The catalytic activity of PtRu nanoparticles for ethylene glycol and ethanol electrooxidation in alkaline media

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The use of excessive fossil fuels has resulted in harmful effects on the environment and potentially human health. In this sense, direct alcohol fuel cells DAFCs are promising energy producing devices. Ethanol and ethylene glycol are appealing fuels for DAFCs due to their lower toxicity and high theoretical energy density, 8.01 kWh kg^{-1} and 5.2 kWh kg^{-1}, respectively [1,2]. In this study, the carbon-supported PtRu nanoparticles with atomic ratios of Pt:Ru of 100:0, 90:10, 70:30 and 50:50 for ethanol and ethylene glycol electrooxidation in alkaline media, was investigated. The nanoparticles were synthesized using sodium borohydride method with 20 wt% of metals loading on carbon [1]. X-ray diffraction (XRD) analysis revealed that Pt and PtRu electrocatalysts have face centered cubic (fcc) structure and suggests the alloy formation for all PtRu/C materials, which was further supported by the X-ray Photoelectron Spectroscopy (XPS). According to transmission electron microscopy (TEM) the nanoparticle mean sizes were 7.3 nm, 5.7 nm, 5.2 nm and 5.1 nm for Pt/C, $Pt_{90}Ru_{10}$/C, $Pt_{70}Ru_{30}$/C and $Pt_{50}Ru_{50}$/C, respectively. Electrochemical measurements carried out in mol L^{-1} KOH + mol L^{-1} alcohol solution (ethanol and ethylene glycol) in a conventional three-electrode electrochemical cell (glassy carbon was used as work electrode and a platinum foil and a Hg/HgO were used as the counter and reference electrodes, respectively) demonstrated that the addition of Ru to Pt enhances the catalytic activity towards ethanol and ethylene glycol electrooxidadion in alkaline media. The catalyst of $Pt_{50}Ru_{50}$/C composition showed the lowest onset potential for ethanol and ethylene glycol electrooxidation (by Cyclic voltammetric), which are 160 mV and 70 mV lower than for Pt/C, respectively. Furthermore, this catalyst outperformed Pt/C and other PtRu/C compositions in chronoamperommetric and direct alcohol fuel cell (DAFC) experiments. DAFC experiments using $Pt_{50}Ru_{50}$/C as anode had the power density 40% and 14 % higher than using Pt/C for ethanol and ethylene glycol, respectively. The enhancement of the catalytic activity might be related to the high amount of oxides species on the $Pt_{50}Ru_{50}$ electrocatalysts surface, which could form Ru-OH at low potential and also due to the electronic effect of PtRu alloy that weakens the adsorption strength of poisonous intermediates from reactions [3].

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