Preparation of PtSn/C electrocatalysts using citric acid as reducing agent for Direct Ethanol Fuel Cell (DEFC)

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Fuel cells employing alcohols directly as combustible (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 a 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 and tin have been added to promote electroactivity. PtSn/C electrocatalyts have been described to be more active than PtRu/C electrocatalysts for ethanol electro-oxidation and their performances also depends greatly on preparation procedures and Pt:Sn atomic ratios [2]. In this work, PtSn/C electrocatalysts with Pt:Sn atomic ratios of 50:50 and 60:40 were prepared using citric acid as reducing agent. The eletrocatalysts were prepared with a metal loading of 20 wt. % using $H_2PtCl_6.6H_2O$ (Aldrich), $SnCl_2.xH_2O$ (Aldrich) as metals sources and Vulcan XC72R as carbon support. The electrocatalysts were characterized by energy dispersive x-ray spectroscopy (EDX), x-ray diffraction (XRD) and cyclic voltammetry (CV). The electro-oxidation of ethanol was studied by CV and chronoamperomety at room temperature in acid medium. The DEFC performances were determined in a single cell with an area of 5 cm^2. The temperature was set to 90°C, the fuel was 2 mol L^{-1} ethanol solution delivered at approximately 1 mL min^{-1} and an oxygen flow of 500 mL min^{-1} and pressure of 2 bars was used. The EDX analysis showed that the Pt:Sn atomic ratios of the obtained electrocatalysts were similar to the nominal atomic ratios used in the preparation. The diffractograms of PtSn/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 and two peaks at 2θ = 34° and 52° that were identified as a SnO_2 phase [2]. The average particle sizes of PtSn/C electrocatalysts were estimated using the Scherrer equation [2] and were in the range of 3 – 9 nm. The electrochemical studies showed that commercial PtSn/C (75:25) electrocatalyst from E-TEK had superior performance for ethanol electro-oxidation at room temperature compared to PtSn/C (50:50) and PtSn/C (60:40) electrocatalysts prepared using citric acid as reducing agent. On the other hand, in the DEFC studies at 90°C, PtSn/C (50:50) and PtSn/C (60:40) electrocatalysts showed superior performance compared to commercial PtSn/C (75:25) E-TEK.

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