

Experimental section and supplementary characterisation data :

A High Throughput Method for Preparation of Highly Conductive Functionalized Graphene and Conductive Polymer Nanocomposites

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Experimental Section

Materials

Natural graphite flakes, 3,4-Dihydroxyphenethylamine hydrochloride (DOPA, 98%), tris(hydroxymethyl)aminomethane (TRIS, 99%) were purchased from Sigma-Aldrich Chem. Co. and used without further purification.

Synthesis of Polydopamine-Coated Graphene Oxide (DGO) and Reduced Polydopamine-Coated Graphene Oxide (RDGO)

GO sheets (1g) synthesized by the modified Hummers's method¹ from natural graphite flakes were suspended in water (0.1~0.5 mg/ml) by sonication. The PH of the suspension was adjusted

to 8.5 by TRIS buffer (10 mM/L). At room temperature, dopamine (2 mg/ml) were added to this suspension and stirred for 4 hours, then the suspension was filtered. The gel like filter cake was then washed by water for several times to get rid of any unreacted dopamine. The wet gel was then dispersed in 2000 ml DMF (0.5 mg/ml calculated based on GO weight) by sonication. Hydrazine (20 ml) were added into this suspension and stirred at room temperature for 24 hrs, and then stirred at 85 °C for 48 hrs. Finally the black solid were filtered by bushel funnel and washed by ethanol and DMF, respectively. The wet solid was then dispersed in DMF by sonication (3hrs) to give a stable stock suspension that contains reduced GO corresponding to 0.8 mg GO per ml.

Preparation of Polyacrylonitrile (PAN)/RDGO Nanocomposites

2g PAN were dissolved in 20 ml DMF. A certain volume of the RDGO/DMF stock solution was mixed with PAN/DMF solution, and then the mixture was concentrated into a viscous solution by rotary evaporation. The viscous solution was casted onto a piece of glass and dried in a vacuum oven at 60 °C to produce PAN/RDGO nanocomposite thin films. The content of graphene in the nanocomposites was calculated according to the initial GO content in the stock solution. For example, if we use 20 ml stock solution (0.8 mg GO per ml stock solution) to mix with 2g PAN, the content of graphene is record as 0.8 wt%. The volume concentration is calculated based on the density of polymer (including PDA and PAN) of about 1.05g/cm³ and the density of graphene of 2.2g/cm³.

Characterization

X-ray photoelectron spectroscopy (XPS) measurements were conducted on a Kratos Analytical AXIS His spectrometer with a monochromatized Al Ka X-ray source (1486.6 eV photons). Wide-angle X-ray diffraction (WAXD) patterns were recorded on a Bruker GADDS X-ray diffractometer using Cu K α radiation generated at 40 kV and 40 mA. For atomic force microscopic (AFM) studies, the GO, DGO and RDGO suspensions were spin-coated onto a silica wafer and dried at room temperature. Tapping mode AFM images were obtained at ambient conditions using a Dimension 3100 AFM (Digital Instruments) with Si tips. The field-emission scanning electron microscopic (FE-SEM) images of the materials were obtained on a JEOL 7600F SEM. Thermo-gravimetric analysis (TGA) was conducted using a TA Q500 TGA

at a heating rate of 10 °C/min (for GO, the heating rate is 1 °C/min) from 100 to 800°C in N₂; prior to the heating, the samples were isothermal at 100 °C for 1 h to remove trace amount of water. Raman spectra were recorded with a WITec CRM200 confocal Raman microscopy system at an excitation wavelength of 488 nm and an air-cooling charge-coupled device (CCD) as the detector (WITec Instruments Corp, Germany). The electrical conductivity of DGO and RDGO paper were measured by a Hewlett Packard 4140B pA Meter/DC Voltage source. The I-V curves were measured at ambient condition, over a range of 3 to -3V with a step of -0.1V across the pair of Au electrodes with a channel length of 100 μm. The electrical conductivity of the PAN/RDGO nanocomposites with low resistance were measured by a MCP-T610 low resistivity meter (Mitsubishi Chemical Analytech) with a standard four point probe, the electrical conductivity of the PAN/RDGO nanocomposites with high resistance were measured by a MCP-HT450 high resistivity meter (Mitsubishi Chemical Analytech).

Reference

1. W. S. Hummers, R. E. Offeman, *J. Am. Chem. Soc.*, 1958, **80**, 1339.

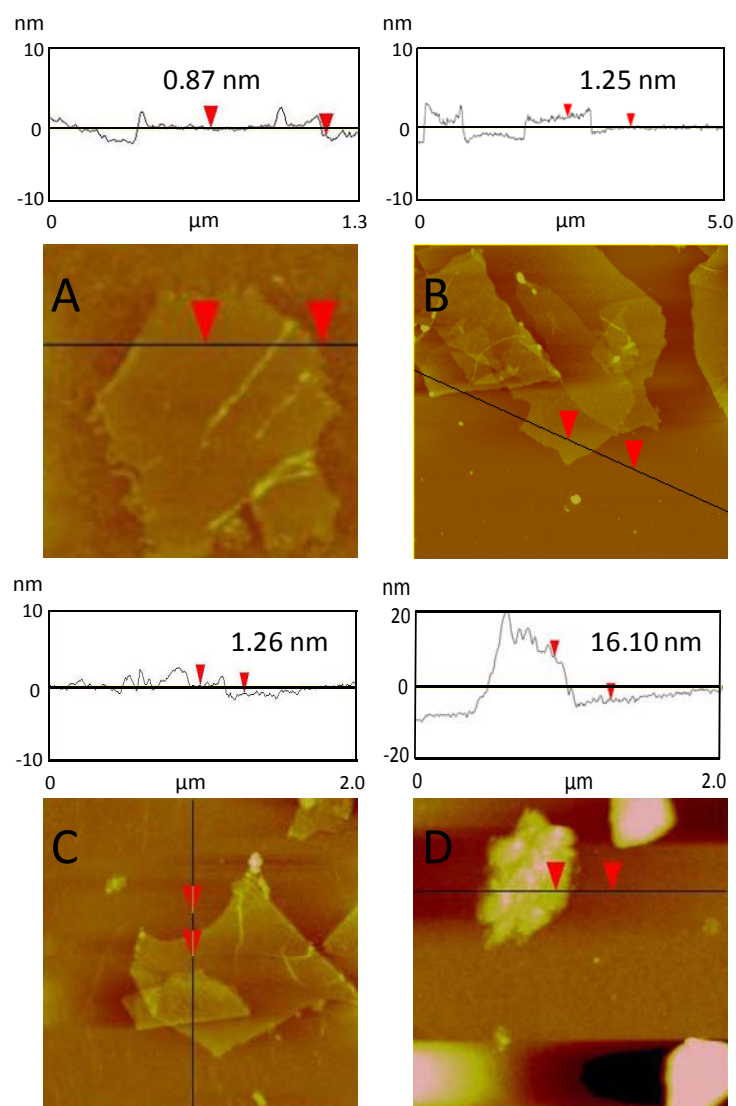


Fig. S1 Atomic Force Microscopic (AFM) height images of GO, DGO and RDGO. A: GO; B: DGO; C: RDGO; D: DGO with 48 hours dopamine polymerization time.

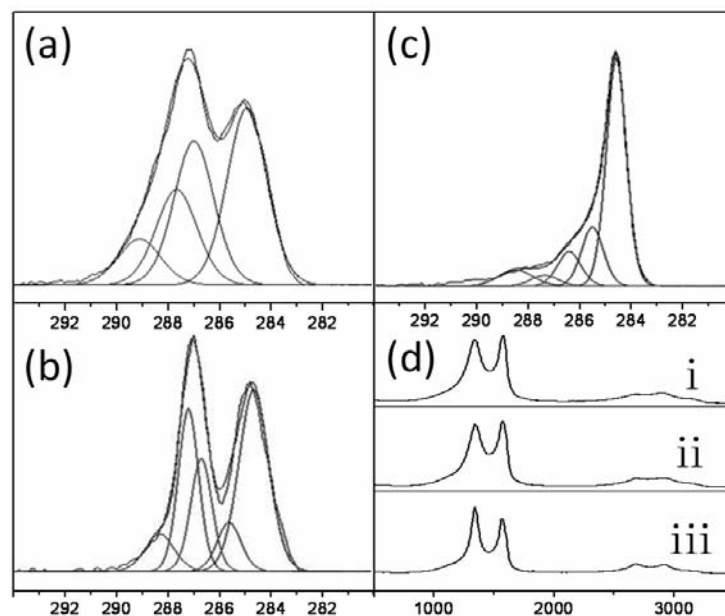


Fig. S2 X-ray photoelectron spectroscopy (XPS) C1s spectra of (a) GO; (b) DGO; (c) RDGO. (d) Raman spectra of (i) GO, (ii) DGO, and (iii) RDGO.

Table S1 Contents of different carbon-containing species in GO, DGO and RDGO estimated from XPS analysis

	C-C	C-O	C=O	O-C=O	C-N
GO	37.7	30.8	21.1	10.5	-
DGO	40.6	17.9	24.7	8.1	8.8
RDGO	60.6	10.9	4.0	7.3	17.2

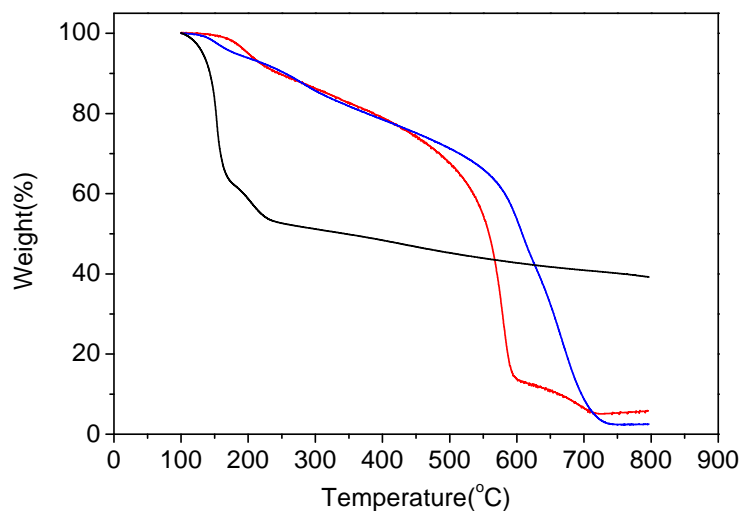


Fig. S3 Thermo-gravimetric analysis (TGA) of GO (black), DGO (red), and RDGO (blue) sheets. Heating rate: 10 °C/min (for GO, the heating rate is 1 °C/min).



Fig. S4 Photograph of the RDGO dispersion in: (A) DMF, (B) DMSO, (C) formic acid, (D) THF, (E) acetone, (F) ethanol, (G) 3% ammonium hydroxide solution, and (H) toluene.

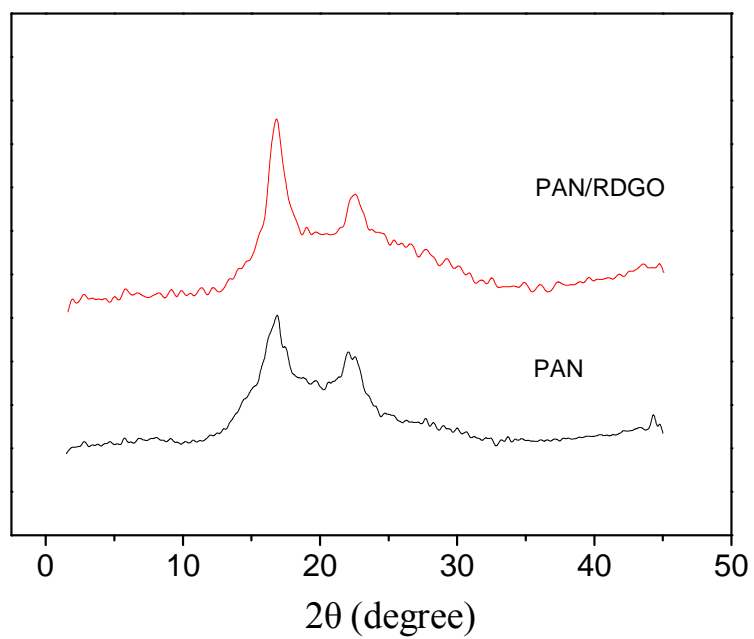


Fig.S5 Wide-angle X-ray diffraction (WAXD) patterns of PAN and the PAN/RDGO nanocomposite with 2.75 vol% RDGO.