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

Ordered intermetallic compounds: a multi-purpose electroactive anode material for fuel cell

M. R. Silva and A. C. D. Ângelo*

Grupo de Eletrocatálise e Reações Superficiais, UNESP, Bauru, SP, CEP 17033360- Brazil.
* Corresponding author, e-mail: acangelo@fc.unesp.br

Abstract – Fuel cells technology have emerged as an alternative way of generating and transporting electricity. Pt-M/C ordered intermetallic nanoparticles have been presented as very promissory materials for PEM fuel cell. These materials were prepared by the polyol procedure. X-ray powder diffraction confirmed the intermetallic identities as hexagonal structures (P63/mmc). TEM images showed that PtSn is highly dispersed and distributed homogeneously over the support and that PtSb and PtPb were, aggregated into small clusters. The EDX analysis confirmed the aimed stoichiometry (1:1). Eteady state polarization curves show that the intermetallics nanoparticles catalyzed alcohol oxidation reactions more actively than Pt/C.

In recent years, the energy question has been the focus of research for a large section of the scientific community, which has lavished a great deal of effort on the search for novel alternatives to the overburdened conventional ways of generating and transporting electrical energy. At this juncture, fuel cells have emerged as an alternative devices of generating and transporting electricity. Ordered intermetallics Platinum electrocatalysts have been recently proposed as very efficient electrocatalysts materials for reactions involved in low temperature fuel cells [1]. This class of compounds presents the synergetic effect of suitable adsorption properties and inhibition of poisoning effect provided by Pt and transition metals sites, respectively. In spite of the great deal of reliable and valuable scientific information resulted from such methodological approach, the bulk material configuration is still far from the actual use in a fuel cell [2]. In order to overcome such technological constraint some efforts have been dedicated to obtain ordered intermetallic nanoparticles of Pt based electrocatalysts [3]. This work describes the synthesis, characterization and electrocatalytic study of the ordered intermetallic Pt-M (M = Sn, Sb, Pb) supported on carbon nanoparticles, for a possible application as anode in PEM fuel cell. The intermetallics electrocatalysts nanoparticles were prepared at a low temperature by the polyol process, in which ethylene glycol was used as solvent and reducing agent and Vulcan Carbon XC72 as support. X-ray powder diffraction technique unequivocally confirmed the intermetallic identities as well crystalline structure, hexagonal (P63/mmc) for both materials. TEM images show that the metal particles in PtSn is highly dispersed and distributed homogeneously over the Vulcan carbon support. TEM images of PtSb and PtPb showed that only in some regions was this intermetallic phase homogeneously distributed. Most of these particles were aggregated into small clusters. Quantitative EDX analysis indicated that the adapted polyol process employed to produce these supported intermetallic particles led to a material of satisfactory stoichiometry (1:1). The electrocatalytic activity (Figure 1), investigated by polarization curves in stationary state, showed that the intermetallics particles catalyzed methanol, ethanol and ethylene glycol oxidation reactions more actively than the Pt/C catalyst prepared by the same method. PtSn/C electrode was by far the best electrocatalyst with a high maximum oxidation current density and, on the other hand, PtSb/C and PtPb/C electrodes showed onset potential less positive than the Pt/C. In general, it was concluded that this study gave valuable insights into the method used to make the ordered intermetallic nanoparticles, and demonstrated the excellent electrocatalytic activity of these materials in comparison to Pt/C.

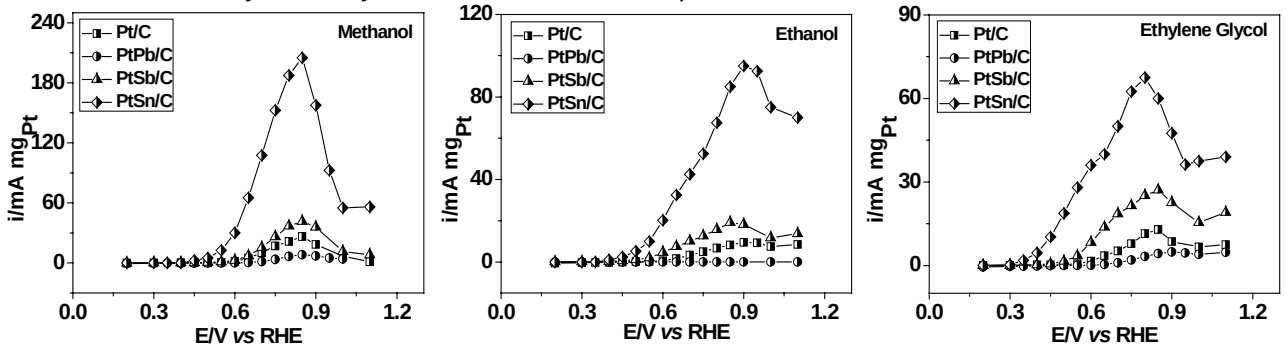

Figure 1. Polarization curves in stationary state in 0.15 mol L^{-1} methanol, ethanol and ethilene glycol solution.

References

[1] A. F. Innocente, A. C. D. Ângelo. J. of Power Sources. 162 (2006) 151-159.
[2] L. C. M. Pinto, E. R. Silva, R. Caram, G. Tremiliosi-Filho, A. C. D. Ângelo. Intermetallics. 16 (2008) 246-254.
[3] R. E. Cable, R. E. Schaak. Chem. Mater. 17 (2005) 6835-6841.