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Durability Studies of High Temperature PEM Fuel Cells. Operational Parameters, Accelerated Testing and Acid Retention

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Abstract

High temperature PEM fuel cell made from polybenzimidazole doped with phosphoric acid doped have reached a rather mature state of development and early commercialization. However, long term durability is still a challenge [1] and that is the subject for the present study.

A large number of single cells (Dapozol, Danish Power Systems) were tested with hydrogen in multichannel test rigs over several years. Degradation rates as a function of temperature (160 - 200 °C), current load (200 - 800 mA cm^{-2}) and flow rates (up to about lambda 10) were measured. Polarization curves and electrochemical impedance spectra were recorded along the test and post mortem analyses were performed after different periods of time. Based on the data, some clear trends are highlighted.

Accelerated stress testing was performed using a potential cycling protocol. It is shown that humidification during the test has a decisive effect on the outcome and validity of the test.

Finally, cells based on a thermally cured membrane proved a degradation rate of as little as 0.5 µV h^{-1} over an extended period of time. [2] This is, to the authors' knowledge, lower than what is ever reported for high temperature PEMFC.

[1] M. T. Dalsgaard Jakobsen, J. O. Jensen, L. N. Cleemann and Q. Li. Chapter 22. Durability Issues and Status of PBI Based Fuel Cells. In Q. Li, D. Aili, H. A. Hjuler and J. O. Jensen (eds). High Temperature Polymer Electrolyte Membrane Fuel Cells-Approaches, Status and Perspectives. Springer-Verlag 2016

[2] M. T. D. Jakobsen, L. N. Cleemann, H. Becker, D. Aili, T. Steenberg, H. A. Hjuler, L. Seerup, Q. Li and J. O. Jensen. Long-term Durability of HT-PEM Fuel Cells Based on Thermally Cross-linked Polybenzimidazole. *Submitted to Journal of Power Sources*