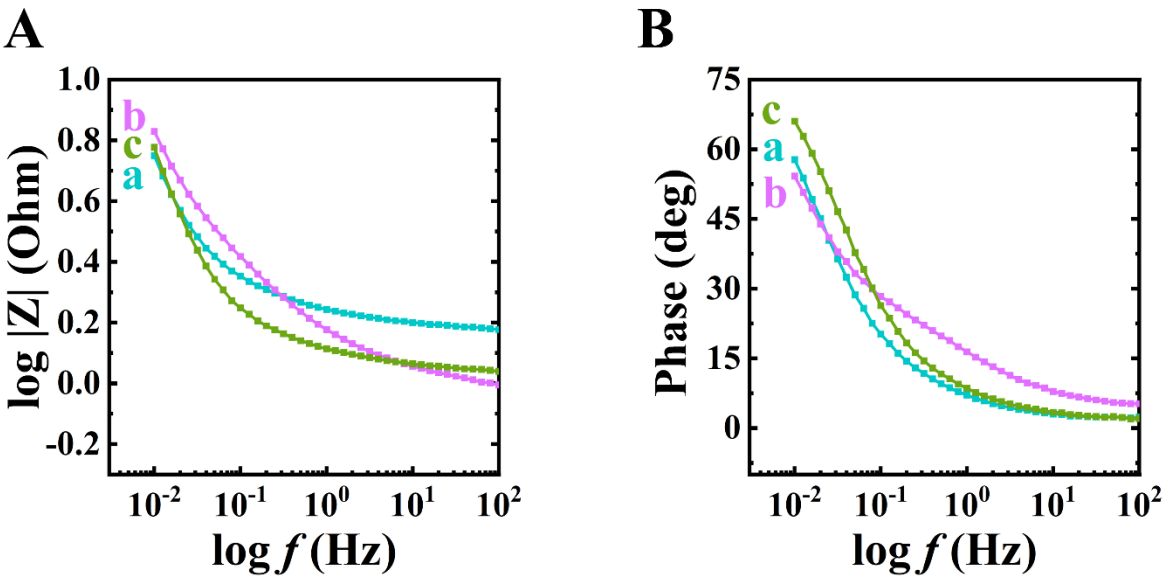

Figure S2. Bold modulus of (A)impedance and (B)phase angle plot for (a)60$Ti_3C_2T_x$-30Fe_3O_4-10MCNT, (b)55$Ti_3C_2T_x$-30Fe_3O_4-15MCNT and (c)55$Ti_3C_2T_x$-25Fe_3O_4-20MCNT electrodes prepared by method 2 with AML of 35 mg cm^{-2}.

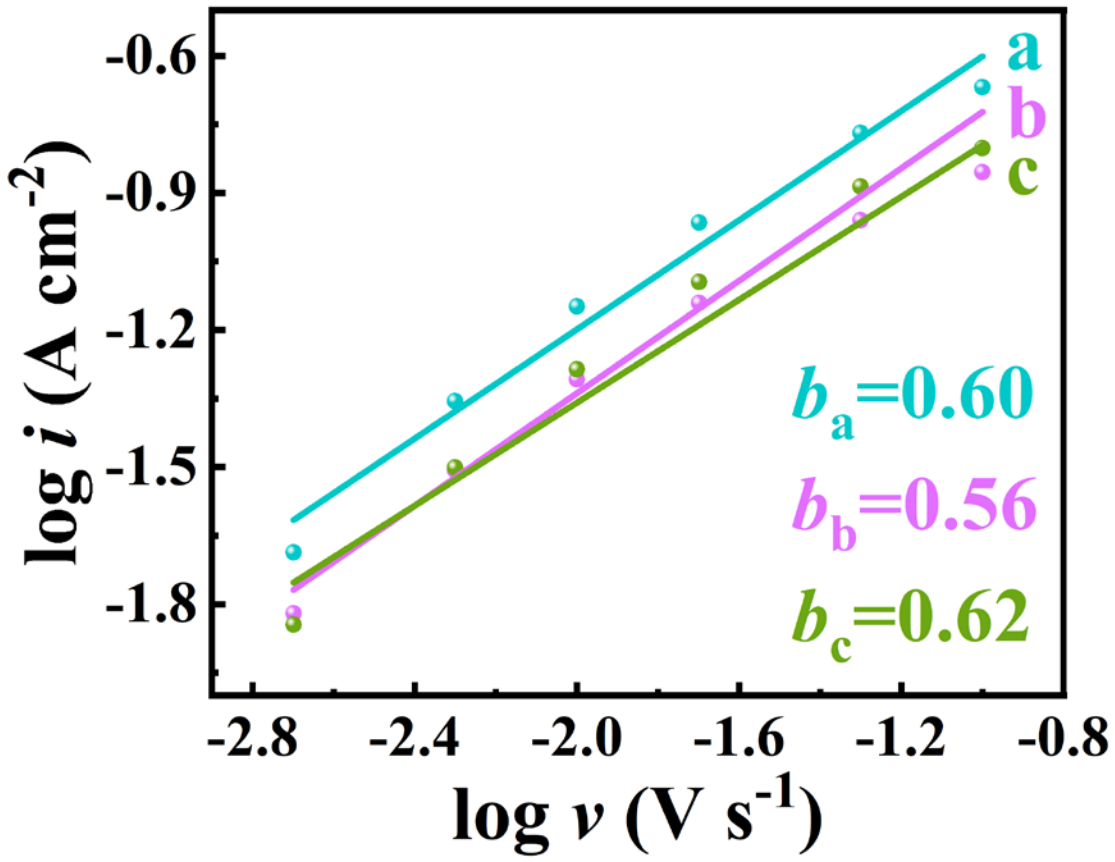

Figure S3. Current (i) versus scan rate (ν) dependence in a logarithmic scale used for the calculation of b value by equation $i=av^b$ for (a)60$Ti_3C_2T_x$-30Fe_3O_4-10MCNT, (b)55$Ti_3C_2T_x$-30Fe_3O_4-15MCNT and (c)55$Ti_3C_2T_x$-25Fe_3O_4-20MCNT electrodes prepared by method 2 with AML of 35 mg cm^{-2}.

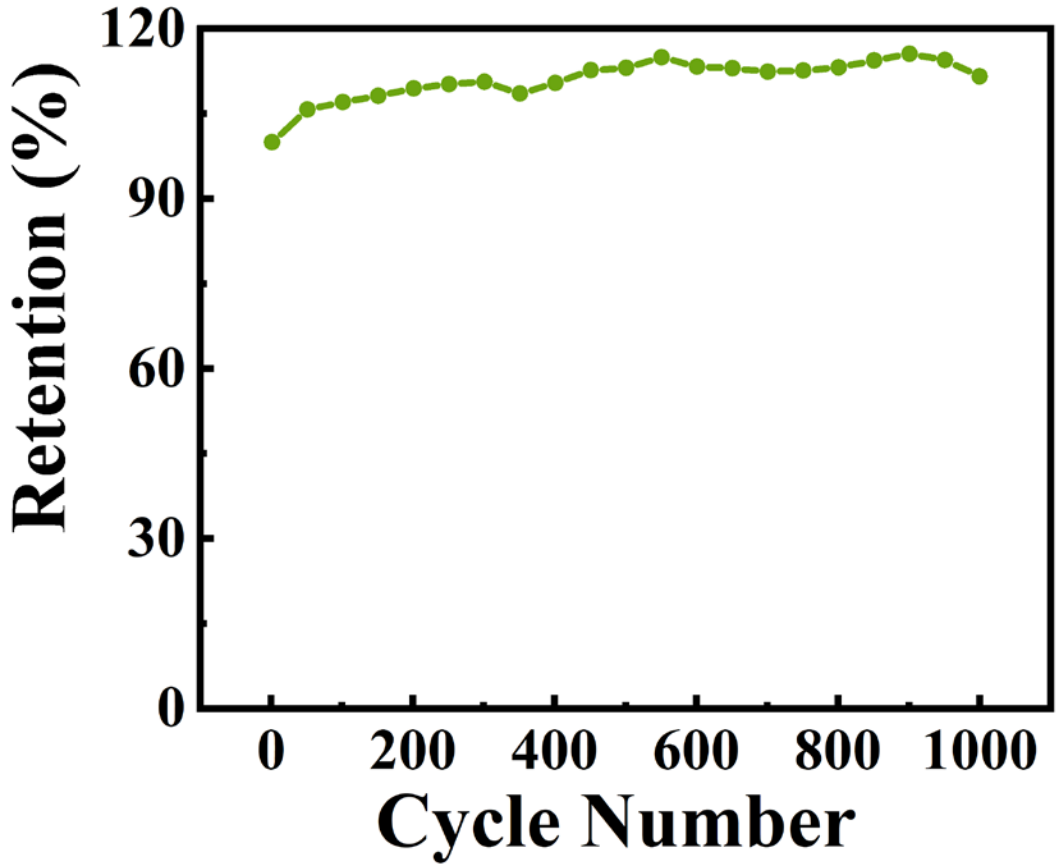

Figure S4. Cycling stability of 60$Ti_3C_2T_x$-30Fe_3O_4-10MCNT electrode at 40 mg cm^{-2} from CV at scan rate of 50 mV s^{-1}.

Table S1. Capacitance(F cm^{-2}) and capacity(mAh g^{-1}) for as-prepared electrodes, calculated from CV data at 2 mV s^{-1} scan rate.

Preparation Method	**Electrode**	**Mass loading (mg cm^{-2})**	**Capacitance (F cm^{-2})**	**Capacity (mAh g^{-1})**
1	60$Ti_3C_2T_x$-30Fe_3O_4-10MCNT	35	2.42	17.29
2	60$Ti_3C_2T_x$-30Fe_3O_4-10MCNT	35	5.44	38.86
2	55$Ti_3C_2T_x$-30Fe_3O_4-15MCNT	35	4.92	35.14
2	55$Ti_3C_2T_x$-25Fe_3O_4-20MCNT	35	4.62	29.85
2	60$Ti_3C_2T_x$-30Fe_3O_4-10MCNT	30	4.18	34.83
2	60$Ti_3C_2T_x$-30Fe_3O_4-10MCNT	40	6.59	41.19

2	60$Ti_3C_2T_x$-30Fe_3O_4-10MCNT	45	5.89	32.72

Table S2. Summary of electrochemical performance of $Ti_3C_2T_x$/Fe_3O_4-based composite anode for supercapacitors.

Material	**Active mass (mg cm^{-2})**	**Areal capacitance (F cm^{-2})**	**Electrolyte**	**Potential window**	**Reference**
$Ti_3C_2T_x$-Fe_3O_4	1	0.37	1M KOH	-1.1~-0.3 V vs. Ag/AgCl	[61]
$Ti_3C_2T_x$-Fe_3O_4-rGO	5	1.25	1M KOH	-1.1~-0.3 V vs. Ag/AgCl	[62]
50$Ti_3C_2T_x$-30Fe_3O_4-20MCNT	35	5.52	0.5M Na_2SO_4	-1.1~-0.3 V vs. SCE	[49]
60$Ti_3C_2T_x$-30Fe_3O_4-10MCNT	40	6.59	0.5M Na_2SO_4	-1.1~-0.3 V vs. SCE	This work