Simple and Fast Route for Hybrid Graphene Oxide/Noble Metal Functional Materials

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The development of two-dimensional (2D) hybrid nanomaterials is a topic of intense and growing interest for extending and improving their applications. The high surface area, specific physicochemical properties and structure make 2D nanomaterials excellent platforms for the development of hybrid structures with multiple properties. For example, the combination of graphene with noble metal nanoparticles can largely extend its catalytic and optoelectronic properties (1). Here, we developed a new strategy to improve the functionalization of graphene oxide, their stability in suspension, and modification with platinum nanoparticles. Graphene oxide (GO) was synthesized from graphite powder using a modified Hummers' method. A dicationic alkoxysilane molecule was synthesized by a reaction between 4',4'-bipirydine and (3-Iodopropyl)trimethoxy-silane. The resulting alkoxysilane was then used to functionalize the GO nanosheets (GO-Bipy) by both covalent and electrostatic interactions. By ion-exchange reactions, $PtCl_6^{2-}$ ions were adsorbed on the surface of GO-Bipy and subsequently converted into Pt nanoparticles by chemical reduction with $NaBH_4$. In a control experiment, GO was also functionalized with 1,1′-Dimethyl-4,4′-bipyridinium dichloride (viologen) (GO-Viol), where only electrostatic interactions keep the molecules attached to the surface. The resulting hybrid nanocomposites were characterized by SEM, TEM, XPS, Raman and Fourier Transform Infrared (FTIR) spectroscopies. The results revealed the success of the surface modification as well as the efficient synthesis of the supported Pt nanoparticles on the Bipy functionalized material, as can be seen in Figure 1A. Finally, the catalytic activity of the developed hybrid material was evaluated toward the hydrogen evolution reaction (HER). Thin films of the samples were transferred to ITO electrodes and thermally treated at 150°C for 12 h. Figure 1B presents the hydrogen evolution curves for all the synthesized materials and clearly shows the potential of the developed method for the *in situ* synthesis of electrocatalysts based on noble metal nanostructures. Additionally, the presence of the cationic alkoxysilane molecules attached on the surface has shown to be indispensable for the efficient functionalization of the graphene oxide surface and the *in situ* synthesis of supported noble metal nanostructures.

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References

[1] X. Li, J. Zhu, B. Wei, Chem Soc Rev, 45 (2016) 3145

Figures

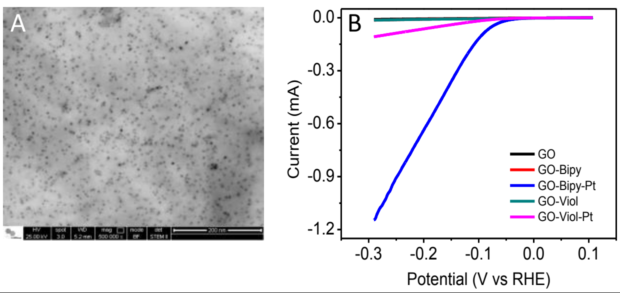

Figure 1: (A) Transmission Electron Microscopy of GO-Bipy-Pt NPs, and (B) HER measurements of the synthesized hybrid materials.