Preparation of PtSn/C, PtRh/C and PtSnRh/C electrocatalysts using an alcohol-reduction process for ethanol oxidation

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Ethanol offers an attractive alternative as a fuel for Direct Alcohol Fuel Cell (DAFC) because it is produced in large quantities from biomass and it is much less toxic than others alcohols. Pt and Pt-alloy catalysts are commonly used in low temperature DAFC [1]. Despite of Pt is considered the best-known catalyst for the adsorption of small organic molecules and breaking C-H bonds, its activity for breaking the C–C bond of ethanol molecule is very low. PtSn/C electrocatalyt has been considered one of the most active electrocatalysts for ethanol electro-oxidation [1,2], however, the principal product formed was acetaldehyde. Souza et al. [3] observed that PtRh/C electrocatalyst was selective for breaking the C-C bond of ethanol molecule leading to CO_2 as the final product, on the other hand, these catalysts were few active for ethanol electro-oxidation. Thus, PtRh/C electrocatalysts were considered promising candidates for ethanol oxidation if a third element is added to improve the overall reaction rate. In this work, Pt/C, PtRh/C (50:50), PtSn/C (50:50) and PtSnRh/C (50:40:10) were prepared by an alcohol-reduction process [2] with metal loading of 20 wt.% using $H_2PtCl_6.6H_2O$ (Aldrich), $SnCl_2.2H_2O$ (Aldrich),and $RhCl_{2.X}H_2O$ (Aldrich) as metals sources and Vulcan XC72 as support. The electrocatalysts were characterized by EDX, XRD and cyclic voltammetry (CV). The electro-oxidation of ethanol was studied by CV and chronoamperomety at room temperature in acid medium. The EDX analysis showed that the metal atomic ratios of the obtained electrocatalysts were similar to the nominal atomic ratios used in the preparation. The diffractograms of Pt/C, PtRh/C, PtSn/C and PtSnRh/C electrocatalysts showed four peaks at approximately 2θ =40°, 47°, 67° and 82°, which are associated with the (111), (200), (220) and (311) planes, respectively, of a face cubic-centered (fcc) structure characteristic of platinum and platinum alloys. For PtSn/C and PtSnRh/C two additional peaks were observed at 2θ =34◦ and 52◦ that were identified as a SnO_2 phase [2]. The average particle sizes for Pt/C, PtRh/C, PtSn/C and PtSnRh/C electrocatalysts were estimated using the Scherrer equation and were in the range of 2–3 nm. PtSn /C (50:50) electrocatalyst showed the best performance for ethanol oxidation at room temperature. PtSnRh/C (50:40:10) electrocatalyst showed a slight decrease in the performance compared to PtSn/C (50:50) electrocatalyst. Pt/C and PtRh/C (50:50) electrocatalysts showed low performances. Direct ethanol fuel cell tests and analysis of the products formed are in progress.

Keywords: Direct Ethanol Fuel Cell, PtSn/C, PtRh/C, PtSnRh/C, alcohol reduction process,
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