PLATINUM-GRAPHENE NANOCOMPOSITES WITH HIGH ELECTROCHEMICAL ACTIVITY FOR POLYMER ELECTROLYTE MEMBRANE FUEL CELL

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Abstract

Platinum-based nanomaterials supported on carbon (e.g. Pt/C) are commonly utilized electrocatalyst in polymer membrane electrolyte fuel cell (PEMFC). Carbon supports are effective in the maximizing the performance and utilization of precious catalyst metal. Such support materials not only maximizing the availability of nanosized electrocatalytst surface area for electron transfer but also should provide better mass transport of reactants to the electrocatalyst. In addition, the conductive support facilitates efficient collection and transfer of electrons to the collecting electrode surface. Carbon black is one the carbon based material has been extensively used as the catalyst support for PEM fuel cells. However commercially available carbon black has obstacles, as it can easily be oxidized which leads to Pt nanoparticle sintering or detaching from the support materials.

Graphene, one-atom thick planar sheet of hexagonally arrayed sp^2 carbon atoms, has attracted tremendous scientific attention in recent years. This two-dimensional material exhibits excellent physical and chemical properties which makes it promising for fuel cells.

In this study graphene is exfoliated from bulk graphite using chemical oxidation method that is convenient to exfoliate graphene sheets via solution based processes. It introduces functional surface groups such as carboxyl, carbonyl, hydroxyl, and epoxy. The presence of these functional groups makes the individual graphene oxide (GO) sheets suspendable in both polar and nonpolar solvents but drastically decreases the conductivity as a result of loss in the conjugated sp^2 network. The functional surface groups of GO can be used as the expedient anchoring sides for metal nanoparticles while preventing restacking and aggregation to form graphite during the chemical reduction to graphene. Moreover, one form of the graphene is graphene nanoplatelets (GNP) that is produced by exfoliating the intercalated graphite is also used for comparison with GO support.

Our study opens an insightful way to compare chemical reduction agents that are mostly used in literature (such as $NaBH_4$, ethylene glycol, ascorbic acid) onto the GNP, GO and thermally reduced GO (TRGO) as support material yet according to our knowledge there is no study that shows which graphene support is better for metal nanoparticles decorations. Additionally, different platinum precursors (such as K_2PtCl_4, H_2PtCl_6) are compared according to the best impregnation method.

The resultant platinum-graphene nanocomposites are characterized with X-ray diffraction (XRD), high resolution-transmission electron microscopy (HR-TEM), Renishaw inVia Raman Spectrometer, electrochemical cyclic voltammetry (CV) with Gamry Instruments Reference 3000 Potentiostat Galvanostat.

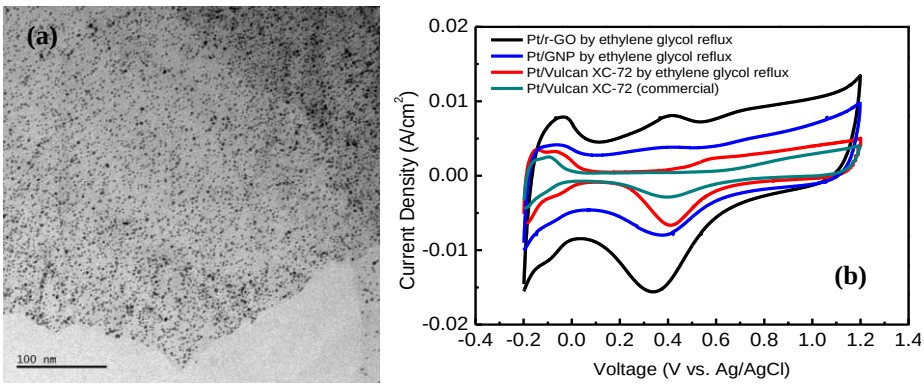

Figure : a) TEM images **b)** Cyclic voltammograms of r-GO/Pt Ethylene glycol reduced with H_2PtCl_6 precursor