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Pt/ZSM-5/C electrocatalysts for PEMFC

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Abstract – In the present work, Pt nanoparticle-based electrocatalysts dispersed on ZMS-5/carbon nanocomposite are obtained and characterized by X-ray diffraction (XRD) and cyclic voltammetry (CV). FCC crystalline Pt structure was obtained, as indicated by the diffraction peaks and platinum-cobalt alloys wee obtained in PtCo/ZSM-5/C samples. The Pt_3Co_1/ZSM-5/C sample (containing 15 wt% Pt) showed higher hydrogen oxidation activity than Pt_3Co_1/C samples, reduced by $NaBH_4$.

The PEMFC cost is highly influenced by the use of platinum as electrocatalyst, which limits the large scale commercialization of such energy conversion devices. Among other features, total or partial platinum replacement in PEMFC electrocatalysts is pointed as a viable solution, aiming to employ other metals and different catalyst support for Pt or Pt bimetallic nanoparticles. The use of inorganic solids with large surface area such as zeolites may allow high nanoparticle dispersions and the use of a smaller amount of platinum in the electrocatalyst composition. The aim of the present work is to obtain and characterize a Pt nanoparticle-based electrocatalyst disperse on ZMS-5 zeolite/carbon nanocomposite by a method adapted from Pang and co-workers [1] using $NaBH_4$ as reducing agent. Pt-based electrocatalysts were also obtained using a reduction method mediated by ethylene glycol [2].

The ZSM-5 powder was dispersed in double-distilled water and submitted at ultrasonic treatment, after washing and drying. The zeolite particles were mixed with H_2PtCl_6 and H_2PtCl_6/$Co(NO_3)_2.6H_2O$ aqueous solution and reduction of metallic ions was performed in sodium borohydride until the solution color changes from yellow to black. The dispersions were submitted to ultrasonic treatment for 30 min. After this period, functionalized Vulcan XC was added into the solutions, which were maintained under ultrasound for 3 h to obtain Pt/ZSM-5/C and PtCo/ZSM-5/C catalysts. In order to obtain Pt/ZSM-5/C by the ethylene glycol reduction method, H_2PtCl_6 solution in ethylene glycol (15 wt% Pt) was added to the zeolite/carbon (1:1 mass ratio) dispersion and the system was kept under reflux during 6 h, filtered and the solid dried under vacuum. Samples with different Pt and PtCo ratios were characterized by X-ray diffraction (XRD) and by cyclic voltammetry (CV) in H_2SO_4 aqueous solution. A dispersion containing the catalyst and Nafion® solution was prepared and deposited onto the graphite base electrode. The Pt/ZSM-5/C prepared by both methods exhibited diffraction peaks at 2θ = 39.7, 46.2, 67.7 e 81.2º relative to the (111), (200), (220) and (311) diffraction planes of Pt fcc structure. PtCo/ZSM-5/C samples exhibited diffraction peaks shifted to higher 2θ values, indicating the formation of bimetallic PtCo alloys.

Figures 1 and 2 depict the cyclic voltammetry curves for Pt-based electrocatalysts in acid media. The electrochemical analyses indicated a similar performance of sample Pt/ZSM-5/C reduced by ethylene glycol compared to other Pt/C catalysts for hydrogen electro-oxidation containing similar platinum concentrations. The Pt_3Co_1/ZSM-5/C sample (containing 15 wt% Pt) showed higher hydrogen oxidation activity than Pt_3Co_1/C samples, reduced by $NaBH_4$.

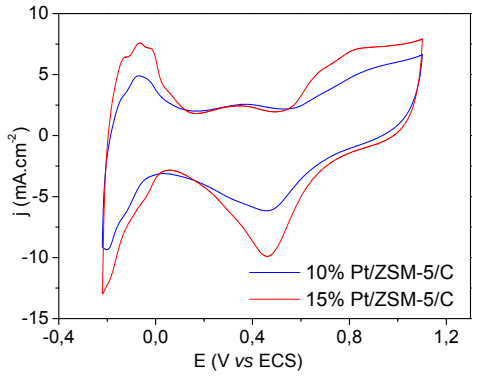

Figure 1. Cyclic Voltammetry (20° cycle) using rotating disc electrode (0,0707 cm^2) for the samples 10 and 15 % Pt/ZSM5/C. H_2SO_4 0,5 M (aq), scan rate 50 mV/s vs ECS.

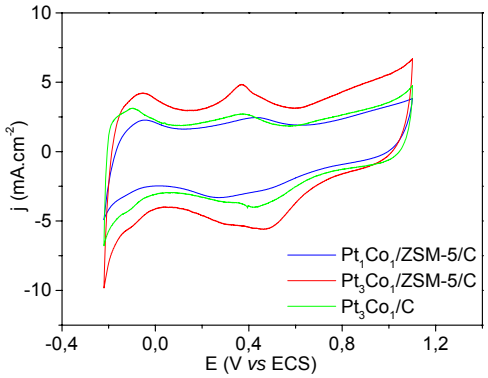

Figure 2. Cyclic Voltammetry (20° cycle) using rotating disc electrode (0,0707 cm^2) for the samples PtCo/ZSM5/C. H_2SO_4 0,5 M (aq), scan rate 50 mV/s vs ECS

References

[1] H. Pang, J. Chen, L. Yang, B.Liu, X. Zhong, X. Wei, J Solid State Electrochem. 12 (2008) 237.
[2] A. M. Rocco, C. A. da Silva, M. I. F. Macedo, L. F. Maestro, M. H. Herbst, G. Solórzano, A. L. Xavier, J Mater Sci. 43 (2008) 557.

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