Electrochemical Characterization of Platinum based anode catalysts for Polymer Exchange Membrane Fuel Cell

By

Oko Unathi Gcilitshana

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Supervisor: Dr. L. Khotseng

Co-supervisor: Dr. S. Pasupathi

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DECLARATION

I declare that “Electrochemical Characterization of Platinum based anode catalysts for Proton Exchange Membrane Fuel Cell” is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Oko Unathi Gcilitshana December 2008

Signed:…….

ABSTRACT

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Oko Unathi Gcilitshana

M.Sc. Thesis, Department of Chemistry, University of the Western Cape

The present state-of-art Proton Exchange Membrane Fuel Cell (PEMFC) technology is based on platinum (Pt) as a catalyst for both the fuel (anode) and air (cathode) electrodes. Platinum is highly active but susceptible to poisoning by CO, which may be present in the H_2-fuel used, especially when it is generated through reforming. Presence of trace amount of CO in the H_2-fuel poisons the anode irreversibly and decreases the performance of the PEMFCs. Binary and ternary supported catalysts have been investigated for improving the performance of PEM fuel cells. Combining Pt with additional elements reduces the overpotential for reactions critical to the power density of PEM fuel cells. Supporting binary and ternary catalysts on carbon increases catalyst utilization, and allows high PEM fuel cell performance at low metal loading.

In this study, the main objective was to investigate the tolerance of platinum based binary anode catalysts for CO poisoning from 10ppm up to1000ppm and to identify the best anode catalysts for PEMFCs that tolerates the CO fed with reformed hydrogen.

Selected platinum based binary catalysts were screened for their activity, hydrogen oxidation and tolerance to CO. The amount of CO was varied between 10ppm and 1000ppm and the tolerance of binary catalysts was evaluated. Also, the effect of sintering on the activity of binary catalysts, particularly on the particle size, dispersion and extent of alloying was studied in order to identify the best CO tolerant anode electrocatalyst. Chronoamperometry was used to screen the electrochemical activity and stability of catalysts. Physical characterizations of the catalysts were carried out using SEM, EDS, TEM and XRD analysis.

Commercial Pt/C used as the baseline was the best electrocatalyst that favored the HOR and in its unsintered state it proved to be the most stable. The binary catalysts used in this study tolerated the CO poisoning better than Pt/C used as a baseline. PtSn/C was identified as the best electrocatalyst because it showed better tolerance towards the CO poisoning than all the studied electrocatalyst. Sintering induced changes in electrocatalyst properties such as a nanoparticle size, morphology, dispersion of the metal on the support, alloying degree, electrocatalytic activity and stability. The dispersion of the metal on the support and electrocatalytic properties of the electrocatalysts were improved. The surface morphology improved from amorphous to more ordered states. The results obtained from SEM EDS showed that the platinum binary electrocatalysts are stable nature because their elemental composition remained the same before and after sintering. XRD results confirmed the crystalline particle structure of Pt and that the electrocatalysts exhibited a face centered cubic-structure. The average particle sizes obtained from XRD and TEM for both sintered and