Preparation of Pt/C, Pt/C-$Sb_2O_5.SnO_2$, Pt/C-$In_2O_3.SnO_2$ Electrocatalysts by Borohydride Reduction Process for Ethanol Electro-Oxidation

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Pt/C, Pt/C-$Sb_2O_5.SnO_2$, Pt/C-$In_2O_3.SnO_2$ electrocatalysts were prepared in the single step using $H_2PtCl_6.6H_2O$ as metal source, sodium borohydride as reducing agent and a physical mixture of 85% Vulcan Carbon XC72 and 15% $In_2O_3.SnO_2$ (indium tin oxide – ITO) or 15% $Sb_2O_5.SnO_2$ (antimony tin oxide-ATO) as support. The electrocatalysts were characterized by X-ray Diffraction and Transmission Electron Microscopy, Cyclic Voltammetry, Chronoamperommetry, Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) Spectroscopy and performance test on direct ethanol fuel cell. The diffractograms of the Pt/C showed four peaks associated with the face-centered cubic (fcc) structure of platinum, while that Pt/C-$In_2O_3.SnO_2$ and Pt/C-$Sb_2O_5.SnO_2$ electrocatalysts showed peaks associated with the face-centered cubic (fcc) structure of platinum and several others peaks associated with Indium-doped SnO_2 (ITO) and antimony-doped tin oxides (ATO) used as supports. Transmission electron microscopy for Pt/C, Pt/C-$Sb_2O_5.SnO_2$ and Pt/C-$In_2O_3.SnO_2$ electrocatalysts showed that the metal particles were homogeneously distributed the support throughout with particle size of 3.0 nm. The electrochemical studies (cyclic voltammetry and chronoamperometry) showed that Pt/C-$In_2O_3.SnO_2$ and Pt/C-$Sb_2O_5.SnO_2$ had superior performance for ethanol electro-oxidation in comparison with Pt/C and in all potential range of interest (0.05-0.9V). The experiments at 100°C on single direct ethanol fuel cells showed that the power density for the Pt/C-$In_2O_3.SnO_2$ was nearly 400% higher than the one obtained using Pt/C indicating an improved tolerance to intermediate adsorbed. The FTIR spectra collected during ethanol electro-oxidation in presence of 0.1 M $HClO_4$ for Pt/C, Pt/C-$Sb_2O_5.SnO_2$ and Pt/C-$In_2O_3.SnO_2$ showed the principal bands at 2344, 1282 and 933 cm^{-1}, which are characteristic of the presence of CO_2, acetic acid and acetaldehyde respectively. For Pt/C-$In_2O_3.SnO_2$ and Pt/C-$Sb_2O_5.SnO_2$ electrocatalysts acetic acid was the main product in the potential range studied as indicated by the integrated band intensities, while that for Pt/C electrocatalysts the acetaldehyde was the main product. The data from Fourier transform infrared spectroscopy also showed that the addition of C-$In_2O_3.SnO_2$ to Pt or C-$Sb_2O_5.SnO_2$ to Pt favor a more complete oxidation of the ethanol molecule, where $In_2O_3.SnO_2$ or $Sb_2O_5.SnO_2$ provides oxygen-containing species to oxidize acetaldehyde to acetic acid.