Supplementary Information

Efficient Coating of Polystyrene Microspheres with Graphene Nanosheets

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Materials

Styrene (AR) obtained from Shanghai Chemical Reagent Co., was purified by distillation under reduced pressure. Azodiisobutyronitrile (AIBN) of chemical reagent grade (Shanghai Chemical Reagent Co.) was purified by recrystallization in 95% ethanol. Poly(vinylpyrrolidone) with an average molar mass of 58 kg/mol (PVP K-30) was purchased from Acros Organics. Graphite with an average size of 30 μm and a purity of > 95% was obtained from Shanghai Chemical Reagent Co. $KMnO_4$, hydrazine hydrate, concentrated sulfuric acid, hydrogen peroxide, hydrochloric acid, absolute ethanol, 95% ethanol, and 2-propanol were purchased from Nanjing Chemical Reagent Co. and used as received. Deionized water (18.2 MΩ·cm) was prepared in a Sartorius Arium 611 system and used throughout the experiment (unless otherwise specified).

Synthesis of Polystyrene (PS) Microspheres

PS microspheres were prepared by dispersion polymerization. For the preparation of the PS microspheres with an average diameter of 2.8 μm, the PVP stabilizer (2.5 g) was dissolved in 2-propanol (160 mL) in a four-necked round-bottom flask and heated to 70 °C. It was purged with nitrogen to eliminate the inhibiting effect of oxygen. A solution of AIBN initiator (0.2 g) predissolved in styrene monomer (20 g) was added to the reaction vessel, with vigorous mechanical stirring. The polymerization was allowed to proceed for 24 h before cooling to ambient temperature. Subsequently, the PS microspheres were transferred from 2-propanol to deionized water by repeated centrifugation and redispersion process, and finally diluted with deionized water to 10 wt% solid content before use.

Preparation of Graphite Oxide Nanosheets (GONSs)

Graphite oxide nanosheets were synthesized via oxidation of grahite (Modified Hummers method), followed by exfoliation of graphite oxide by ultrasonic treatment. Concentrated H_2SO_4 (23 mL), graphite (0.5 g), and $NaNO_3$ (0.5 g) were added into the 250 mL three-necked round flask and stirred in an ice bath at 0 °C. $KMnO_4$ (3 g) was added slowly in order to keep the temperature of the mixture below 20 °C. After the addition of $KMnO_4$, the mixture solution was heated up to 35 °C, which was maintained for 120 min. Then, deionized water (40 mL) was added gradually, and the resultant mixture solution was maintained below 100 °C for 15 min. The reaction was terminated by the addition of a large amount of deionized water (100 mL) and 30% H_2O_2 solution (3 mL), after which the color of the mixture changed to bright yellow. Subsequently, the mixture was filtered and washed with 5% HCl aqueous solution and deionized water. The graphite oxide powder was obtained by drying. Finally, the suspension of graphite oxide nanosheets was prepared by ultrasonic treatment of graphite oxide suspension, containing 50 mg graphite oxide powder and 50 mL deionized water, for 45 min.

Preparation of PS/GNSs Nanocomposite Particles

As a typical synthetic process, PS emulsion (5 g) was added to deionized water (45 mL), and the dispersion was heated up to 80 °C under mechanical stirring. Then, the suspension of graphite oxide nanosheets (5 mL) was added, followed by the addition of hydrazine hydrate (0.1 mL). The above mixture was allowed to reaction for 24 h before cooling to ambient temperature. The resultant PS/GNSs nanocomposite particles were purified by repeated centrifugation and redispersion cycles, washing three times with ethanol and deionized water, respectively. Finally, the nanocomposite particles were redispersed in deionized water.

Characterization

The morphology of PS microspheres and the resultant nanocomposite particles were observed by scanning electron microscope (SEM) using an S-4800 instrument (Hitachi Co., Japan). All the samples were sputter coated with carbon prior to examination by SEM. Raman spectra were measured by use of MultiRam spectrometer (Bruker Co., Germany). Thermogravimetric analysis (TGA) was conducted with a Pyris 1 TGA instrument (PerkinElmer Co., USA) at a heating rate of 20 °C per min in N_2 from room temperature to 700 °C. X-ray photoelectron spectroscopy (XPS) analyses were carried out on a PHI5000 VersaProbe photoelectron spectrometer (ULVAC-PHI Co, Japan).

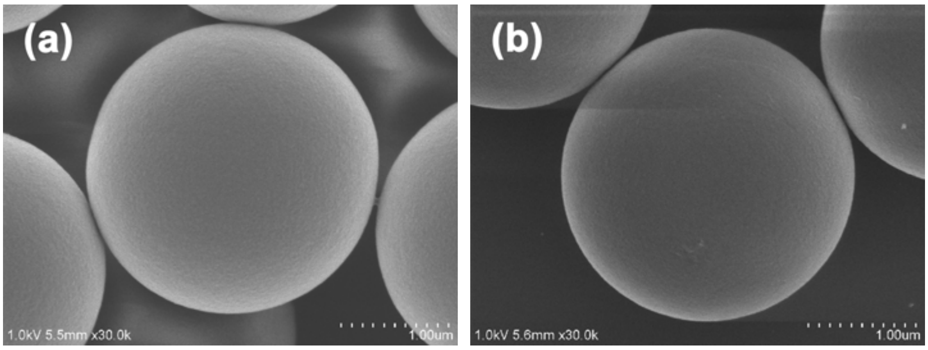

Figure S1. SEM images of PS particles (a) and PS/GNSs nanocomposite particles prepared by using weight ratio of graphite oxide/PS of 1:200 (b).

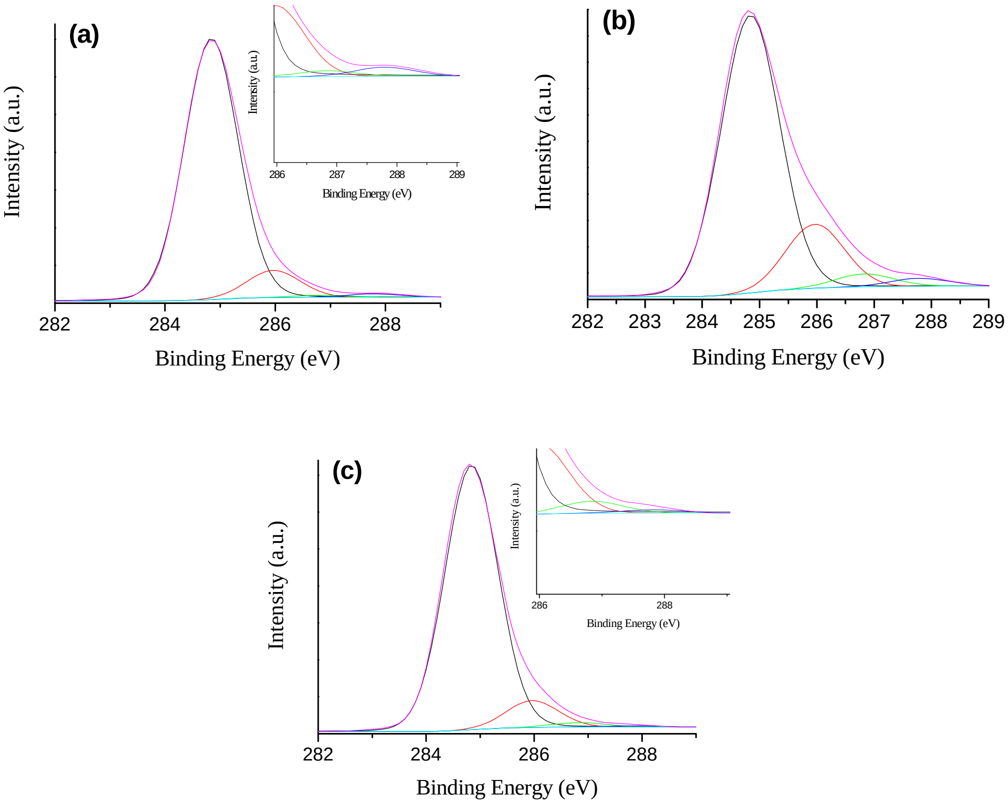

Figure S2. The C1s XPS spectra of PS/GNSs nanocomposite particles prepared by using different weight ratio of graphite oxide/PS of 1:200 (a), 1:100 (b), and 1:50 (c). The inserted graphics in Figure S2a and S2c have been locally enlarged, respectively.