VI Encontro SBPMat 2007
28 out | 1 nov
SERHS GRANDHOTEL NATAL

6th Brazilian MRS Meeting
October 28th - November 1st

SBPMat Brazil-MRS

The influence of the preparation method in the catalytic activity towards ethanol oxidation using carbon nanofibers as catalyst support

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Abstract – The aim of this work is to identify the influence of catalyst preparation methodology on the properties and the structure of metallic particles deposited over carbon nanofibers support for use in a Direct Ethanol Fuel Cell (DEFC). The catalysts were prepared by sol-gel method and a method which consists in change tin cations adsorbed in the surface, for metallic particles by a redox process.

Ethanol is a green fuel that can be used directly in fuel cells, however the electro-oxidation of ethanol does not result in its complete combustion, there are other by-products formed. These by-products formation results in a low system efficiency as well as a catalyst poisoning when platinum is used as anode [1]. For this reason, binary and ternary catalysts based on platinum have been studied [2,3]. The motivation of this study is to characterize a binary catalyst usually used to oxidize ethanol (Pt/Pd) in order to reduce the surface poisoning. Two important changes were performed: first, the substrate employed in this work consists on carbon nanofibers produced in the Combustion and Propulsion Laboratory. Second, the preparation method was changed in order to compare the structure influence (pure metallic or their oxides) in the catalysts properties towards ethanol electro-oxidation.

The catalysts, prepared by sol-gel method, were obtained in the same way as described by Calegaro et al. [3]. The other catalysts were obtained using a methodology, which consists in surface sensitization by tin and its substitution by the metallic element through a redox reaction, for now on called the change method. The first method leads to the formation of oxides whereas the second one leads to the formation of metallic components. The catalytic activity was evaluated by polarization curves obtained in a potentiodynamic method with a scan rate of 0.1 mV s^{-1}, in a Gamry G750 Potentiostat.

Different from the results frequently obtained when another kind of substrate is used, mainly Vulcan XC72, carbon nanofibers allowed to obtain the oxides by sol-gel methodology, as examined by EDS. However, a better dispersion of the metallic particles was obtained by the change method (Fig. 1). The potentiodynamic curves (Fig. 2) indicate that the catalyst obtained by the change method is more efficient, the potential for the beginning of ethanol oxidation is c.a. 0.750 V while for the catalyst prepared by sol-gel method is c.a. 0.810 V. This result shows that besides the better dispersion related to the increase of the active area, there is an influence of the catalyst structure in the electro-oxidation of ethanol.

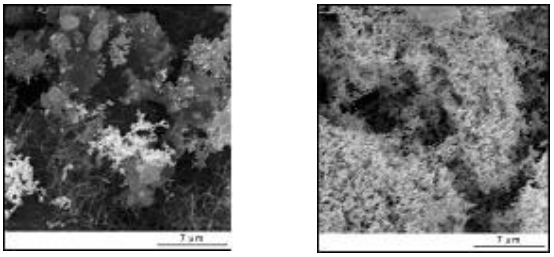

Figure 1: Micrographics of catalysts. Obtained by sol-gel and by change method.

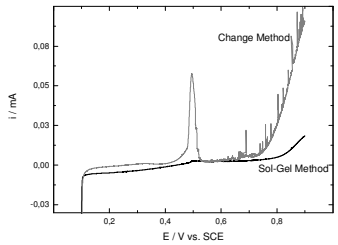

Figure 2: Potentiodynamic curves of catalysts carbon nanofibers/Pt-Pd in 0.5 mol dm^{-3} H_2SO_4 + 1.0 mol dm^{-3} Ethanol.

References

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