Electrochemistry investigation of three different carbon black support for PtSnNiGa/C electrocatalyst for DEFC application

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Abstract

This paper present physicochemical and electrochemical investigations of electrocatalysts with nominal composition of $Pt_{50}Sn_{20}Ni_{25}Ga_5/C$ supported on Vulcan XC72, Printex-L6 carbons and a carbon produced through natural gas pyrolysis on Argon plasma (Black Plasma).

Introduction

Different types of carbon materials such as carbon black, carbon nanotubes, nanofibers, graphene sheets have been used as support for Pt-based electrocatalyst for *polymer electrolyte fuel cells*, especially the DEFC's [1]. These materials may present greater efficiency of ethanol electrooxidation reaction (EOR), which takes place at the fuel cell anode. The carbonaceous materials usually have high surface area, which contribute to the electrocatalyst nanoparticles dispersion, and high conductivity.

In this paper, electrocatalysts with $Pt_{50}Sn_{20}Ni_{25}Ga_5/C$ nominal composition supported on carbon Vulcan XC72, Printex -L6 and Black Plasma were produced through thermal decomposition of polymeric precursor method. The electrochemical measurements were carried out using a graphite electrode with 0,16cm^2 of geometric area as work electrode, a graphite electrode with 4cm^2 of geometric area as counter electrode and a $[Ag/AgCl]_{sat}$ electrode as reference electrode. The electrochemical tests were performed using a H_2SO_4 0.5M solution as support electrolyte (SE).

Results

The cyclic voltammetry were performed in SE in absence and presence of ethanol 1.0M are presented in Figure 1A and Figure 1B, respectively. The chronoamperometry of ethanol oxidation results (Figure 1C) indicates that $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{XC72}$ has larger stable current density regarding $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{L6}$ and $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{Plasma}$. The stability test (Figure 1D) indicates that the $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{XC72}$ and $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{L6}$ was more stable than $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{Plasma}$. The EIS data (Figure 2) suggest that the $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{XC72}$ has lower charge transfer resistance comparing to $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{L6}$ and $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{Plasma}$, leading a higher rate for EOR.

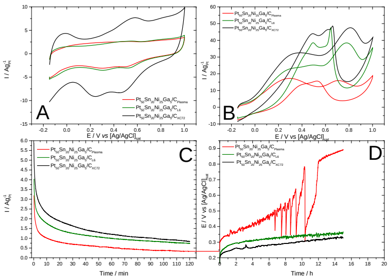

Figure 1: (A) cyclic voltammetry in SE (B) cyclic voltammetry in ethanol 1.0M + SE (C) chronoamperometry in ethanol 1.0M in SE (D) chronopotenciometry in ethanol 1.0M in SE

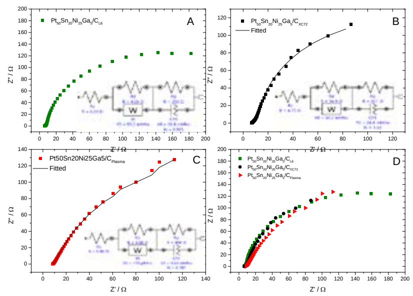

Figure 2: Nyquist Plot for (A) $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{L6}$ (B) $Pt_{50}Sn_{20}Ni_{25}Ga_5/C_{XC72}$ (C) $Pt_{50}Sn_{20}Ni_{25}Ga_5/CP_{lasma}$ (D) electrocatalysts.

Conclusions

The electrochemical analysis suggest that the Vulcan XC72 is the best support material for PtSnNiGa/C electrocatalysts, comparing to Printex L6 and Black Plasma carbons.

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[1]Santos Evangelista, T. C.; Paganoto, G. T.; Cesar, M.; Guimarães, C.; Ribeiro, J. *J. Spectrosc.* **2015**, 1–7.