Preparation of reduced graphene oxide decorated with high density Ag nanorods for non-enzymatic hydrogen peroxide detection

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Experimental section

Materials

NaH_2PO_4, $KMnO_4$, Na_2HPO_4, NaCl, H_2O_2 (30 wt%), ethylene glycol (EG), $NaNO_3$, H_2SO_4 and poly-(vinylpyrrolidone) (PVP, $M_w = 90000$) were purchased from Beijing Chemical works (Beijing, China). $AgNO_3$ was obtained from Shanghai Chemical Corp. (Shanghai, China). Graphite powder was purchased from Aladin Ltd. (Shanghai, China). All chemicals were used without any further purification. The water used throughout all experiments was purified through a Millipore system. Phosphate buffer saline (PBS) was prepared by mixing stock solutions of NaH_2PO_4 and Na_2HPO_4 and a fresh solution of H_2O_2 was prepared daily.

Characterizations

UV-Visible (UV-Vis) spectrum was obtained on a UV5800 Spectrophotometer. X-ray photoelectron spectroscopy (XPS) analysis was measured on an ESCALAB MK II X-ray photoelectron spectrometer using Mg as the exciting source. Powder X-ray diffraction (XRD) datum was recorded on a RigakuD/MAX 2550 diffractometer with Cu-Kα radiation (λ=1.5418 Å). Raman spectra were obtained on J-Y T64000 Raman spectrometer with 514.5 nm wavelength incident laser light. Infrared (IR) spectra were recorded with a Bruker 66 V FT-IR spectrometer. The morphology of the samples was observed by field emission scanning electron microscopy (FE-SEM) on a JSM-6700F electron microscope (JEOL, Japan). Transmission electron microscopy (TEM) measurement was made on a HITACHI H-8100 electron microscopy (Hitachi, Tokyo, Japan) with an accelerating voltage of 200 kV. Electrochemical measurements are performed with a CHI 660D electrochemical analyzer (CH Instruments, Inc., Shanghai). A conventional three-electrode cell was used, including a glassy carbon electrode (GCE, geometric area = 0.07 cm^2) as the working electrode, a Ag/AgCl (saturated KCl) electrode as the reference electrode, and platinum foil as the counter electrode. The potentials are measured with a Ag/AgCl electrode as the reference electrode. All the experiments were carried out at room temperature.

Preparation of GO

GO was prepared through a modified Hummers method with graphite powder. 1 g of graphite was added into 23 mL of 98 % H_2SO_4, then the mixture was under stirring at room temperature for 24 h. After that, 100 mg of $NaNO_3$ was introduced into the mixture and stirred for 30 min. Subsequently, the mixture was kept below 5 ºC by ice bath, and 3 g of $KMnO_4$ was slowly added into the mixture. After being heated to 35-40 ºC, the mixture was stirred for another 30 min. After that, 46 mL of water was added into above mixture during 25 min. Finally, 140 mL of water and 10 mL of 30 % H_2O_2 were added into the mixture to stop the reaction. After the unexploited graphite in the resulting mixture was removed by centrifugation, as-synthesized GO was dispersed into individual sheets in distilled water at a concentration of 0.5 mg/mL with the aid of ultrasound for further use.

Calculation of content of AgNRs in AgNRs-rGO hybrids in thermal gravimetric analysis

The weight loss from room temperature to 200 ºC is about 4.07 %, which is attributed to the vaporization of functional groups containing H_2O adsorbed to the hybrids. The weight of the sample decreases within the temperature ranging from 200 to 400 ºC is about 3.81 %, which is associated with the removal of oxygen containing functional groups, and it stands for the process of GO being reduced to rGO. It can be seen that the content of AgNRs in AgNRs-rGO hybrids is about 92.48 %.

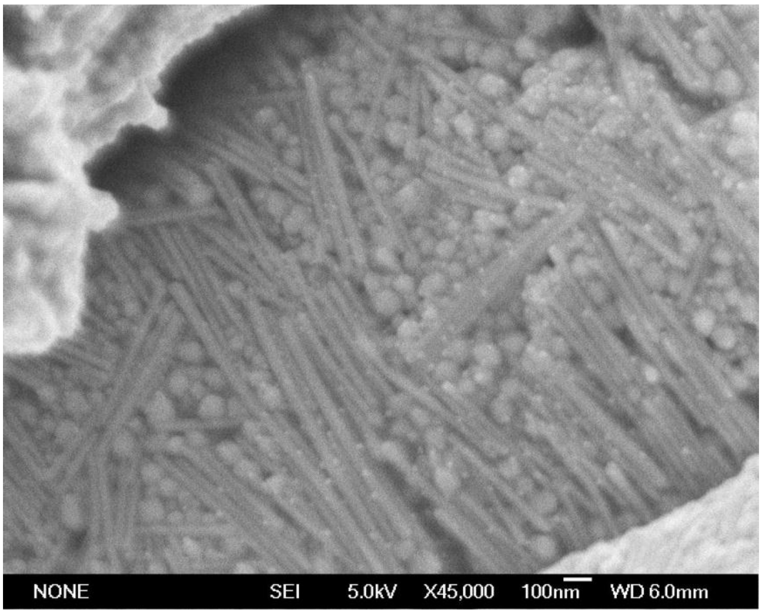

Fig.S1 SEM image of AgNRs.

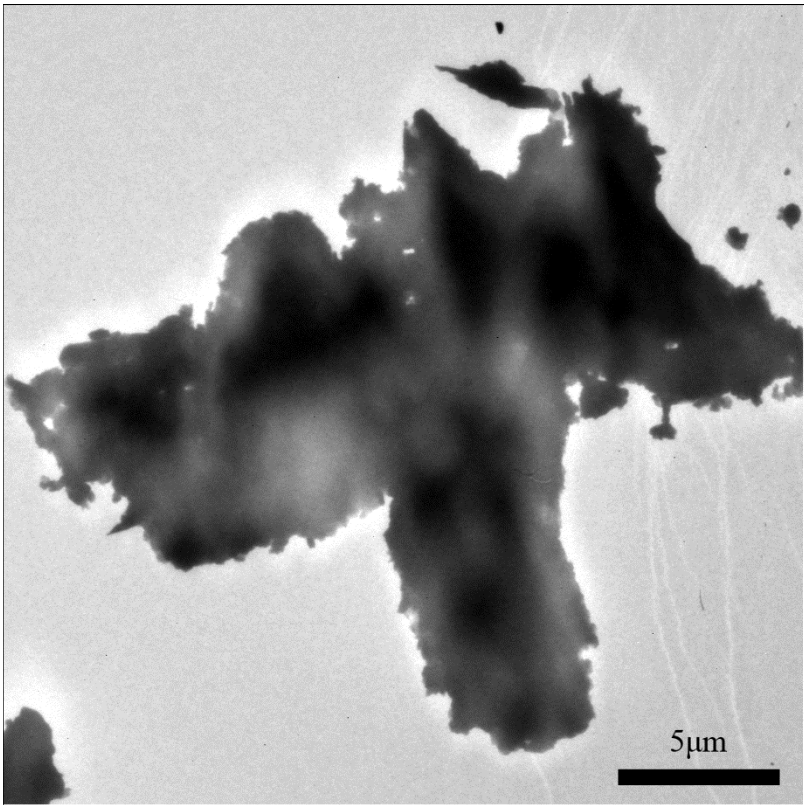

Fig. S2 TEM image of AgNRs-rGO hybrids.

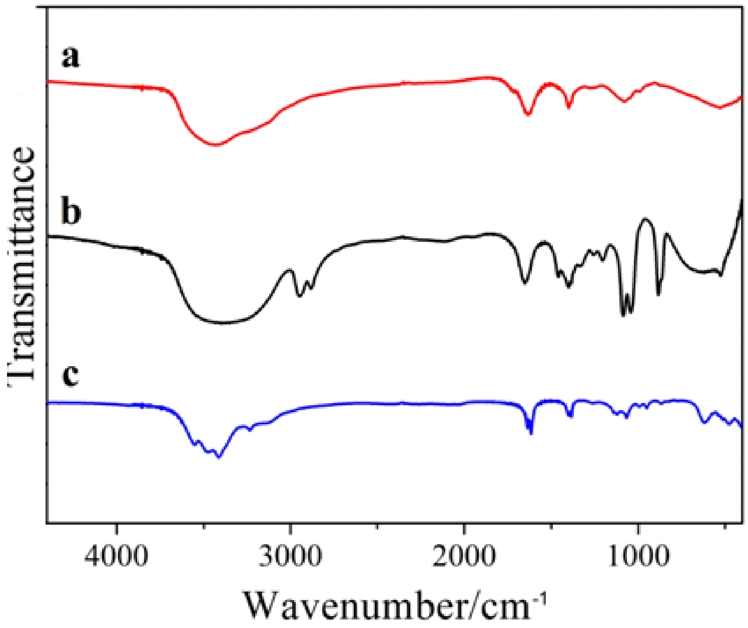

Fig. S3 FTIR spectra of (a) GO, (b) rGO, and (c) AgNRs-rGO hybrids.

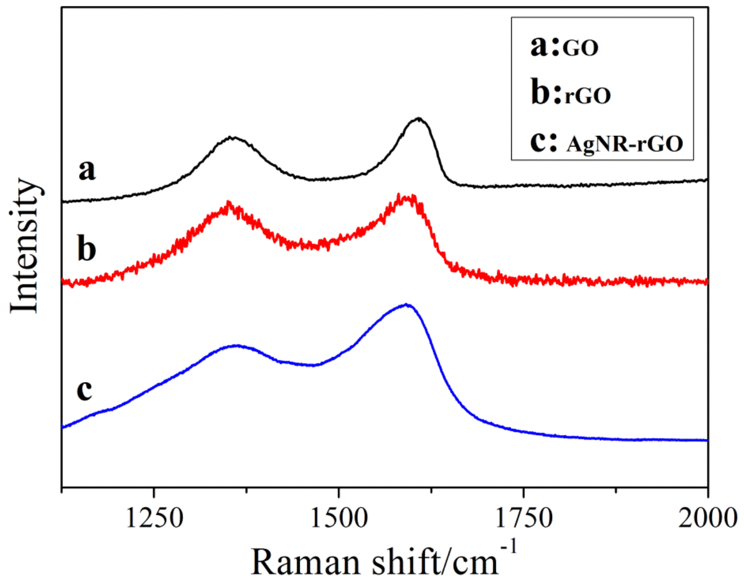

Fig. S4 Raman spectra of (a) GO, (b) rGO, and (c) AgNRs-rGO hybrids.

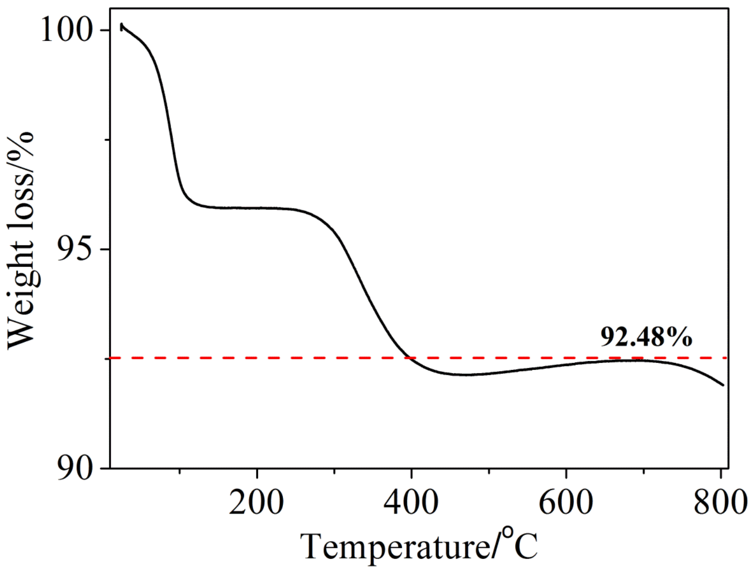

Fig. S5 TG curve of AgNRs-rGO hybrids.