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Durability Issues and Status of HT-PEM Based on Acid Doped Polybenzimidazoles

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Acid–base polybenzimidazole membranes represent an effective approach to achieve high temperature operation of polymer electrolyte membrane fuel cells. The technology has encouragingly shown to be a viable option for replacing or supplementing conventional power systems. In terms of long term durability, more than 18,000 hours with an average degradation rate of around 5 µV/h have been demonstrated under steady state operation while degradation rates of about a few hundred microvolts have been reported for a startup-shutdown cycle. In this talk the understanding of degradation mechanisms and their interaction with the fuel cell durability performance is presented. Oxidative degradation of the polybenzimidazoles seems to occur at the weak link of the benzeniod rings bearing nitrogen atoms. Possible attack by the peroxide radicals inside fuel cells are assumed and have been extensively investigated by e.g. accelerated aging tests with the Fenton agent. Significant degradation of the polymers is identified and modification of the polymer macrostructures, covalently crosslinking and ionically blending of the polymers have been shown to improve the materials durability.

Acid transfer within the membrane electrode assemblies (MEAs) and its leach out of the cell are of critical concern. Via an evaporation mechanism the acid loss seems to be at a level of about a few µg m-2 s-1 of the electrode area, corresponding to a loss of a few percents of the total acid content in a fuel cell stack after 40,000 hours. Acid transfer within the MEAs, not necessarily resulting in acid loss out of a cell, seems more critical for the fuel cell performance degradation.

Carbon corrosion and platinum dissolution in the acidic electrolyte at elevated temperatures are well recognized to be enhanced at higher temperatures and higher electrode potentials. This is particularly an issue when platinum alloy catalysts are considered for the HT-PEM fuel cells. More efforts are also needed to develop resistant support materials based on either structured carbons or non-carbon alternatives. Other issues as well as further improvement of key materials, components and the technology as a whole will be briefly outlined.