

Abstract

In my doctoral thesis I was dealing with electrochemical characterization of electrocatalysts for potential use in low temperature fuel cell. The first part of research involves the usage of rotating disc electrode as a conventional methodology for evaluation of catalytic activity of catalysts' thin films. These mainly consist of nanoparticulate platinum based alloys dispersed on a high surface area carbon. We have shown that the rotating disc electrode methodology can also be applicable for determination of activity of non-ideal thin films. However, in order for that to occur, one should evaluate the activity within the low current density region. The obtained activity can be transformed to values that would be obtained in the usual high current density region if the film was uniform. This transformation can be performed by an empirical correlation.

In the second part of research I was investigating degradation of electrocatalysts under conditions found in low temperature fuel cells and in electrolyzers. For these purposes a highly sensitive *on line* analytical method was developed. The method is based on the electrochemical flow cell coupled to an inductively coupled plasma mass spectrometer. This method enables performing electrochemical experiments while at the same time monitoring resulting concentrations of dissolved species. Several issues were tackled resulting in new insights. For example, it was confirmed that the stability of platinum based nanoparticles is particle size dependent and increases with size. Apart from that the stability is dramatically lowered by the presence of chloride impurities which change the corrosion mechanism. Dissolution strongly depends on the catalyst film thickness as well; initially, with increasing thickness the dissolution is inhibited, however by further increasing the thickness the dissolution is accelerated again.

In the case of nanoparticulate platinum based alloys, the corrosion of both metals depends on crystal structure. Superficial structure ordering inhibits the dissolution of non-noble metal. However, for the same reason, a more intense platinum dissolution occurs. The stability of both metals is promoted by gold doping. Furthermore, platinum can be stabilized by addition of ruthenium nanoparticles. By doing so, the corrosion of non-noble metal is promoted, hence platinum dissolves to a lesser extent.

In the case of methanol oxidation catalysts, namely platinum-ruthenium alloys, the dissolution of ruthenium accelerates the dissolution of platinum – if compared to the non-ruthenium analogue. Methanol promotes dissolution of both metals. In the case of ruthenium this is due to Ru_2O_3 consumption in the methanol oxidation reaction whereas in the case of platinum dissolution is enhanced due to inhibited redepositon of platinum ions triggered by the blockage of carbon monoxide.

Key words: rotating disc electrode, electrocatalyst, corrosion, nanoparticles, electrochemical flow cell