Electrocatalysts and membranes for using in PEMFCs and AEMFCs fed by contaminated hydrogen

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Catalytic ethanol dehydrogenation has been proposed as a promising method to produce H_2 without CO and CO_2.[1] However, the dehydrogenation generates other types of organic by-products such as ethyl acetate, acetaldehyde and leaves unreacted ethanol that can cause power losses in the fuel cell. To make this technology accessible, fuel cells performances must be improved. In this context, we studied the influence of the main contaminants present in the hydrogen produced by the catalytic dehydrogenation of ethanol on the performance of proton exchange membrane fuel cells (PEMFCs) and anion exchange membrane fuel cells (AEMFCs). Investigations comprised the elucidation of the processes and reactions involved in the corresponding electrode systems, as well as the phenomena governing the electrochemical performance in the alkaline and acidic media, and in the absence and in the presence of the by-products. For the AEMFCs, the research initially involved the syntheses of ionomers and membranes and the optimization of their performances in single cells, using pure hydrogen and conventional electrocatalysts (Pt-Ru/C in the anode and Pt/C in the cathode).[2] However, due to the chemical instability when exposed to the contaminants, these materials seem to undergo degradation, leading to almost total and irreversible losses of the cell performance. A positive fact was that AEMs showed much less crossover of contaminants from the anode to the cathode. Through analyses by different techniques, it was found that unreacted ethanol is the main poison in the case of PEMFCs, with acetaldehyde and ethyl acetate having minor contributions. Different anodic and cathodic catalysts were tested in order to obtain better fuel cells performances, such as Pt-Sn/C, Pt- W/C, Pt-Co/C, Pt-Cr/C and Pt/C (Fig. 1). Also different types of membranes were tested (Nafion® 115, 117, and 212). The best result was achieved when the Pt- Co/C catalyst was used at the cathode (with Pt/C at the anode), for which the loss of power density was only 20% compared to a cell fed by pure H_2 and with Pt/C on both electrodes (working at 0.7 V).

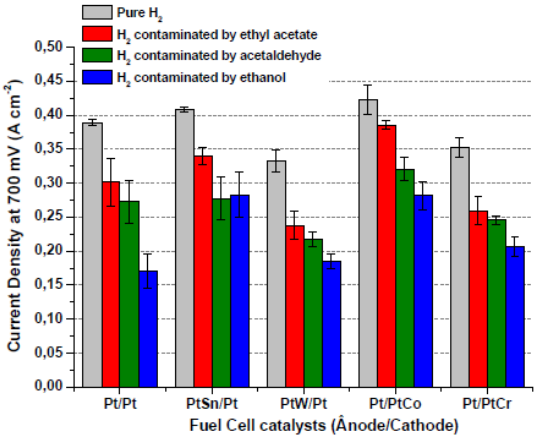

Figure 1. Current densities at 700 mV of the studied fuel cells when fed by pure hydrogen and hydrogen contaminated by ethanol, acetaldehyde and ethyl acetate.

Acknowledgements:
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References:
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