Preparation of PtRu/C, PtBi/C and PtRuBi/C electrocatalysts by an alcohol-reduction process for ethanol oxidation

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Fuel cells employing alcohols directly (direct alcohol fuel cell, DAFC) are attractive as power sources for mobile, stationary and portable applications. Compared to hydrogen-fed fuel cells, which need a reforming system or have problems of hydrogen storage, DAFCs use a liquid fuel, thus simplifying the fuel delivery system [1]. Ethanol offers an attractive alternative as the direct fuel because it is produced in large quantities from biomass and it is much less toxic than others alcohols. Due to the low electrocatalytic activity of platinum for practical DAFC applications, elements like ruthenium have been added to promote electroactivity. In this aspect it is important to study new binary and ternary electrocatalysts for ethanol oxidation [1,2]. In this work Pt/C, PtRu/C (90:10), PtRu/C (50:50), PtBi/C (90:10), PtBi/C (50:50), PtRuBi/C (80:10:10) and PtRuBi/C (50:40:10) were prepared by an alcohol-reduction process [1] with metal loading of 20 wt.% using $H_2PtCl_6.6H_2O$ (Aldrich), $RuCl_3.xH_2O$ (Aldrich),and $Bi(NO_3)_3.5H_2O$ (Aldrich) as metals sources and Vulcan XC 72 as support. The electrocatalysts were characterized by EDAX, X-ray diffraction (XRD) and cyclic voltammetry (CV). The electro-oxidation of ethanol was studied in acid medium by cyclic voltammetry and chronoamperometry using thin porous coating technique. The X-ray diffractograms of Pt/C, PtRu/C, PtBi/C and PtRuBi/C electrocatalysts showed a broad peak at about $2\theta = 25°$ that was associated with the carbon support and four diffraction peaks at about $2\theta = 40°$, 47°, 67° and 82° characteristic of the face centered cubic structure (fcc) structure of platinum and platinum alloys. For PtBi/C (50:50) electrocatalyst it was also observed the presence of the bismuth oxide phase (Bi_2O_3). The Pt:Ru, Pt:Bi and Pt:Ru:Bi atomic ratios (EDAX) of the obtained electrocalysts were similar to the nominal atomic ratios used in the preparations and the average crystallite size were in the range of 2–4 nm. The electrochemical studies showed that PtRuBi/C (80:10:10) electrocatalyst had superior performance for ethanol electro-oxidation at room temperature compared to PtRu/C and PtBi/C electrocatalys.

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