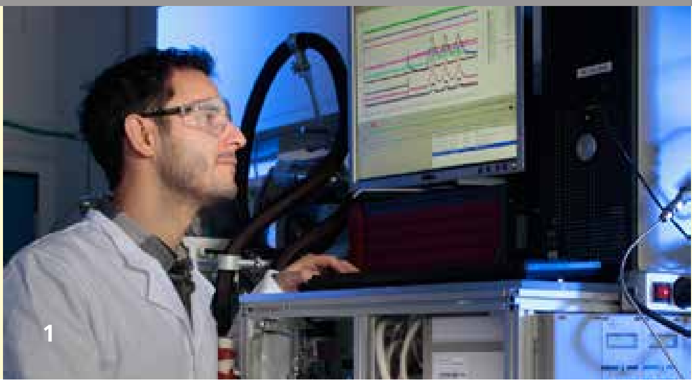
FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY ICT



1 + 2 *Carbon corrosion test bench in the laboratory.*

OPERATIONAL CARBON CORROSION IN POLYMER ELECTROLYTE FUEL CELLS

Fuel cells are seen as clean electricity generators for the future, and are a focus of development in many concepts for long-range electric vehicles. The goal is to achieve an operating time of 6000 hours for the fuel cell. Degradation of the electrodes often leads to a much earlier breakdown of the fuel cells and therefore to a failure of the whole system. Here the trade-off between the requirement for a small platinum load and a long life expectancy of the fuel cell becomes apparent. To reduce the platinum load, the platinum is applied with a high dispersion level to a conductive carbon-based support. Corrosion of the carbon and therefore loss of the catalyst are two major factors in cell degradation.

At Fraunhofer ICT a test bench with integrated online-measurement was developed, which enables investigation of the carbon corrosion of fuel cell electrodes under operating conditions similar to real-life conditions. The efficacy of modifications to the electrodes can consequently be validated.

Fraunhofer ICT in Pfinztal thus offers a rare and specialized method to quantify electrode degradation. By coupling a single cell test bench with a mass spectrometric characterization of the product gases, conclusions can be drawn regarding the degradation behavior of the cell. To obtain precise statements regarding the behavior of the cell in the planned environment, these investigations are conducted under conditions similar to the real-life application, and also with a dynamic fuel cell operation.

With this technique it is possible, for example, to identify detrimental operating points of a cell. Based on these findings the manufacturer can avoid these points, and an optimal operation strategy can be derived to increase the lifetime of the cell.

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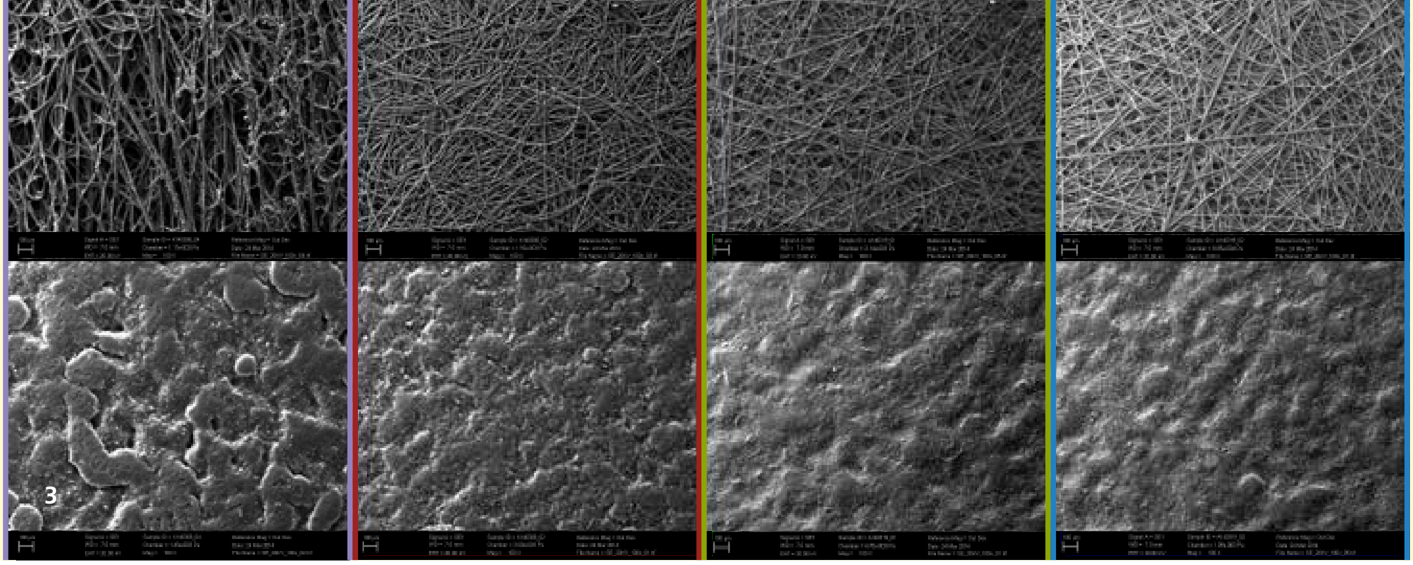


Life expectancy of the fuel cell and investigations with inline mass spectrometry

During operation, the life expectancy of fuel cells is reduced by different mechanisms which add to the degradation of cell components. These are classified as membrane degradation, catalyst degradation and carbon corrosion (C-corrosion). During degradation/corrosion processes, different substances are generated as reaction products of corrosion reactions in a fuel cell. If these substances, for example CO_2, pass through the exhaust system of the fuel cell, they can be detected by inline mass spectrometry. Inline mass spectrometry can therefore help to identify critical fuel cell conditions at which degradation processes are accelerated. It is also possible to evaluate the corrosion resistance of catalysts in a classic DEMS (differential electrochemical mass spectrometry) setup.

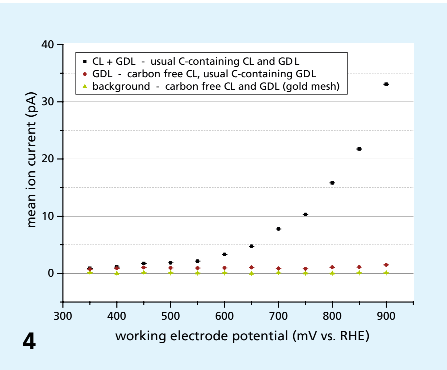
By this means, effects such as
- catalytic contribution of the metal catalyst to corrosion
- resistance of different carbon supports

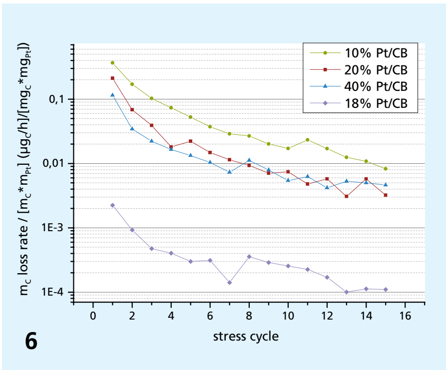
can be investigated.

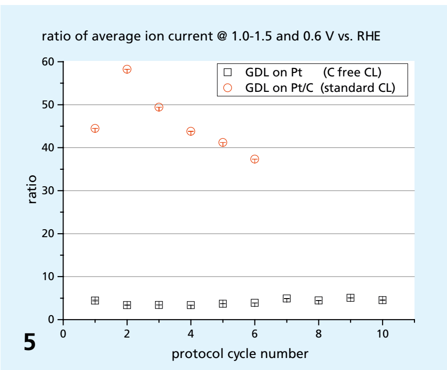
A comparison with the cell remains important to evaluate effects like temperature and gas composition.

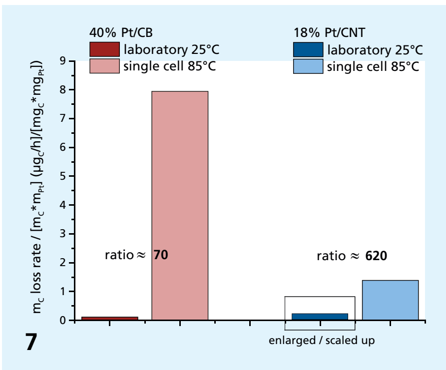
Our offer

- Investigation of the carbon corrosion rate at the
  – Catalysts
  – Membrane-electrode assembly (MEA)
  – Catalyst layer
  – Gas diffusion layer
- Experimental evaluation of polymer membrane and binder corrosion in MEAs
- Discrimination of different mass transport limitations
- Performance tests
- Accelerated stress tests









3 SEM images of different GDLs: SGL 10AA, H2315 C2, TGP-H-090, TGP-H-120; top: uncoated substrate.

4 CO_2 release from MEAs with different ratios of carbonaceous components.

5 Ratio of CO_2 release during corrosion -ADT and normal operation for: MEA with carbon support and MPL (red) and without carbon support with MPL (black).

6 DEMS tests to measure the effect of support and catalyst load on carbon corrosion.

7 Comparison of results from DEMS and single cell tests.