Electronic Supplementary Information

Enhanced mechanical properties and thermal stability of PSMA by functionalized graphene nanosheets

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Experimental

Materials

Graphite powders (99.99995%, 100 mesh) was purchased from Alfa Aesar. 3-aminopropyltriethoxysilane was purchased from Liyang Mingtian Chemical Engineering Corporation. H_2O_2 (30 %) and N, N-dimethylformamide (DMF) were analytically pure and obtained from Sinopharm Chemical Reagent Co, Ltd. P_2O_5, $K_2S_2O_8$, $KMnO_4$, H_2SO_4, hydrazine hydrate were analytically pure and obtained from Nanjing Chemical Reagent Co., Ltd. PSMA (XIRAN SZ 26080, M_w = 80000) with a concentration of maleic anhydride 26 mol%, was supplied by Shanghai Zhaocheng Scientific Development Corporation. All these reagents were used as received.

Preparation of RGO

RGO was prepared via chemical reduction methods referring to Stankovich.[19] In general, GO was firstly prepared by modified Hummers method.[20] As-prepared GO was purified by the washing with deionized water and centrifuged for 3 times, and then re-dispersed in deionized water by ultrasonication. The GO suspension was frozen dry to obtain the GO powders. Then 0.1 g of GO powders was dispersed in 200 mL of DMF via ultrasonication for 0.5 h. 0.2 g of hydrazine hydrate was added into the dispersion to reduce GO at 90 ^oC for 24 h. The reaction mixture was filtrated and washed by DMF for several times to remove the unreacted hydrazine hydrate. The

final product was dispersed in DMF by ultrasonication and the concentration of the suspension was measured.

Functionalized RGO with APTS

In this work, we found that the dispersion stability of RGO in DMF could be greatly improved by the functionalization of ATPS. For modification by APTS, 0.1 g of GO powders was dispersed in 200 mL DMF by ultrasonication for 0.5 h. 0.2 g of APTS was added in the GO dispersion and the mixture was stirred at 80 ^{o}C for 10 h to get the APTS-grafted-GO. After the reaction, the resultant was filtrated and washed by DMF for several times to remove the unreacted APTS. Brown powders (APTS-grafted-GO) was obtained after washing and dispersed in 200 mL of DMF by ultrasonication for 30 min. Then, 0.2 g of hydrazine hydrate was added into the dispersion to reduce APTS-grafted-GO at 90 ^{o}C for 24 h. The reaction mixture was filtrated and washed by DMF for several times and APTS-RGO was obtained. The product was also dispersed in DMF by ultrasonication and the concentration of the dispersion was measured.

Preparation of PSMA/graphene nanocomposites

To prepare the PSMA/APTS-RGO composites, the APTS-RGO dispersion with a calculated volume was first diluted by DMF. The total volume of the diluted APTS-RGO dispersion was 40 ml. 4 g of PSMA was added in the dispersion. The mixture was stirred for 12 h then transferred into a glass plate to remove the solvent under 100 ^{o}C for 6 h. The samples were finally dried under vacuum at 180 ^{o}C for 10 h.

Characterization methods

The Fourier transform infrared spectra (FTIR) were recorded on a NICOLET NEXUS 870 spectrophotometer to characterize and confirm the chemical structure of GO, RGO and APTS-RGO.

X-ray photoelectron spectroscopy (XPS) (VG Microtech 2000 ESCA) was carried out on a monochromatized Al Kα X-ray source (1486.6 eV).

Thermogravimetric analyses (TGA) were performed by using a Perkin-Elmer TGA-7 thermo gravimetric analyzer under nitrogen flow at a heating rate of 20 ^{o}C/min.

Transmission electron microscopy (TEM) was employed to study the morphologies of the RGO and APTS-RGO by JEM-2100, and the samples were prepared after a 30 min ultrasonic treatment in DMF. The fracture surfaces of neat PSMA and PSMA/APTS-RGO were examined by using a scanning electron microscopy (SEM, Hitachi S-4800).

The dynamic mechanical tests were carried out on a dynamic mechanical analyzer (DMA) (Rheometric Scientific IV) from 70 ^{o}C to 220 ^{o}C under a nitrogen atmosphere, at a heating rate of 2 ^{o}C/min and frequency of 1 Hz. The samples for test were 20mm in length, 5mm in width and 1mm in thickness.

Rheology measurements were performed on HAAKE Rheo-Stress 600 rheometer over a wide temperature, 180 °C ≤ T ≤ 220 °C, using a set of 20 mm diameter parallel plates with a sample thickness of ca. 0.7 mm.

Results and discussion

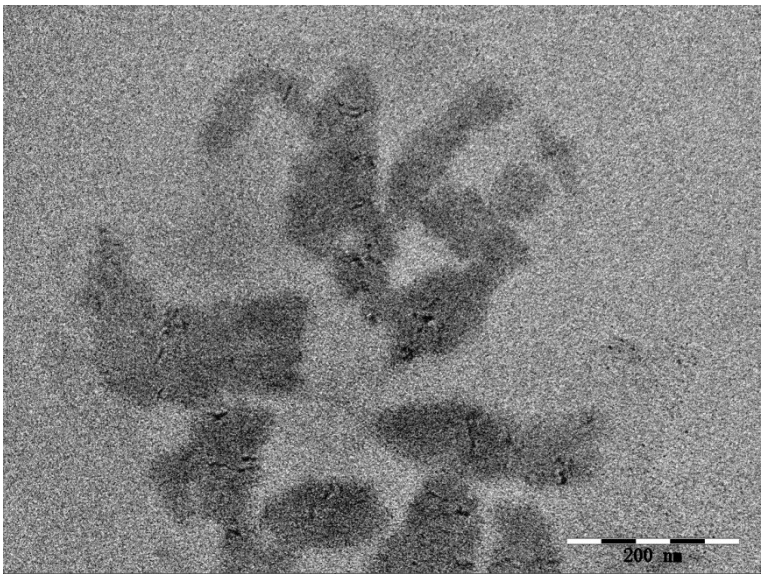

Fig. S1. TEM image of PSMA/APTS-RGO nanocomposites