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Characterization of MEA degradation for an open air cathode PEM fuel cell

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ABSTRACT

As fuel cell technology matures and time scale to commercialization decreases, the need for a more comprehensive knowledge of materials' aging mechanisms is essential to attain specified lifetime requirements for applications. In this work, the membrane electrode assembly (MEA) degradation of an eight-cell PEM low power stack was evaluated, during and after fuel cell aging in specified testing conditions of load-cycling that may compromise the durability of the catalyst. The stack degradation analysis comprised observation of catalytic layers, morphology and composition. Examination of the MEAs cross sections, in a joint SEM and TEM study, revealed thickness variation of catalytic layer (up to 47% for the cathode layers), and cracking, delamination, and catalyst migration were observed even though catalyst sintering and consequent loss of electrochemical active area seem to be predominant together with F loss from the ionomer used as binder in the catalytic layers.

1. Introduction

The durability of fuel cells under various ambient conditions is an important issue for their successful commercialization. Proton exchange membrane (PEM) fuel cells operate under very aggressive conditions in both anode and cathode environments.

Even though the number of installed units around the world continues to increase and dominate the pre-markets, the present lifetime requirements for fuel cells cannot be guaranteed, creating the need for a more comprehensive knowledge of the material aging mechanisms.

The subject of degradation and durability has attracted attention over the last few years and a considerable number of publications exist on this topic, but the mechanisms are not well understood.

Fuel cell performance is affected by irreversible changes in the kinetic and/or transport properties of the cell. Various factors have been shown to affect the useful life of PEM fuel cells [1–4]. Other issues arise from component optimization and operational conditions, such as impurities in either the fuel [5–9] or oxidant stream [10–14], temperature (including subfreezing exposure) [15,16], low relative humidity (RH) [17,18] or RH cycling [19], load-cycling [20,21], etc. Other factors that can affect cell performance and durability include transient versus continuous operation, start-up and shutdown procedures [22], as well as fuel [23,24] or air starvation [25].

Several research groups have also reported the accelerated effects of open circuit potential (OCV) operation on PEM fuel cell component degradation, including the membrane and catalyst layers [26–29].

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