Reversible and Irreversible Degradation Rates Determined in PEM Fuel Cells

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One of the major challenges for the commercialization of polymer electrolyte membrane fuel cells (PEMFCs) is the limited lifetime due to degradation processes of the different fuel cell components. The investigation of the underlying degradation mechanisms and mitigation strategies for fuel cell operation and for material development are key factors for PEMFC research and development.

This presentation is focused on reversible and irreversible degradation phenomena in PEMFCs. A new systematic approach for the analysis of reversible and irreversible degradation rates in an operating fuel cell will be introduced. A detailed description of voltage loss rates and particularly of the discrimination between reversible and irreversible voltage losses will be given.

A major motivation of the presented work is the lack of common testing procedures and determination approaches of voltage losses in durability tests of fuel cell. This issue results in severe difficulties in the comparison of results obtained by different testing facilities. This is limiting factor for the development of fuel cell components because the results within different research projects cannot be correlated, especially if only one value for a degradation rate is reported, e.g. for defined current density and defined test operating conditions. In order to systematically analyze voltage losses durability measurements of several hundreds of hours were performed in PEMFC single cells and stacks. Specific test protocols containing regular refresh procedures were used for this purpose. This enables to distinguish between reversible and irreversible voltage losses. To test the refresh procedures and analyze their effect on cell performance, parameters such as the duration of e.g. a soak time step have been varied. Between these refresh steps the cells were typically operated for 50 to 150 h. For in-situ diagnostics of the operated cells performance curves, HFR (high frequency resistant) measurements, and CVs (cyclic voltammograms) were recorded in order to determine the impact of the refresh procedures on the cells.