11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

PtCo/C electrocatalysts preparation and characterization: reduction with $NaBH_4$

F. A. M. Loureiro(1), G. Solórzano(2), A. M. Rocco(1) *

(1) Grupo de Materiais Condutores e Energia, Escola de Química, Universidade Federal do Rio de Janeiro, e-mail: amrocco@eq.ufrj.br.
(2) DCMM, Pontifícia Universidade Católica do Rio de Janeiro, e-mail: guilsol@puc-rio.br

Abstract – PtCo/C electrocatalysts in different atomic ratios were prepared by the impregnation method. All the samples were characterized structurally by XRD, electrochemically by cyclic voltammetry in H_2SO_4 and H_2SO_4/CH_3OH aqueous solutions, chronoamperommetry and morphologically by TEM. All the catalysts showed electroactivity for hydrogen and methanol oxidation and the averaged size particles was about 3.6 nm. Chronoamperommetry studies show the higher performance for Pt_3Co_1/C with j_{eq} =3,74 mA/cm^{-2}, after 15 minutes.

Bimetallic nanoparticle catalysts for PEMFC usually include a primary metal (Pt), which presents a high performance for hydrogen or methanol electro-oxidation and a secondary metal, which can improve the catalytic activity or prevent CO primary metal poisoning. Generally, the metals synergistic effects improve the catalytic activities for the electrochemical reactions [1, 2]. Most of the literature reports regarding bimetallic electrocatalysts are related to PtRu, however, combinations of Pt with other metals like Co, Ni and Fe has also been reported.

In the present work, bimetallic electrocatalysts were prepared through the impregnation method with the atomic ratios Pt:Co/C 3:1, 1:1, 1:3 and 1:5, keeping the Pt mass ratio of 10 % of the Vulcan XC 72R carbon support mass. In the impregnation procedure, aqueous solution of Pt and Co metallic salts and carbon Vulcan XC 72-R dispersion were used, followed by a reduction of the metallic ions with a $NaBH_4$ concentrated aqueous solution. All the samples were characterized by XRD (Figure 1) and electrochemical measurements by cyclic voltammetry to determine the electrochemical surface area (ESA), Figure 2. The electroactivity values for the hydrogen and methanol oxidation and chronoamperommetry were studied. All the samples showed diffraction peaks near 2θ = 39.7, 46.2, 67.7 e 81.2º relative to the (111), (200), (220) and (311) diffraction planes of Pt fcc structure, but all peaks shift to 2θ higher values, indicating the formation of bimetallic alloys. The chronoamperommetry characterization showed the electrocatalyst stability for the methanol oxidation. Morphological studies by TEM showed narrow particles average size distribution, and the smallest average size particles calculated by the Scherrer's equation was 3.6 nm. The electrochemical analysis indicated that the sample Pt_3Co_1/C presented the best performance for hydrogen electro-oxidation in acid media with ESA = 33 m^2/g, higher than the commercial catalyst Pt/C (23m^2/g), which was analyzed at the same experimental conditions. The CO tolerance was similar for all samples studied in the present work. The chronoamperommetry studies showed the higher performance of Pt_3Co_1/C with j_{eq} =3.74 mA/cm^{-2}, after 15 minutes. Despite increasing Co concentration generally leads to activity decrease, the electrocatalysts studied in the present work exhibit a higher electroactivity compared with commercial Pt/C catalyst with the same Pt mass. The experimental conditions for the preparation of the catalysts are currently under modification aiming to improve the properties of the electrocatalysts.

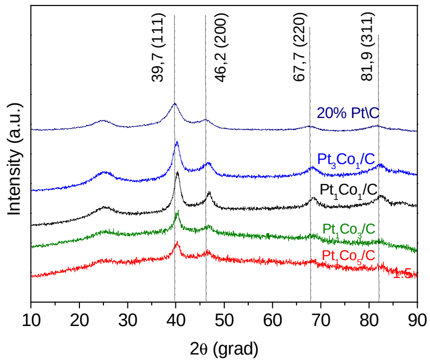

Figure 1. XRD patterns of the sample series PtCo/C studied and commercial catalyst 10% Pt/C used for comparison.

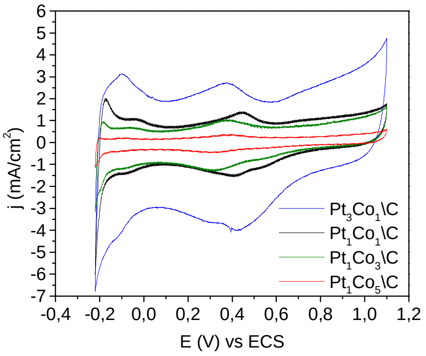

Figure 2. Cyclic Voltammetry (20° cycle) using rotating disc electrode for the sample series PtCo/C. H_2SO_4 0,5 M (aq), scan rate 50 mV/s vs ECS.

References

[1] K.-Y. Chan; J. Ding, J. Ren; S. Cheng.; K. Y. J. Tsang, Journal Material Chemistry. 14 (2004) 505.

[2] E.Casado-Rivera, D.J. Volpe, C. Lind, C. Downie, T. Vazquez-Alvarez, A.C. Angelo, F. J. DiSalvo, H. D. Abruna, Journal American. Chemistry. Society. 126 (2004) 4043.

FAPERJ, CNPq e UFRJ/CENPES