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A Durability Study of High-temperature PEMFC. Effects of Operating Parameters and Thermal Curing

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Several groups have demonstrated lifetimes of 10.000-20.000 hours for high-temperature PEM fuel cell based on phosphoric acid doped polybenzimidazole (PBI). Nevertheless, durability is still a critical issue that deserves attention. [1]

In the present study, a large number of cells manufactured by Danish Power Systems were tested with hydrogen and air in multichannel test rigs over several years. The operating parameters, temperature, gas flow rates and current load, were varied between 160 and 200 °C, stoichiometry up to about 10 (to mimic an air cooled cell) and current densities between 200 and 800 mA cm^{-2}, respectively. The cells were repeatedly characterized by polarization curves and/or electrochemical impedance spectroscopy. Post mortem analyses were performed by means of microscopy of cross sections, X-ray diffraction for platinum particle size and acid titration of cutout samples of the cells. The usual degradation effects were observed (catalyst particle growth, membrane thinning and acid loss), including the trend of increasing decay rate with increasing temperature or current load. Additionally, a similar correlation with gas flow rate was seen. The long-term degradation was explained as being mainly an effect of acid loss.

In another series of experiments, accelerated stress tests in the form of potential cycling were carried out. Then a decisive effect of humidification was seen. Potential cycling under un-humidified nitrogen resulted in an apparent degradation, which was reversed almost completely after a period of normal operation with air and hydrogen.

Finally, a cell with thermally cured PBI [2] was operated under constant current with a decay rate as low as 0.5 µV h^{-1} for several thousands of hours. [3]

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