



Development of faceted platinum electrocatalysts for low temperature fuel cell

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The oxygen electroreduction overpotential is one of the main contributions to the losses in efficiency and power density in low temperature fuel cells. Pt is an effective electrocatalyst for electrodic reactions involved in low-temperature H₂/O₂ proton exchange membrane (PEM) fuel cells, particularly the oxygen electroreduction reaction (ORR). This reaction represents one of the main limitations in H₂/O₂ fuel cell operating at low temperatures, due to its slow electrode kinetics¹. To ensure maximum utilization, Pt electrocatalysts are dispersed as nanoparticles on carbon-supports. The morphology and crystalline orientation of the dispersed metal are very important factors to be considered for understanding the effect of the electrocatalyst surface structure on the kinetics of electrocatalytic reactions. It is known that the molecular ORR in acid media becomes strongly dependent on Pt surface morphology in a wide overpotential range, being favored on (111)-type faceted Pt nanoparticles¹. In this work, the preparation and characterization of high surface area carbon-supported faceted Pt electrocatalysts, with a defined and well characterized morphology for using in PEM fuel cell, is presented. High surface area faceted Pt crystallites were obtained by applying a square wave potential pulse of high frequency in aqueous chloroplatinic acid at 25°C, between lower and upper potential limits of -0,2 V and 1,2 V, respectively, which favors the formation and growth of faceted Pt nanoparticles with a preferential crystal orientation on conductive supports. The influence of the electrodeposition time on the characteristics of the faceted Pt electrocatalyst for the ORR on H₂/O₂ PEM fuel cells is evaluated. Thus, size, distribution, amount, morphology and crystallographic orientation of faceted Pt electrocatalysts, for different electrodeposition times, were determined. The development of faceting with preferential crystal orientation of the electrodeposited Pt nanoparticles was followed through the changes in the relative height of weakly and strongly bound H-atom voltammetric current peaks. The electrochemical active surface area of the Pt electrodeposits was determined through the hydrogen electrosorption charge by voltamperometric techniques. The net charge for the electrodeposition process was determined through an electronic coulometer and the amount of Pt deposited was measured by using a spectrophotometric method². The characterization studies of metal electrodeposits by using SEM, TEM, XRD and cyclic voltammetry revealed the presence of highly faceted Pt nanoparticles having a predominant (111) preferential crystal orientation, which have shown a greater catalytic activity for the ORR. The amount of electrodeposited Pt and the size of faceted Pt nanoparticles were determined, showing a decrease of amount and average size particle as the electrodeposition time diminishes.

References

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