Supplementary Information for

Scalable Solid-State Synthesis of 2D Transition Metal Oxide/Graphene Hybrid Materials and their Utilization for Microsupercapacitors

Muxuan Yang,[a] Pratik Kasbe,[a] Jinyu Bu,[a] and Weinan Xu[a,]*

[a] School of Polymer Science and Polymer Engineering, The University of Akron, Akron, OH 44325, USA

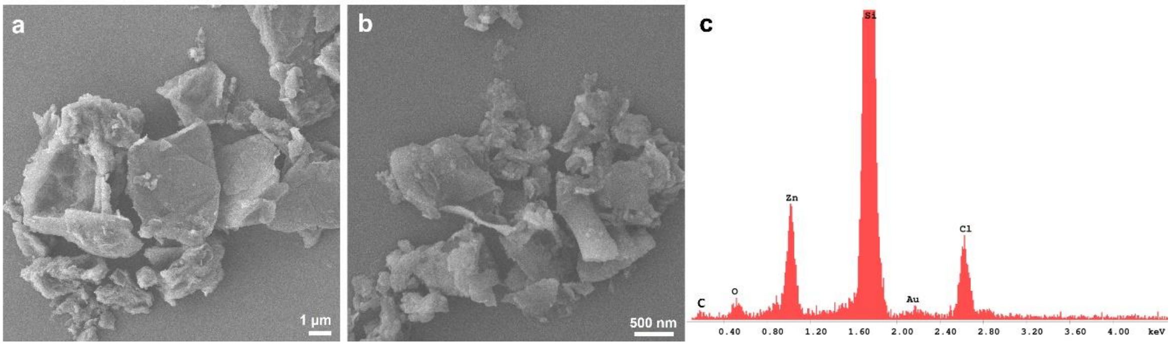

Fig. S1 SEM images (a-b) and EDX spectrum of 2D ZnO/rGO (10/1) nanocomposite.

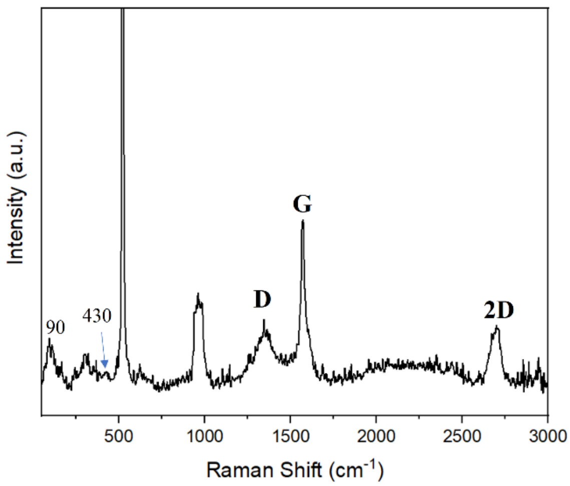

Fig. S2 Raman spectrum of 2D ZnO/rGO (10/1) nanocomposite.

* Corresponding author email: weinanxu@uarkon.edu

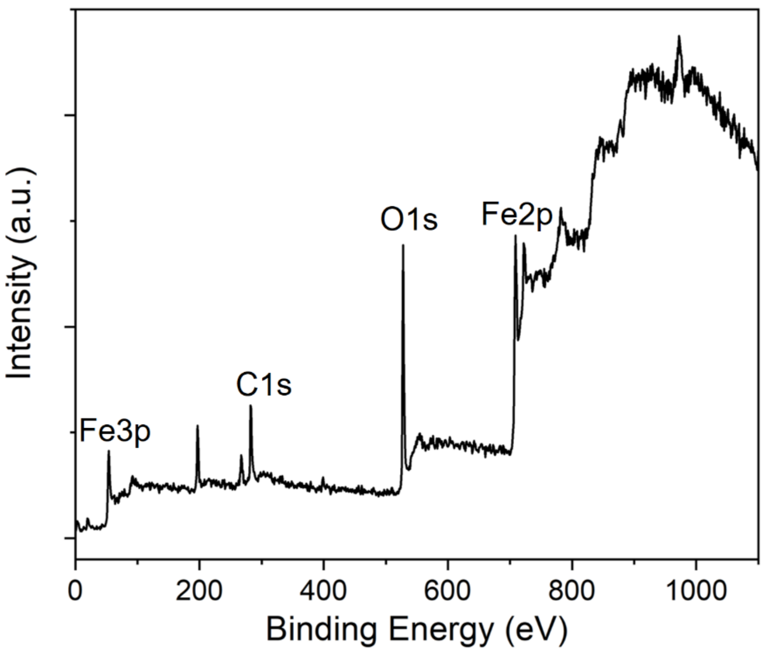

Fig. S3 XPS survey scan of the 2D Fe_2O_3/rGO (10/1) nanocomposite.

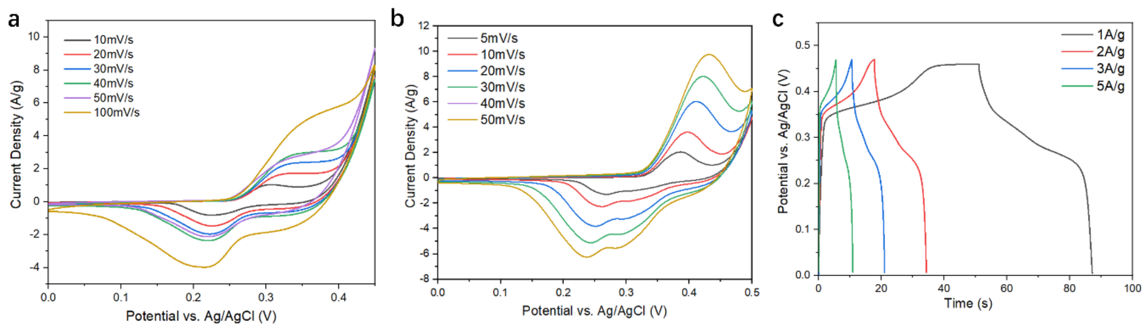

Fig. S4 (a) CV scans of 2D Fe_2O_3 at scan rates from 10mV/s to 100mV/s. (b) CV scans of 2D Fe_2O_3/rGO (20/1) with scan rates from 5mV/s to 50mV/s. (c) GCD curves of 2D Fe_2O_3/rGO (20/1) with rates from 1A/g to 5A/g.

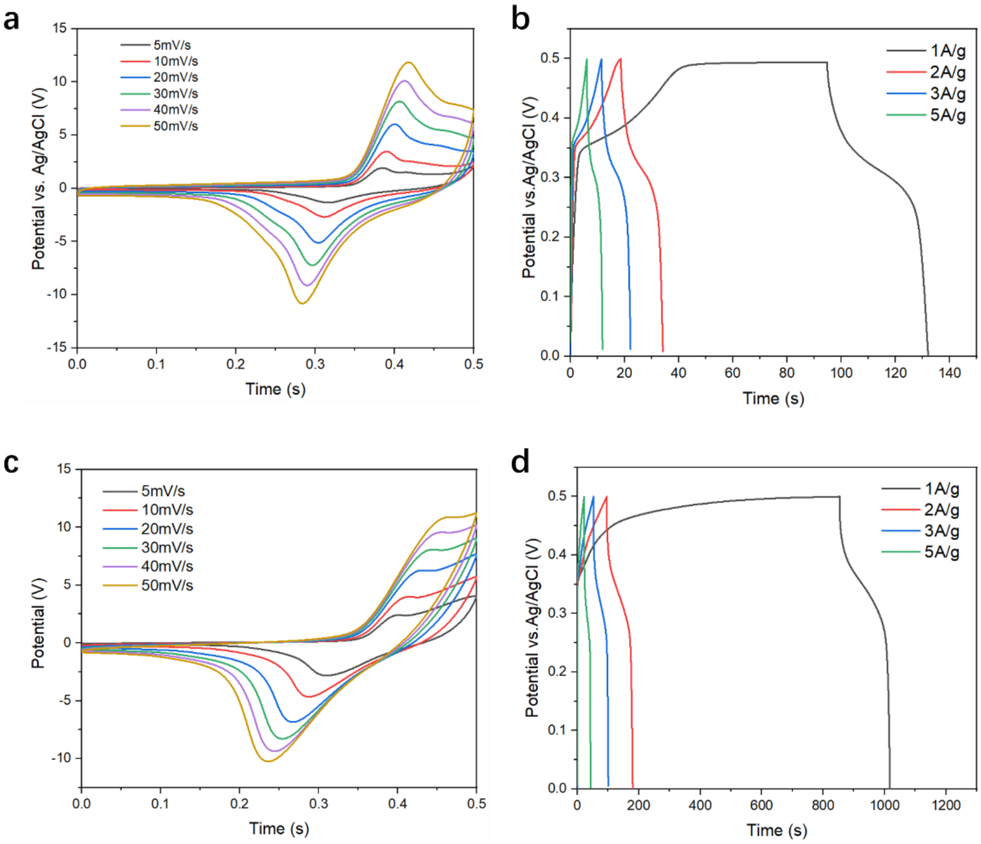

Fig. S5 Electrochemical behavior of 2D ZnO/rGO nanocomposites in 3 electrode test. (a) CV scans of 2D ZnO/rGO (100/1) from 5mV/s to 50mV/s. (b) GCD curves of 2D ZnO/rGO (100/1) from 1A/g to 5A/g, (c) CV curves of ZnO/rGO (10/1) from 5mV/s to 50mV/s. (d) GCD curves of 2D ZnO/rGO (10/1) from 1A/g to 5A/g.

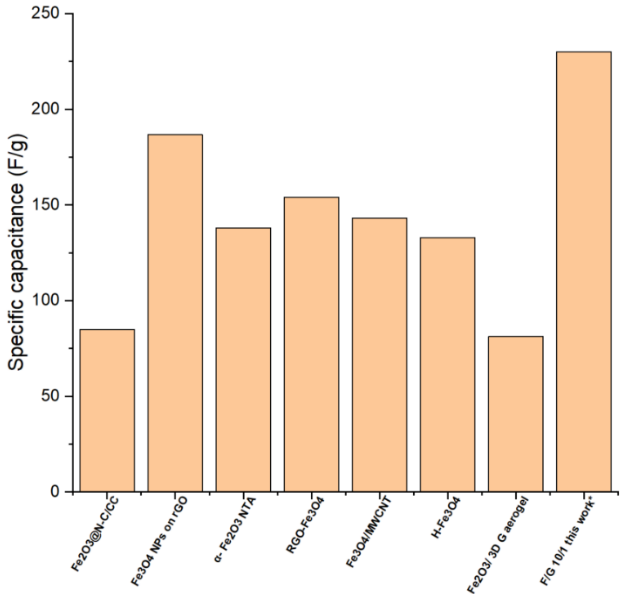

Fig. S6 Specific capacitance of the 2D Fe_2O_3/rGO (10/1) nanocomposite in this study compared with relevant literature results.

Table S1 Comparison of the specific capacitance of 2D Fe2O3/G with other literatures

Materials and structure	Synthetic Method	Specific capacitance	Electrolyte	Reference number
Fe_3O_4 nanoparticle on rGO sheet	Electrophoretic deposition and electrochemical reduction	154 F/g at 1A/g	0.5M Na_2SO_4	70
Iron oxide nanoneedles on N-doped carbon nanoarray	Hydrothermal synthesis	85 F/g at 1A/g 183.8 mF/cm^2 at 3mA/cm^2	1M KOH	72
Fe_3O_4 nanoparticles on rGO	Hydrothermal synthesis	220.1 F/g at 0.5A/g	1M KOH	73
Iron oxide nanotube array	Anodization and annealing	138 F/g at 1.3A/g	1M Li_2SO_4	74
Fe_3O_4 nanoparticles covered MWCNTs	Multi-step chemical synthesis	143 F/g at 1A/g	1M KCl	75
H-Fe_3O_4 nanoparticles	Hydrothermal synthesis and ultrasonication	207.7 F/g at 0.4A/g	1M Na_2SO_3	76
Nano-iron oxide/3D graphene aerogel	Hydrothermal synthesis	81.3 F/g at 1A/g	0.5M Na_2SO_4	77
2D Fe_2O_3/rGO	Solid state microwave synthesis	331.4 F/g at1mV/s 230.1F/g at 1A/g	1M KOH	This work

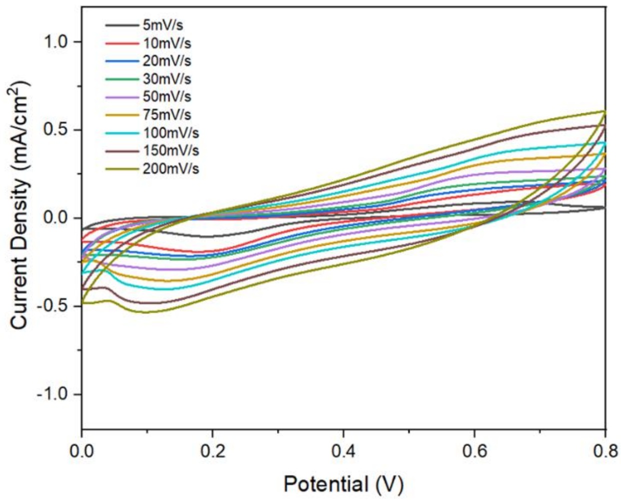

Fig. S7 Cyclic Voltammetry scans of symmetric device fabricated with only 2D Fe_2O_3/G at different scan rate from 5mV/s to 200mV/s.

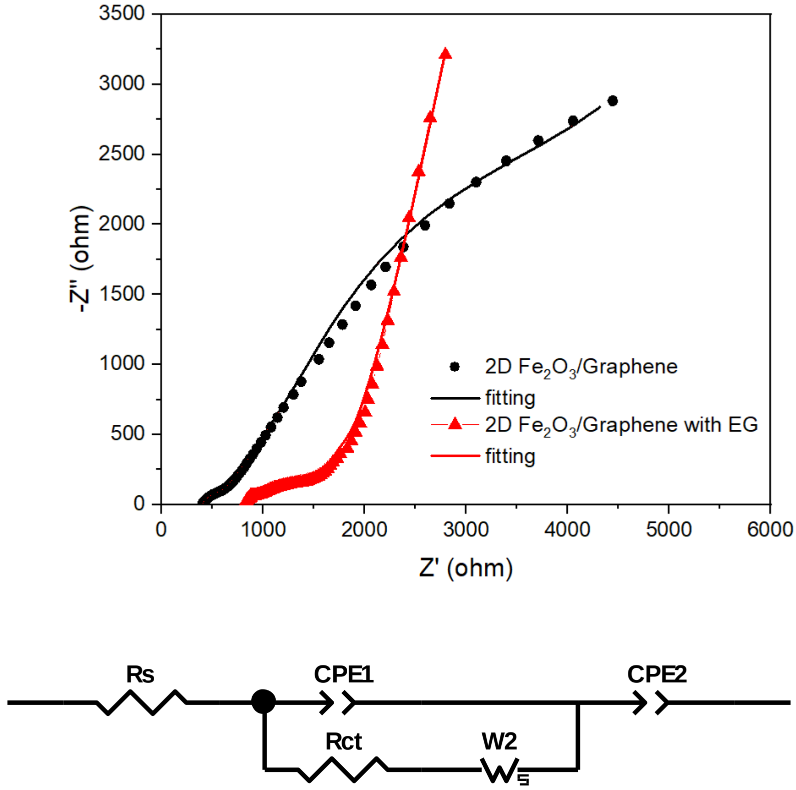

Fig. S8 Nyquist plots and fitting from EIS measurements (top), as well as the equivalent circuit diagram used for data fitting (bottom).

Table S2 EIS data fitting results

	Rs	Rct	W-R	χ square
2D Fe2O3/rGO	384.1	817.5	28017	0.00299
2D Fe2O3/rGO with EG	750.9	1506	428	0.00134

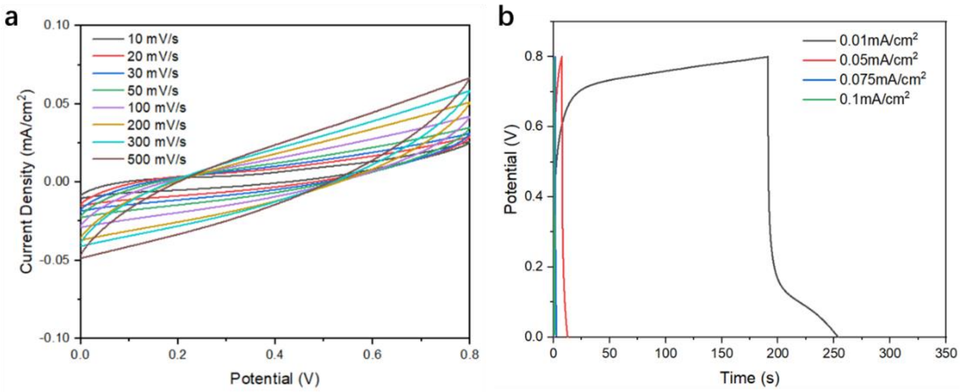

Fig. S9 Electrochemical behavior of symmetric device fabricated by spray coating. (a) CV scans from 10mV/s to 500mV/s. (b) GCD curves from 0.01A/g to 0.1A/g,

Capacitance Calculation

Specific capacitance was calculated from both CV curves and discharge curves in 3 electrode test, using the following equation:

$$Cs = \frac{\int_{V_1}^{V_2} IdV}{mv(V_2 - V_1)} \qquad (1)$$

Where Cs is the gravimetric capacitance, V_1 and V_2 is the lowest limit and highest limit of the potential window, m is the total weight of active materials and ν is the scan rate in CV test.

For GCD result, specific capacitance was calculated following:

$$Cs = \frac{I \int Vdt}{m(\Delta V)^2} \qquad (2)$$

Where I is the constant current during the test, $\int Vdt$ is the integrated area of the discharge curve, m is the total weight, and ΔV is the potential drop over discharging process.

In two electrode test, the specific capacitance of the planar devices were calculated via

$$C_A = \frac{2\int_{V_1}^{V_2} IdV}{Av(V_2 - V_1)} \qquad (3)$$

Where A is the active area of the electrode, the factor two is because the series capacitance formation in 2-electrode system.