Electronic Supplementary Material (ESI) for Materials Chemistry Frontiers.

Supporting Information

Titanium and nitrogen co-doped porous carbon for high-performance supercapacitors

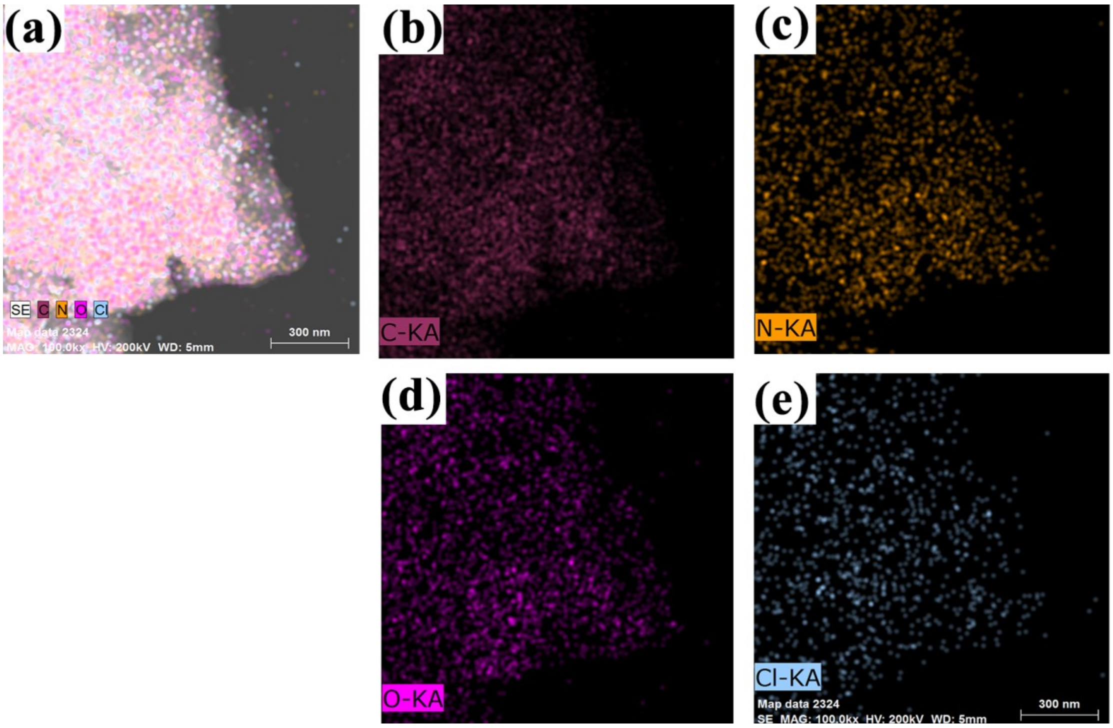

Figure S1. Elemental distribution of NOClC (a). The STEM-EDS elemental mappings of carbon (red) (b). nitrogen (pink) (c). oxygen (dark green) (d); chlorine (blue) (e).

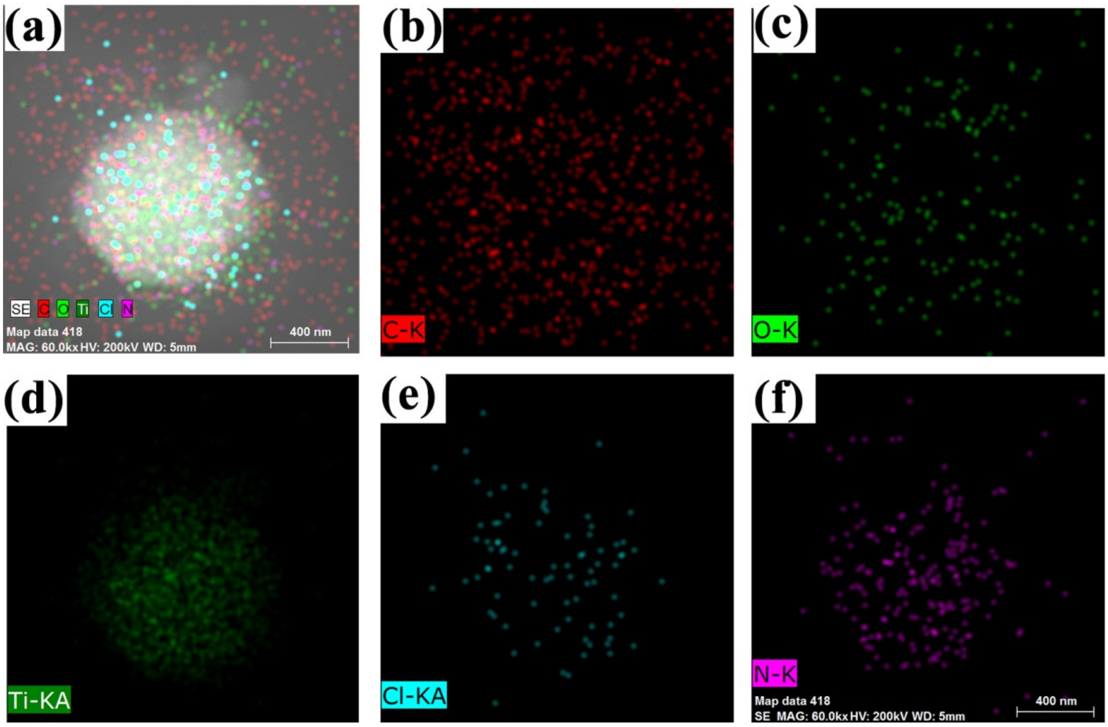

Figure S2. Elemental distribution of TiNOClC (a). The STEM-EDS elemental mappings of carbon (red) (b). nitrogen (pink) (c). titanium (green) (d). oxygen (dark green) (e). chlorine (blue) (f).

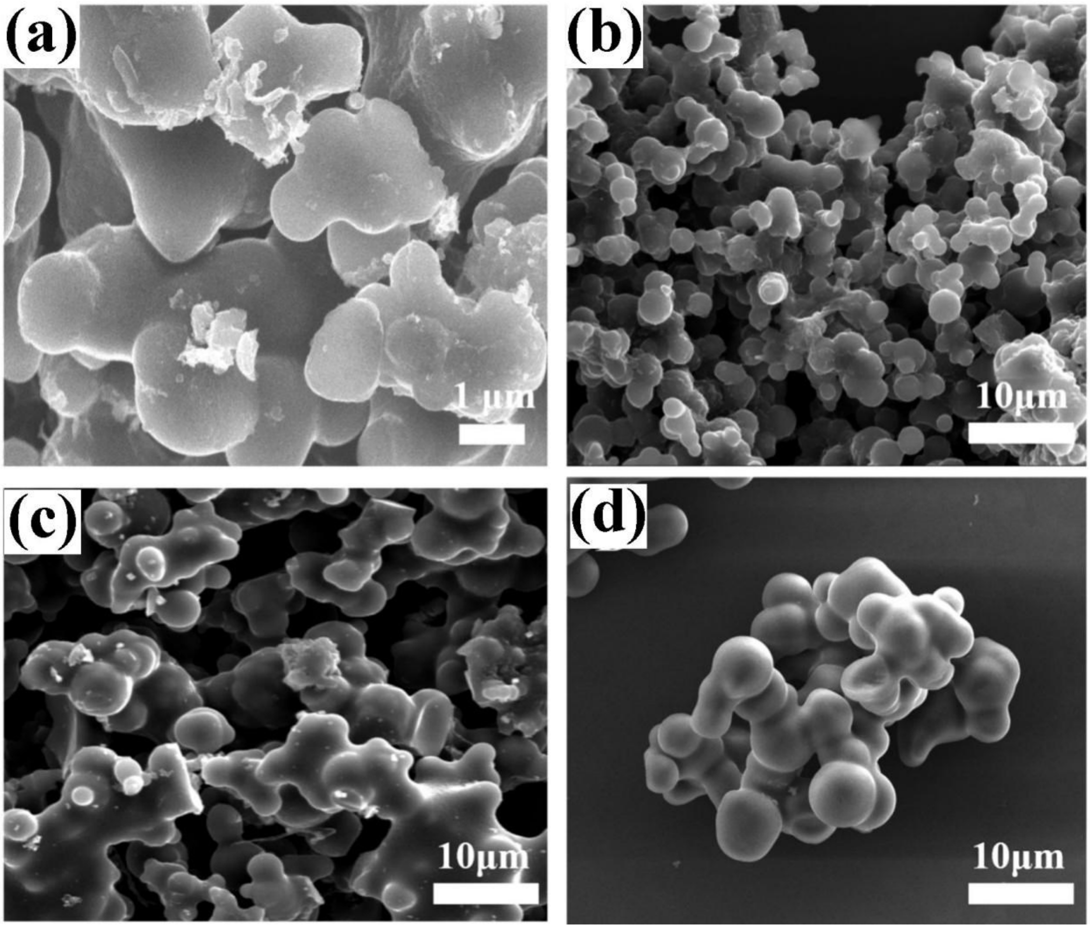

Figure S3. Structure of different metal doped carbon materials. (a) Sn-doped. (b) Mn-doped. (c) Ni-doped. (d) Cu-doped.

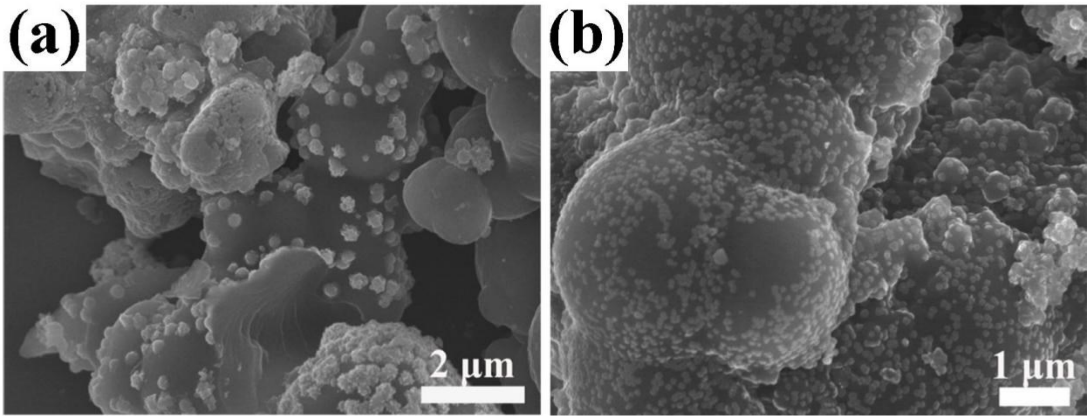

Figure S4. Structure of doped carbon materials synthesized using different amounts of Ti nanoparticles, (a) 300 mg. (b) 500 mg.

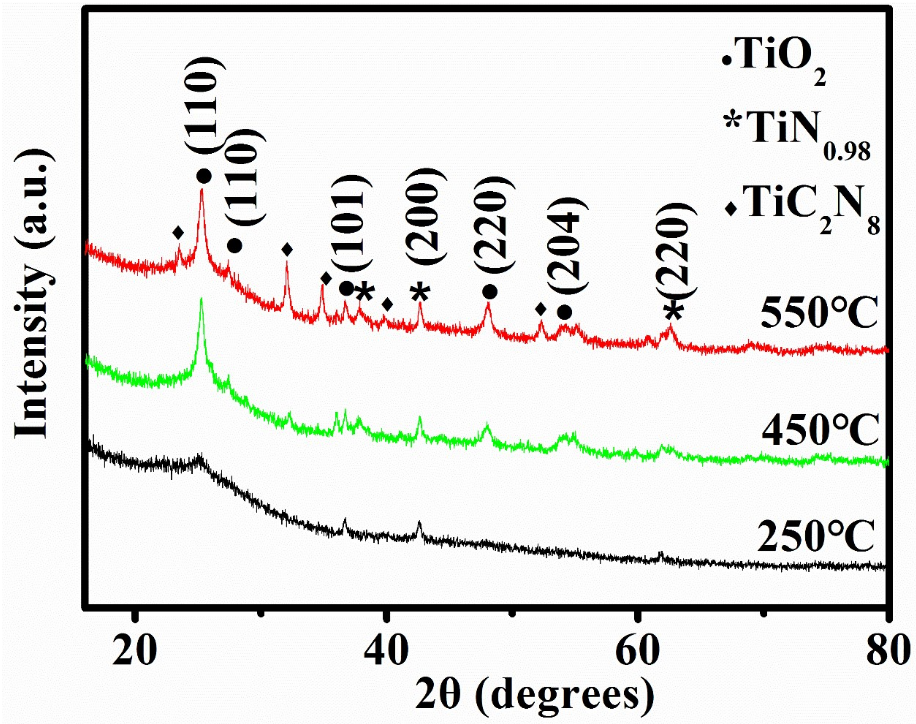

Figure S5. XRD spectra of TiNOClC materials with different temperature treatment (250℃, 450℃, 550℃). The spectrum of TiO_2 mostly corresponds to anatase TiO_2 (JC-PDS, #73-1764).

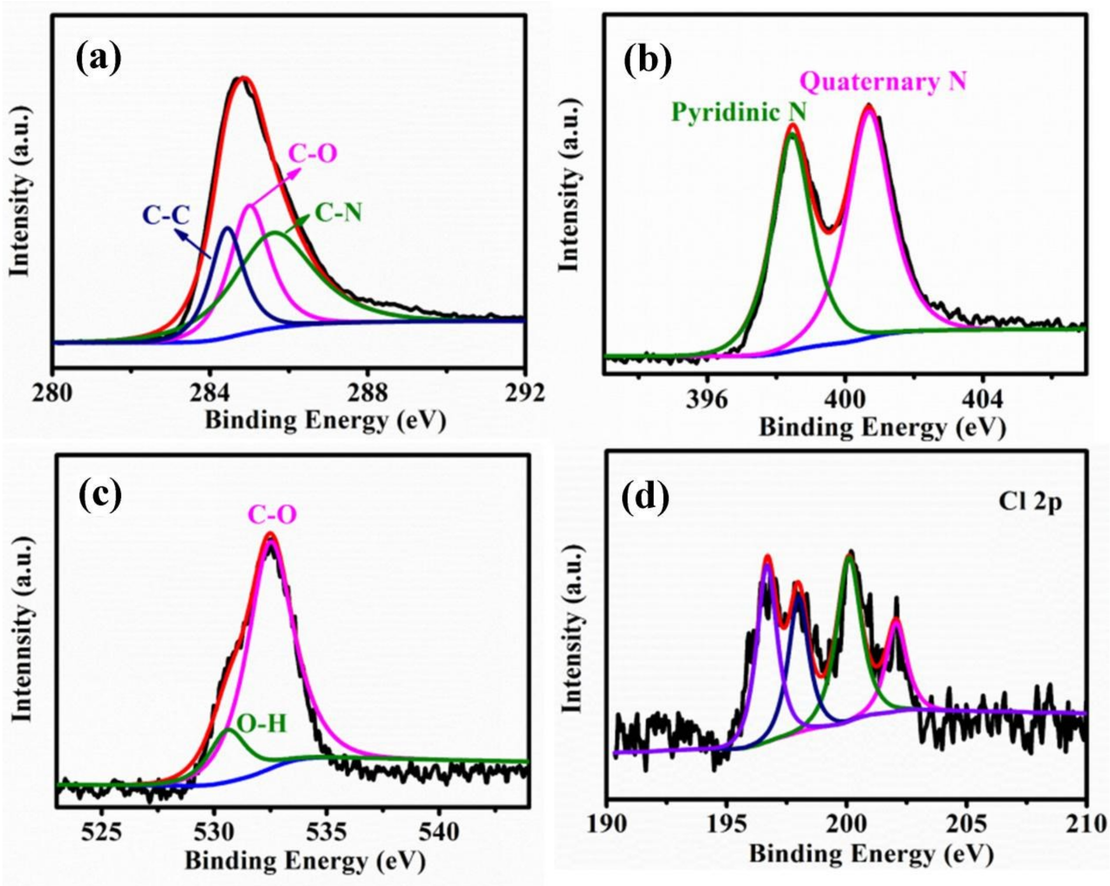

Figure S6. High-resolution XPS survey spectrum of NOClC for C 1s (a), N 1s (b), O 1s (c), and (d) Cl 2p (chlorine content is only 0.4%).

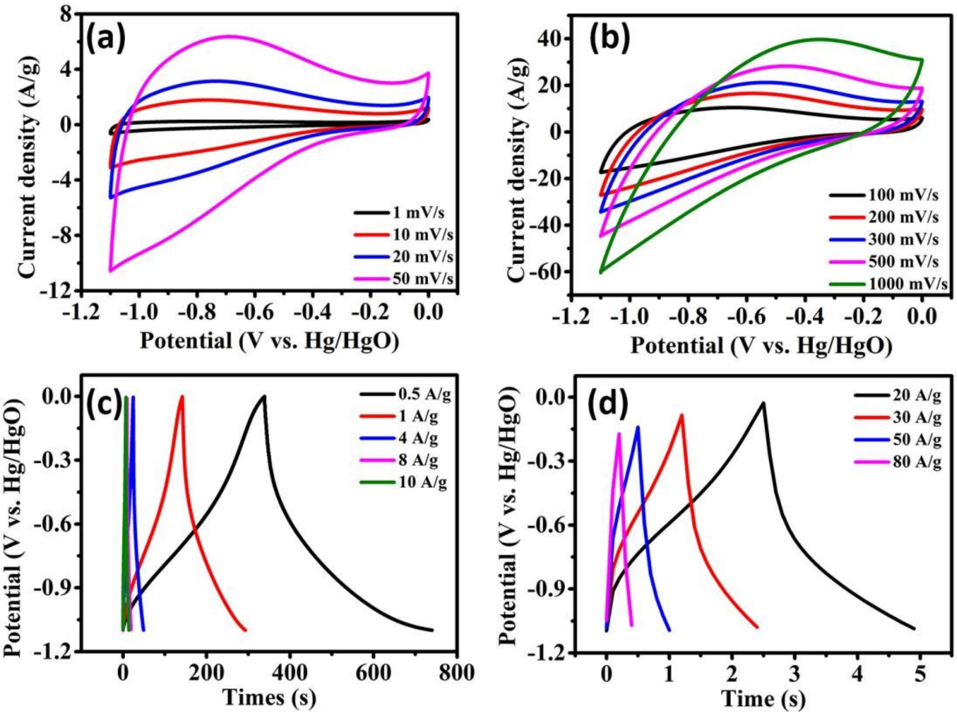

Figure S7. Performance of NOClC in 6 M KOH electrolyte solution. (a) and (b) CV curves of NOC at scan rates of 1-1000 mV s^{-1}, (c) and (d) galvanostatic charge/discharge curves at current densities of 0.5-80 A g^{-1}.

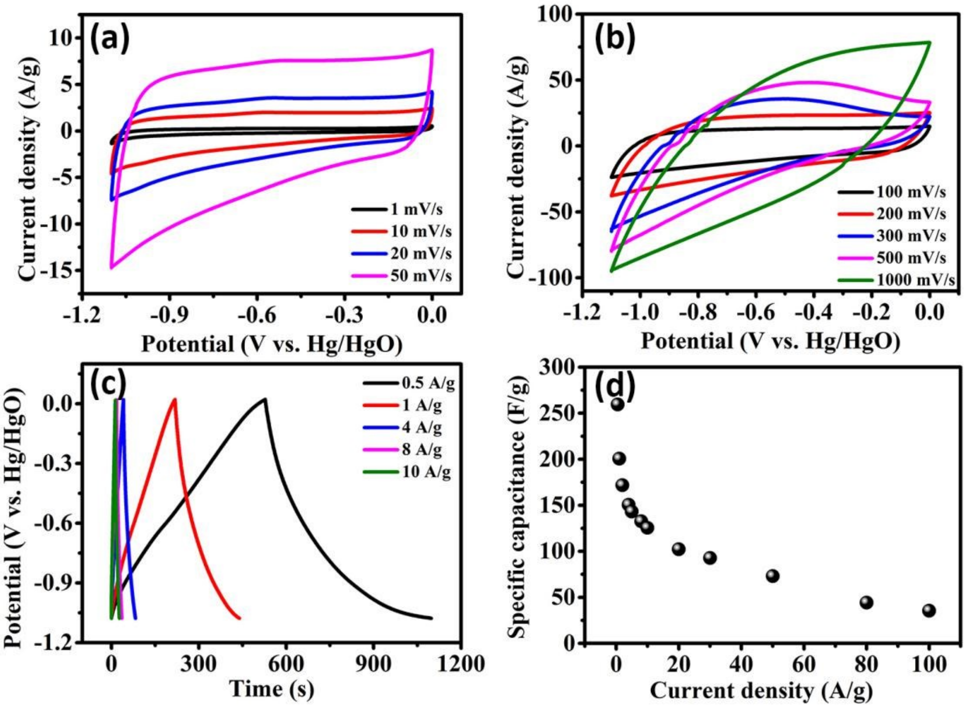

Figure S8. Performance of TiNOClC in 6 M KOH electrolyte solution. (a) and (b) CV curves of TiNOClC at scan rates of 1-1000 mV s^{-1}, (c) and (d) Specific capacitance calculated from GCD curves vs. current density.

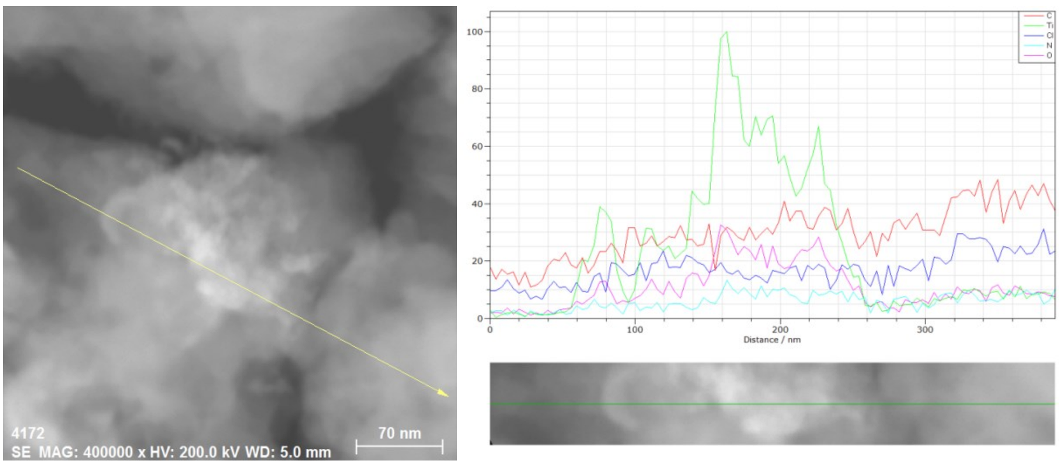

Figure S9. Line scan of TiNOClC samples.

Figure S10. Peak fitting for Raman spectra of NOClC and TiNOClC samples.

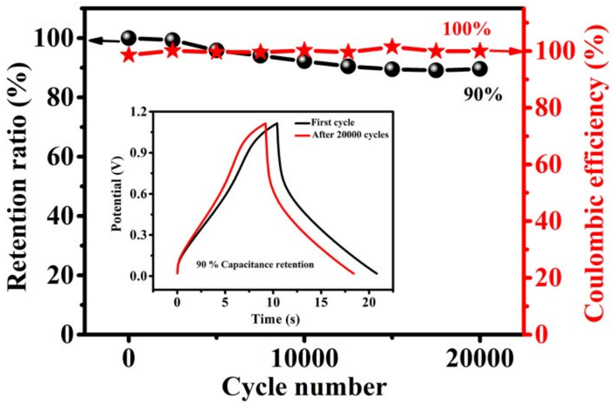

Figure S11. Cycling stability and coulombic efficiency at a current density of 5 A g^{-1} for TiNOClC-based two-electrode symmetrical cell. Inset: the first and 20000th cycle of GCD curves at current densities of 5 A g^{-1} for TiNOClC-based two-electrode symmetrical cell.

Table S1. The specific surface area and pore volume of NOClC and TiNOClC.

Samples	S_{BET} (m^2 g^{-1})	A_{micro} (m^2 g^{-1})	A_{meso} (m^2 g^{-1})	V_{pore} (cm^3 g^{-1})	V_{meso} (cm^3 g^{-1})
NOClC	59.4	49.2	17.2	0.103	0.019
TiNOClC	44.9	13.4	31.5	0.058	0.005

Table S2. Element compositions of NOClC and TiNOClC according to XPS and element analysis, respectively.

Products	**XPS (PP At. %)**				
	C%	N%	O%	Cl%	Ti%
NOClC	79.04	16.89	3.42	0	0
TiNOClC	59.64	18.58	16.53	2.40	2.85
	Element analysis				
	C%	N%	O%	Cl%	Ti%
NOClC	70.07	12.24	17.29	0.4	0
TiNOClC	67.49	11.78	16.71	1.1	2.92

Table S3. Parameters obtained by using the equivalent circuit simulation.

Samples	Cp	Rct	Rgb	CPE	Zw	Rs
NOClC	0.032	8.9×10^{-5}	0.39	2.8×10^{-5}	1.8×10^{-6}	0.077
TiNOClC	0.55	1×10^{-12}	1.15	0.5	0.48	0.47

Table S4. Stability comparison with other Ti-based two-electrode supercapacitors.

	Number of cycles	Cycling stability	Test conditions	Refs
TiC_xN_{1-x}	10000	90%	10 A/g	S1
TiNbN	20000	98%	2 mA/cm^2	S2
$Ti_3C_2T_x$/RGO	6000	85.0%	4 A/g	S3
TiN	10000	95%	1.7 mA/cm^2	S4
TiN/Ti	10000	95.0%	26.66 mA/cm^2	S5
TiO_2@MnO_2	2000	81.0%	0.25 A/g	S6
$Ti_3C_2T_x$/MWCNT	1000	97.0%	20 mV/s	S7
HMPC//TiO_2-NWAs	3000	66.4%	1 mA/cm^2	S8
PS–TiN	13000	80.0%	0.67 mA/cm^2	S9
TiON-900-MCo	10000	79.0%	0.25 A/g	S10
TiN@MnO_2	15000	98.3%	100 mV/s	S11
TiN	10000	90.0%	100 mV/s	S12

Notes and References

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