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Effect of the Composition of Pt and Pb on the Oxidation of Formic Acid in Carbon Supported Electrocatalysts

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Abstract – Pt-PbO_x/C catalysts with different metallic composition (90% Pt – 10 % Pb and 10% Pt – 90 % Pb) were synthesized to promote the formic acid oxidation in H_2SO_4 media. Electrochemical studies revealed that the catalyst composed by 10% of Pt and 90 % of Pb presented the best performance in this kind of system. The synergic effect of the oxide increases when the PbO_x is present in large quantities.

Direct Formic Acid Fuel Cells (DFAFC´s) are promising devices for applications in portable devices, presenting a theoretical open circuit potential (OCP) equal to 1.45 V. One of the advantages of using acid formic as fuel is related to the smaller crossover effect through the Nafion® membrane when compared with methanol. Despite the lower power density, the concentration of the formic acid can achieve 20 mol L^{-1}, while the concentration of methanol is normally only of about 2 mol L^{-1}.

The oxidation of formic acid can be carried out mainly by two parallel pathways [1]: The direct pathway and the chemical adsorption pathway. In the direct pathway, the formic acid is directly oxidized to CO_2.On the other hand, in the second possibility, the process starts with the chemical CO adsorption on the surface of the electrode.

In this study, the synthesis and characterization of Pt-PbO_x/C catalysts by the Sol-Gel Method [3] was carried out with different compositions of metals (10% Pt – 90 % Pb and 90% Pt – 10 % Pb, in mass of metals). All measurements were carried out in an Autolab PGSTAT 100 potentiostat/galvanostat system in a conventional electrochemical cell provided with three electrodes (a Pt foil with 2 cm^2 of geometrical area as counter electrode and an Ag/AgCl electrode as reference).

Figure 1 shows the cyclic voltammograms for the oxidation of the formic acid for the Pt-PbO_x/C anodes composed by 90% Pt – 10 % Pb (a) and 10% Pt – 90 % Pb (b). In the figure, it is possible to observe that the catalyst composed by 10 % of platinum has the best performance for the oxidation of the formic acid, with no important currents of reactivation during the process, indicating that the catalyst with 10 % of Pt probably oxidizes the acid by the direct pathway mechanism. On the other hand, the catalyst with 90 % of platinum presented a similar response of that observed for the Pt/C anode.

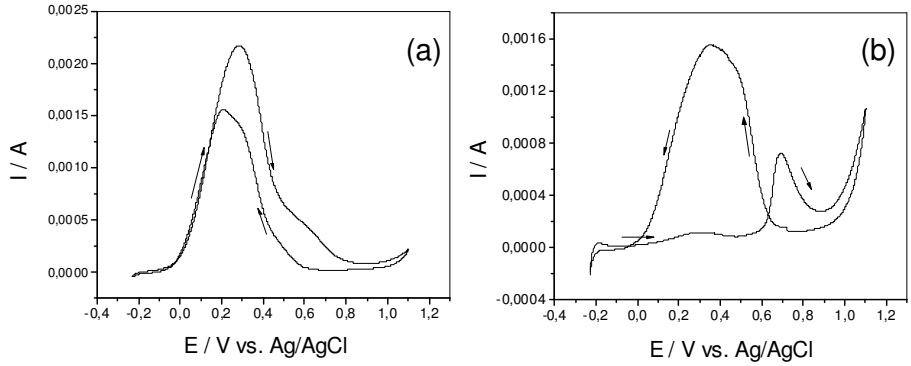

Figure 1: Cyclic voltammetries for Pt-PbO_x/C catalyst with (a) 10 % of Pt and 90 % of lead and (b) 90 % of Pt and 10 % of lead. Scan rate = 20 mV s^{-1}. The curves indicate that the Pt-PbO_x/C catalyst with less Pt is better to oxidize the formic acid in H_2SO_4 0.5 mol L^{-1}.

References

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