

## Electrocatalytic Activity of Graphene-supported Pt-Cu Catalysts Prepared by an Impregnation Method for Ethanol Oxidation

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Compared with traditional energy, direct ethanol fuel cells (DEFCs) have some apparent advantages such as low reaction temperature (<100°C), easy storage and transportation of fuel, high energy efficiency, and little pollution to the environment. Therefore, DEFCs are considered to be one of the ideal renewable energy resources with a promising prospect for commercial applications. Despite these advantages, there are still some critical obstacles inhibiting broad applications of DEFCs. The performance of fuel cells largely depends on anode and cathode reactions, which are substantially affected by the activity of expensive noble Pt catalysts. Consequently, different Pt-based bimetallic and trimetallic catalysts have been extensively investigated to replace pure Pt catalysts [1], and novel carbon materials have been explored as catalyst supports to effectively disperse catalyst particles [2]. In this study, graphene-supported Pt/Cu and Pt nanoparticles were synthesized by an impregnation method followed by a heat treatment in H<sub>2</sub> atmosphere, and their electrocatalytic activities were measured for ethanol oxidation.

For the synthesis of graphene-supported Pt [3], one mg of H<sub>2</sub>PtCl<sub>6</sub>·xH<sub>2</sub>O was mixed with 20 mg of graphene, which was dispersed in 10 μl of acetone solution, and ultra-sonicated for 30 min. The resulting slurry was dried in a convection oven at 100 °C for 10 h to allow the evaporation of acetone. The mixture was then treated with 4% H<sub>2</sub> in Ar gas at 250 °C for 3 h. For the synthesis of graphene-supported Pt/Cu, the only difference was to add 0.33 mg of CuCl<sub>2</sub> to the solution of graphene and Pt precursor.

Electrocatalytic activities of graphene-supported Pt (Pt/G) and Pt/Cu (PtCu/G) nanoparticles for ethanol oxidation were measured in a conventional three electrode cell using a CHI 670D electrochemical work station [4]. Pt wire served as a counter electrode, Ag/AgCl as a reference electrode, and glassy carbon (3 mm in diameter) coated with nanoparticles as a working electrode. All electrolyte solutions were deaerated under flowing nitrogen gas for 20 min. Electrocatalytic ethanol oxidation was conducted in 1 M CH<sub>3</sub>CH<sub>2</sub>OH + 0.5 M H<sub>2</sub>SO<sub>4</sub> electrolyte by cyclic voltammetry between -0.3 V and 1.0 V, and impedance measurements at 0.3 V.

Electrocatalytic efficiencies of Pt/G and PtCu/G catalysts are compared with regard to oxidation potential and forward oxidation peak current density. The magnitude of the forward peak current density is directly proportional to the amount of ethanol oxidized at the electrode. As shown in Fig. 1a, in comparison to Pt/G catalyst, PtCu/G catalyst exhibits much higher oxidation current density. This suggests that PtCu/G is better than Pt/G in the activity for ethanol oxidation. At the same time, as shown in Fig. 1(b), it was obvious that the diameter of the semicircle for PtCu/G catalysts is smaller than the diameter for Pt/G catalysts. Therefore, PtCu/G

can provide low charge transfer resistance and thereby enhance the electrocatalytic activity for ethanol oxidations.

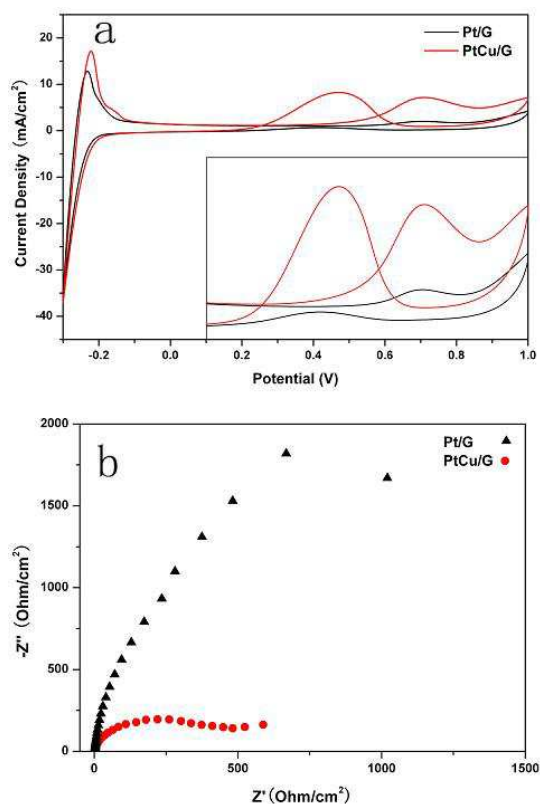


Fig.1. Electrocatalytic activity of Pt/G and PtCu/G for ethanol oxidations: (a) Cyclic voltammograms of catalysts in 1 M CH<sub>3</sub>CH<sub>2</sub>OH/0.5 M H<sub>2</sub>SO<sub>4</sub> at 50 mV/s between -0.3 V and +1.0 V versus Ag/AgCl, and (b) impedance plots of those catalysts at 0.3 V.

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