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Study of the Effect of Temperature on Pt Dissolution in PEM Fuel Cells Via Accelerated Stress Tests

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Abstract

Operation of polymer electrolyte membrane fuel cells (PEMFC) at higher cell temperatures accelerates Pt dissolution in the catalyst layer. In this study, a Pt dissolution accelerated stress testing protocol involving the application of a potentiostatic square-wave with 3s at 0.6 V followed by 3s at 1.0 V was developed to test fuel cell membrane electrode assemblies (MEAs). The use of this Pt dissolution protocol at three different temperatures (40°C, 60°C and 80°C) was investigated for the same membrane electrode assembly composition. Impedance analysis of the membrane electrode assemblies showed an increase in polarization resistance during the course of the accelerated stress testing. Polarization analysis and electrochemical active surface area (ECSA) loss measurements revealed evidence of increased cathode catalyst layer (CCL) degradation due to Pt dissolution and deposition in the membrane as the cell temperature was raised. Scanning electron microscope (SEM) images confirmed the formation of Pt bands in the membrane. A diagnostic expression was developed to estimate kinetic losses due to oxygen reduction using the effective platinum surface area (EPSA) estimated from cyclic voltammograms. The results indicated that performance degradation occurred mainly due to Pt loss.

Key words: accelerated stress testing, fuel cell catalyst, durability, voltage loss analysis, electrochemical surface area