Electronic Supplementary Material (ESI) for Nanoscale.

A three-dimensional graphene aerogel containing solvent-free polyaniline fluid for high performance supercapacitors

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1. Experimental Section

1.1 Materials

Aniline and ammonium peroxydisulfate (APS) were purchased from Gelest, Inc. (USA). Nonylphenol polyoxyethylene ether sulphate (NPES, $CH_3(CH_2)_8$-$C_6H_4(OCH_2CH_2)_{10}OCH_2CH_2CH_2SO_3H$) was bought from Sigma-Aldrich Corporation (Saint Louis, USA). Graphite powder was provided by XFNANO Materials Tech Co., Ltd. (325 mesh, purity is more than 99.8 wt%, imported high purity, Nanjing, China).

1.2 Synthesis of GO and self-suspended PANI

GO was prepared by natural graphite powder with a modified Hummers method.[1] S-PANI was obtained according to our previous method.[2] Specifically, 1.86 g aniline and 4.56 g

APS were dissolved in 50 mL acetone containing 7.62 g NPES, respectively. After freezing to 0 °C, the two solutions were mixed rapidly and transferred into a three-necked flask for polymerization under moderate stirring. The temperature of the reaction medium was kept below 5°C using an ice/water mixture around the flask. After 8 h polymerization, the polymer solution was dialyzed to remove the low molecular weight compounds using a cellulose dialysis membrane/bag (8200 molecular weight cut off) by circulating deionized water around the dialysis bag for 72 h. Finally, the PANI doped with long-chain NPES was dried in a vacuum at 150 °C for 8 h.

1.3 Fabrication of RGO/S-PANI Aerogel

Typically, 60 mg GO was dispersed in 15 ml distilled water by sonication for 2 h to obtained a 4 mg/ml GO suspension. Meanwhile, 15 ml S-PANI aqueous solution (4 mg/ml) was prepared by the same way. Then the above GO and S-PANI aqueous solutions were mixed and sonication for 30 min. The mixture was transferred into a 50 ml Teflon-lined stainless-steel autoclave, and treated hydrothermally at 180 °C for 20 h. After naturally cooled to room temperature, the RGO/S-PANI hydrogel was obtained. The as prepared hydrogel was washed several times with distilled water to remove the residues. Subsequently, the washed hydrogel was frozen drying for 48 h to completely remove water. Pure reduced RGO aerogel was prepared with the same procedure for comparison.

1.4 General Characterization

Fourier transform infrared FTIR spectra analysis of the composites was carried out by employing a Nexus IR measurement system (Thermo Nicolet Nexus, USA) using KBr pellets. X-ray photoelectron spectroscopy (XPS) analysis was carried out on an ESCALAB 250Xi Photoelectron spectrometer (Thermo Fisher, USA). HRSEM images were obtained with an S-4800 scanning electron microscope (HITACHI, Japan) at 5 kV Scanning electron microscopy (SEM) images were obtained by JSM-5610LU SEM (Hitachi, Japan). Nitrogen adsorption and desorption were determined by nitrogen physisorption at 77 K on a Micrometritics ASAP 2020M analyzer.

1.5 Electrochemical measurement

All electrochemical measurements were conducted using CHI660E electrochemical workstation (Shanghai Chenhua Co. Ltd., China). The working electrode was prepared by casting a nafion-impregnated sample onto a glassy carbon electrode with a diameter of 3 mm. Typically, 3 mg of the composite was dispersed in 1 ml dimethyl formamide (DMF) solution containing 5 μl of nafion solution (5 wt% in water) by sonication for 30 min. Then 3 μl of the suspension was dropped onto the glassy carbon electrode and dried in an oven before the electrochemical test. Electrochemical performances were carried out in a conventional three-electrode cell in 1 M H_2SO_4 electrolytes at a constant temperature of 20 °C. Platinum foil and saturated calomel electrode were used as the counter and reference electrodes, respectively. The specific capacitance is calculated based on the equation:

$$\mathrm{C} = \mathrm{I}\Delta\mathrm{t}/\mathrm{m}\Delta\mathrm{V} \tag{1}$$

where I, $\Delta\mathrm{t}$, m and $\Delta\mathrm{V}$ are the current density, discharge time, mass of the active material and the voltage change excluding the IR drop during the discharge process, respectively.

2. Figures and Tables

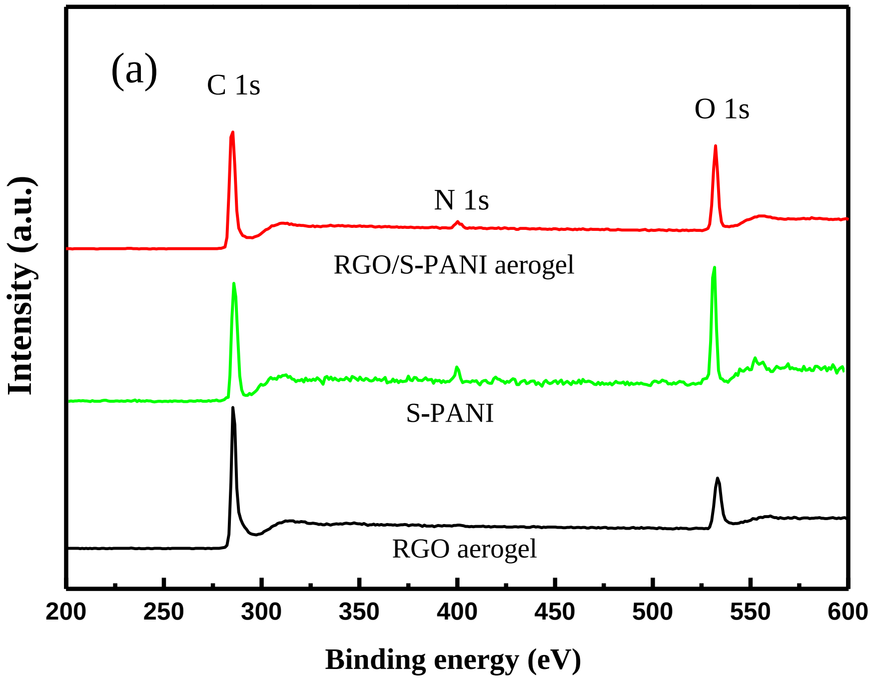

Figure S1Wide scan survey spectrum of RGO and RGO/S-PANI aerogel

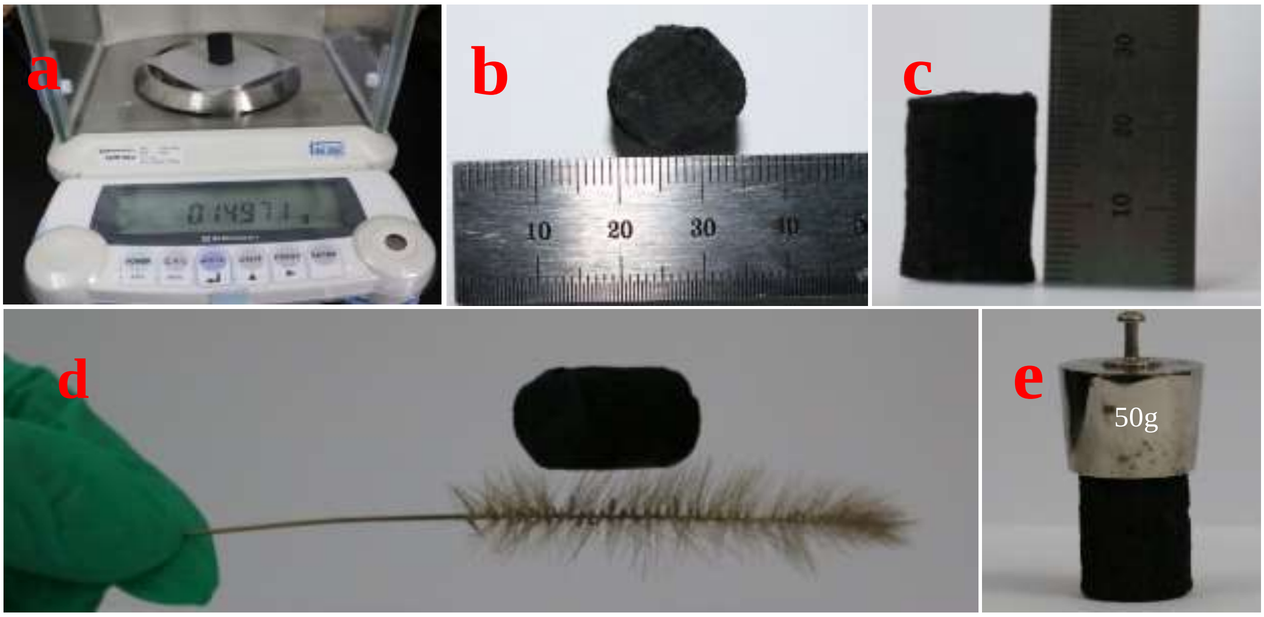

Figure S2 Digital images of RGO/S-PANI aerogel. (a-c) Mass and Size of RGO/S-PANI aerogel. (d) A RGO/S-PANI aerogel standing on a bristle grass. (e) A 4 cm^3 RGO/S-PANI aerogel supporting a weight of 50 g.

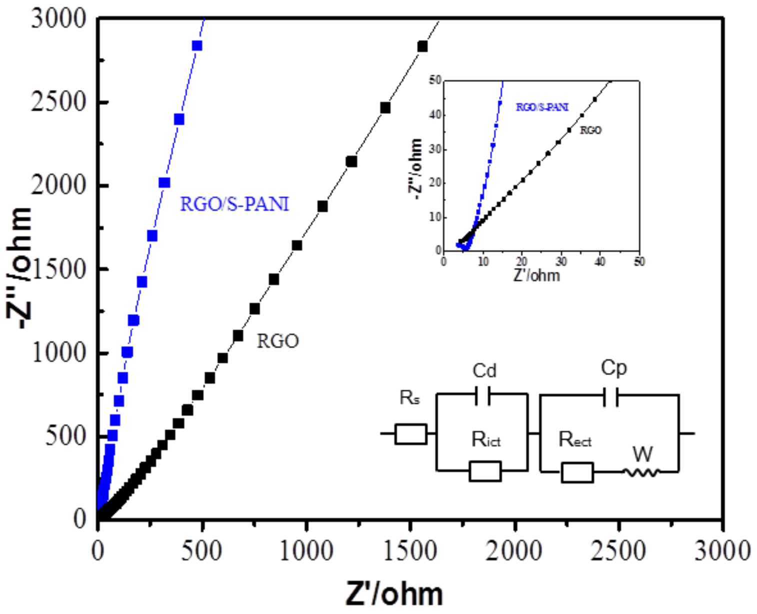

Figure S3 Nyquist plots for RGO and RGO/S-PANI electrodes using a sinusoidal signal of 2.5 mV over the frequency range from 0.01 Hz to 100000 Hz. Z´ and Z″ are referred to the real and imaginary impedances, respectively.

Table S1 The performance of graphene and PANI composites for supercapacitors

Materials on 3D graphene	Synthesis methods	Specific capacitance (F g^{-1})	Stability	Ref.
PANI nanowires	In-suit polymerization	385 at 0.5 A g^{-1}	88% (5000 cycles at 5 A g^{-1})	3
RGO-PANI hollow sphere	Layer-by-layer assembly	380 at 0.5 A g^{-1}	83% (1000 cycles at 0.5 A g^{-1})	4
PANI-PAMPA	In-suit reduce of graphene oxide	223.82 at 0.4 A g^{-1}	87% (5000 cycles at 10 A g^{-1})	5
PANI nanoparticles	In-suit polymerization	438.8 at 0.5 A g^{-1}	76.5% (2000 cycles at 2 A g^{-1})	6
PANI nanowires		520.3 at 0.25A g^{-1} 330.0 at 2 A g^{-1}	500 cycles	7
Solvent-free PANI fluid	Directly self-assembly	480 at 1 A g^{-1} 344 at 40 A g^{-1}	96.1% (10000 cycles at 10 A g^{-1})	This work

3. References

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