Palladium-based Electrocatalysts for Ethanol Oxidation Reaction in Alkaline Direct Ethanol Fuel Cell

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Direct ethanol fuel cells require adequate electrocatalysts to promote the carbon-carbon cleavage of ethanol molecule. Typical electrocatalysts are based on platinum, which have shown improved activity in acidic media. However, Pt-based catalysts have high cost and are easily deactivated by CO poisoning. Therefore, novel catalysts have been developed, and among then, palladium-based materials have shown promising results for the oxidation of ethanol in alkaline media. The present study reports on the performance of alkaline direct ethanol fuel cel (ADEFC) by using carbon-supported Pd, PdSn, PdNi, and PdNiSn produced by impregnation-reduction of the metallic precursors. The effect of chemical functionalization by acid treatment of the carbon support (Vulcan) was investigated. The electrocatalysts were studied by thermogravimetric analysis (TGA), X-rays diffraction (XRD), transmission electron microscopy (TEM), cyclic voltammetry (CV), and ADEFC tests. TGA measurements of functionalized Vulcan evidenced the characteristic weight losses attributed to the presence of surface functional groups due to the acid treatment. A high degree of alloying between Pd and Sn was inferred from XRD data, whereas in both PdNi and PdNiSn, Ni occurs mostly segregated in the oxide form. TEM analyses indicated agglomeration of Pd and PdSn particles, whereas a more uniform particle distribution was observed for PdNi and PdNiSn samples. CV curves showed that the peak potential for the oxidation of ethanol shifts towards negative values for all samples supported on functionalized Vulcan indicating that ethanol oxidation is facilitated. Microstructural and electrochemical features were confirmed by ADEFC tests, which revealed that the highest open circuit voltage and maximum power density were achieved for PdNiSn electrocatalysts supported on functionalized Vulcan with uniform particle distribution and improved triple phase boundaries.

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