Institute of
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FTIR spectroscopic imaging of aged fuel cell components

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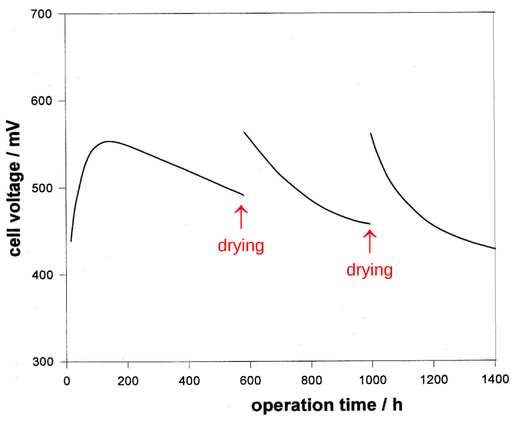
Introduction

Regarding fuel cells as an environmentally friendly energy converter one of the major unsolved problems beside the costs is an insufficient lifetime. In polymer electrolyte fuel cells humidity management is one of the key point for their performance.
The water management is mainly determined by the hydrophobic/hydrophilic properties of the gas diffusion layer (GDL) including the micro porous layer. Thus the degradation of GDL and micro porous layers MPL therein are the key point for the understanding of reduced fuel cell lifetimes.
In the past the partially decomposition of the polymers in the GDL and the MPL was observed by X-ray photoelectron spectroscopy measurements on fresh and aged GDL and MPL. The decomposition of the polymers due to fuel cell operation changes the hydrophobic/hydrophilic properties of the GDL, MPL and catalyst layer and consequently also the water balance in the cell.

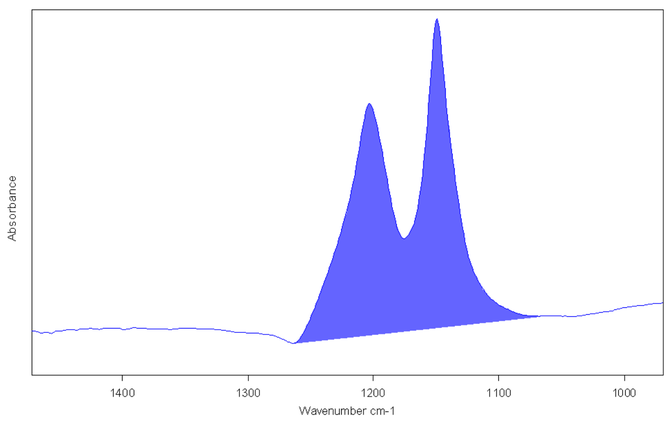


Change of performance during long term operation

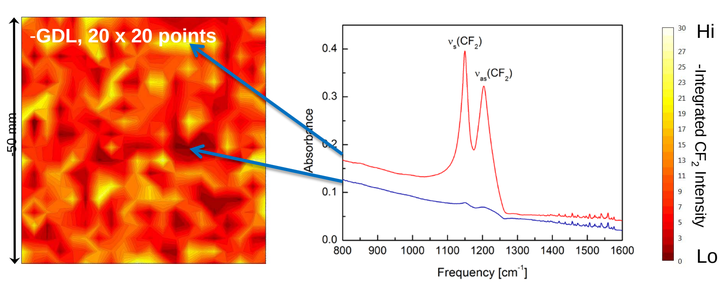
Disadvantage of these XPS investigations are that the measurements were performed under ultrahigh vacuum conditions and the X-ray radiation induces also a decomposition of the polymers, therefore the FTIR spectroscopy as a non-destructive investigation method for the polymers and their distribution is very interesting.

FTIR Imaging

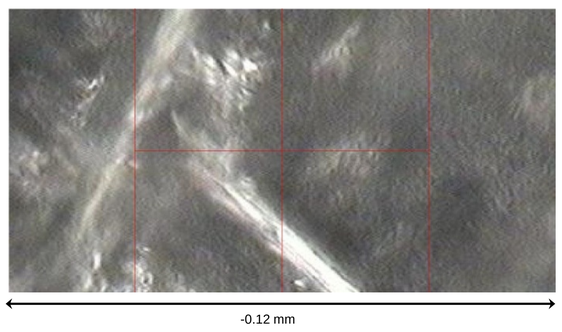
FTIR allows an significant reduction of the measurement time and makes the imaging of the polymer distribution in the components easier compared to XPS investigations.

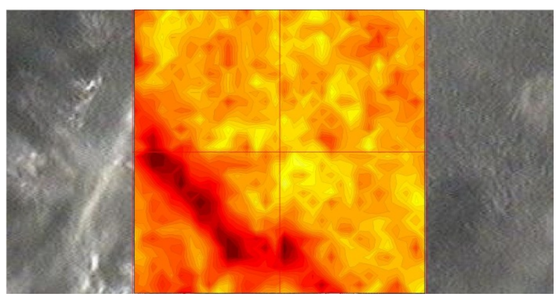


FTIR spectrum of an MPL measured in the range of the C-F vibration with ATR technique. The integral under both peaks (blue) is used for the imaging of the polymer distribution



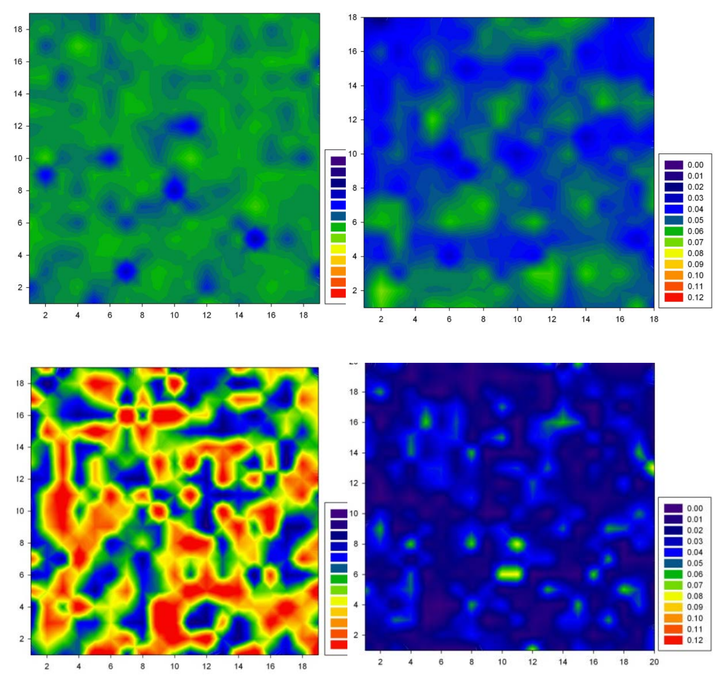
FTIR-ATR image of a GDL 50x50 mm², 20 x 20 points measured by rasterizing the sample. The colors are related to the intensity of the C-F vibration signal.



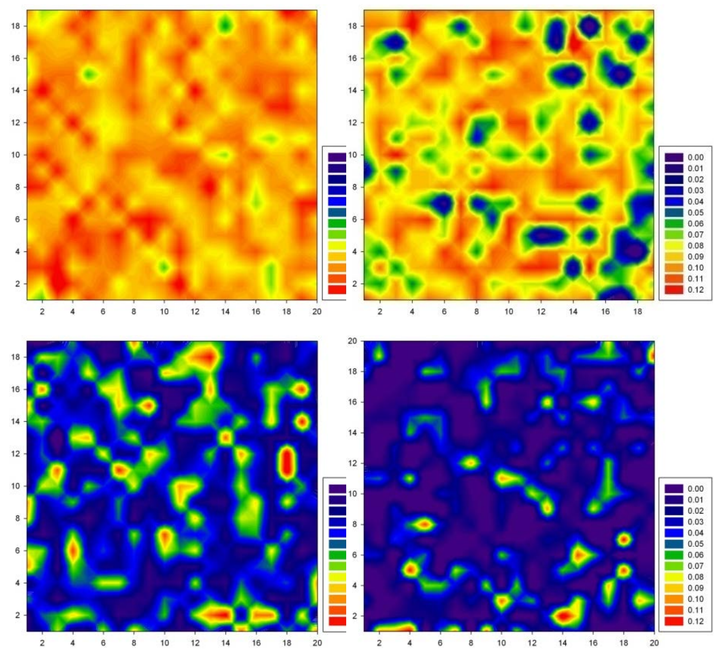


Photography of a GDL (on top) and FTIR-ATR image (below) measured by a an FPA detector with 64x64 pixel. An area of 64x64 µm² (128x128 points) is imaged.

Infrared microscopy on fresh and aged components



Intensity of the C-F vibration measured of MPL (on top) and the paper side (bottom) of a commercial GDL. The fresh component is on the left side, the aged on the right side. The investigated area is 50x50 mm², measured 20x20 points.



Intensity of the C-F vibration measured of MPL (on top) and the paper side (bottom) of a GDL with dry sprayed MPL. The fresh component is on the left side, the aged on the right side.

The decrease in the intensity of the C-F vibration is related to the decomposition or loss of the hydrophobic polymer in the GDL and MPL.

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