Electroless Deposition of Silver Nanoparticles on Graphene Oxide surface and Its Applications for Hydrogen Peroxide Detection

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Metal-graphene hybrid materials have received much attention due to their applications in fuel cells, batteries, and chemical or biosensors. Gaphene decorated with metal nanoparticles exhibits special electrical, thermal, mechanical, optical, and catalytic properties. The typical approaches to synthesize metal-graphene nanocomposites include the utilizing electrochemical, chemical vapor deposition, thermal and chemical reduction. Herein, a new process to decorate GO with silver nanoparticles was developed through the electroless deposition technique. This process was performed by treated GO with a series of metal solutions, initially with Sn^{2+}, then with Ag^{+}. And finally, Ag nanoparticles were deposited on GO surfaces (Ag-NPs/GO) (Figure 1).

As expected, both Sn^{2+}-GO and Ag-NPs/GO exhibited good solubility in aqueous solution, the color of Sn/GO is black color and Ag-NPs/GO solution exhibits little bite yellow color. The binding of Sn^{2+} on GO surface is through the electrostatic force between $–COO^{-}$, $–O^{-}$ and Sn^{2+}. And the small size of Ag-NPs on GO surface does not change the suspension properties of GO, so the introduction of Ag-NPs does not affect its hydrophilic properties of GO surface. And thus both Sn/GO and Ag-NPs/GO suspension exhibit a very state property.

From Uv-Vis spectra, a strong adsorption peak at 402 nm assigned to Ag-NPs/GO is observed, suggesting the formation of Ag-NPs onto GO surface. And the wavelength of 402 nm refers to about 10 nm of Ag-NPs. These data confirm that the particle size of GO is about 10 nm.

It is well known that the Ag-NPs exhibit high catalytic activity for reduction of H_2O_2, and then the cyclic voltammetery of H_2O_2 on Ag-NPs/GO electrode was then investigated. It is well known that GC had no reduction towards the redution of the reduction of H_2O_2 is pretty weak. Figure 2 shows the results of cyclic voltammetry of various concentrations of H_2O_2 at Ag-NPs-GO/GC electrode. The cyclic voltammogram demonstrates that the reduction peaks for H_2O_2 results a linear relation between the peak currents versus the concentrations. These observations indicate that the Ag-NP/GO exhibits catalytic ability for H_2O_2 reduction.

Figure 3 depicts a typical current–time plot of the Ag-NPs/GO/GC in N_2-saturated 0.1 M PBS buffer on successive step change of H_2O_2 concentrations. When H_2O_2 was added into PBS solution, the response of Ag-NPs/GO/GC to H_2O_2 reaches a stable value rapidly. At the applied potential of −0.40 V, the reduction currents of H_2O_2 increased dramatically and achieved 95% of the steady state current within 10s, indicating a fast amperometric response behavior and proved that the Ag-NPs/GO exhibit notable catalytic ability for H_2O_2 reduction. Its potential applications for the detection of hydrogen peroxide were tested, with a linear range from 10 μM to 20 mM, and the detection limit was estimated to be 0.5 μM.

In conclusions, electroless deposition technique can provide a convenient and efficient method of metal nanoparticle deposited onto GO surface. This process was successful in producing Ag-NPs deposited on GO surface. The Ag-NPS/GO was of particular interest due to its capability of being utilized as a H_2O_2 sensor. Overall, this study provides an initiation point for further examination of the various metal deposited Go nanocomposites as excellent modules for potential sensor systems, produced in a fast, convenient, and cost effective manner.

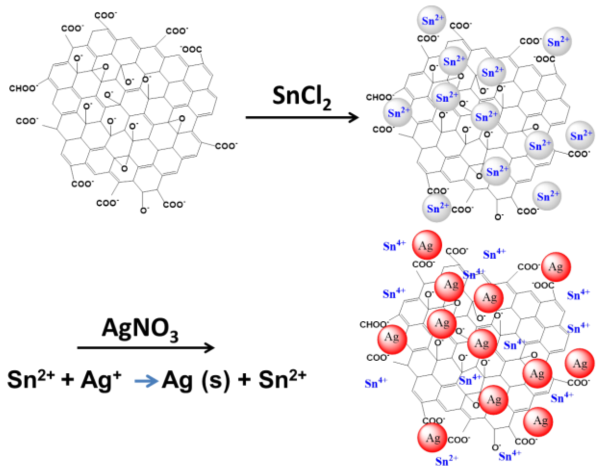
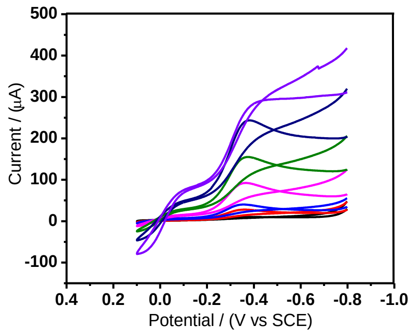


Figure 1 Schematic illustration for the electroless deposition process of Ag-NPs/GO



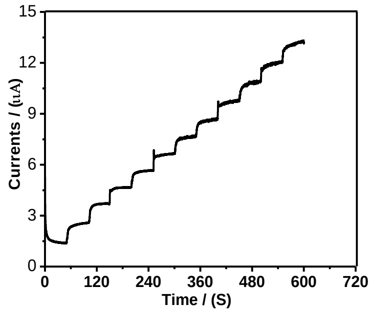


Figure 2 Cyclic Voltammograms of Ag-NPs/GC electrodes towards H_2O_2 solution with various concentrations.

Figure 3 The current–time curve of the Ag-NPs/GO/GC on successive step change of H_2O_2 concentrations.

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Figures

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