

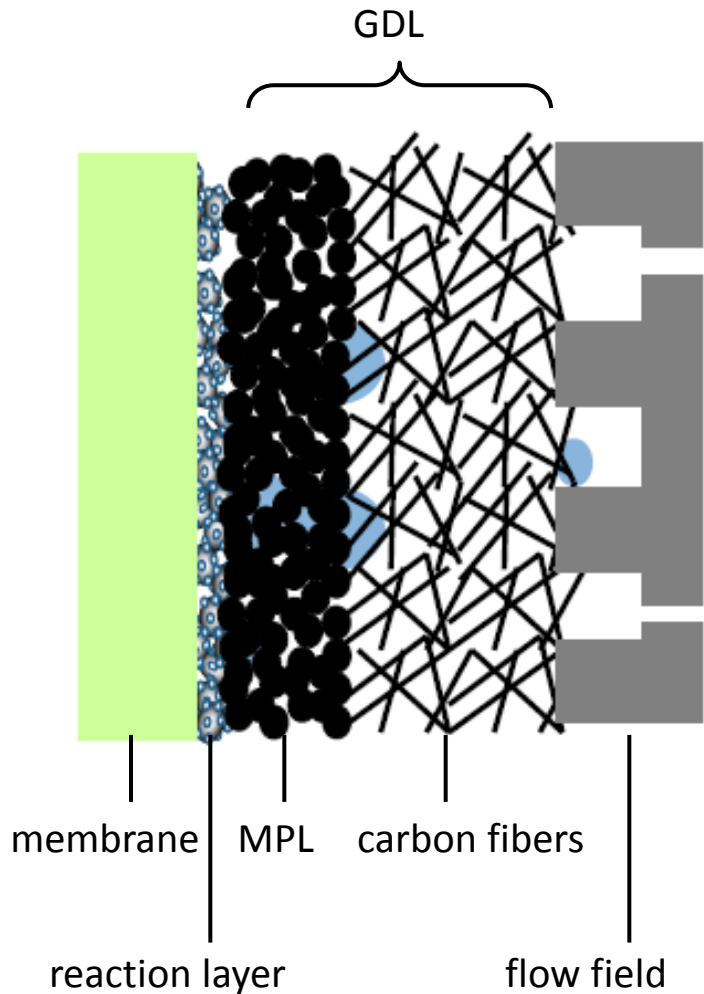
Influence of the MPL on PEM fuel cell performance

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J. Scholta, K.A. Friedrich

Knowledge for Tomorrow



Introduction:



Main requirements of GDL:

- Provision of gas and water transport
- Significant electrical and thermal conductivity
- Mechanical support of CCM

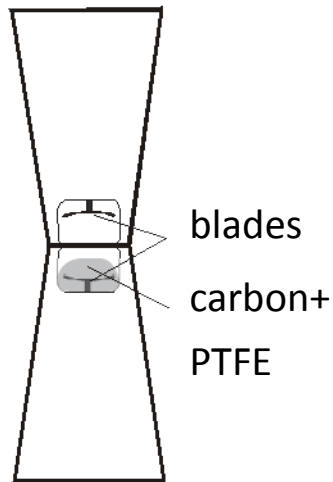
Objective:

- Investigation of the influence of the MPL on PEM fuel cell performance
- Approach: Development of self-supporting MPL
- Advantage: Manufacturing and following treatments of the MPL are independent from the GDL substrate

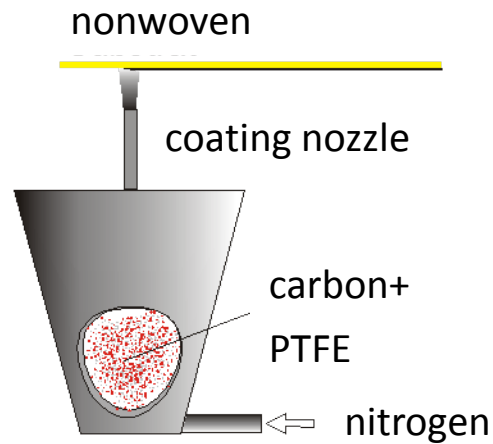


Dry spraying technology:

1. mixing



2. coating



3. fixation

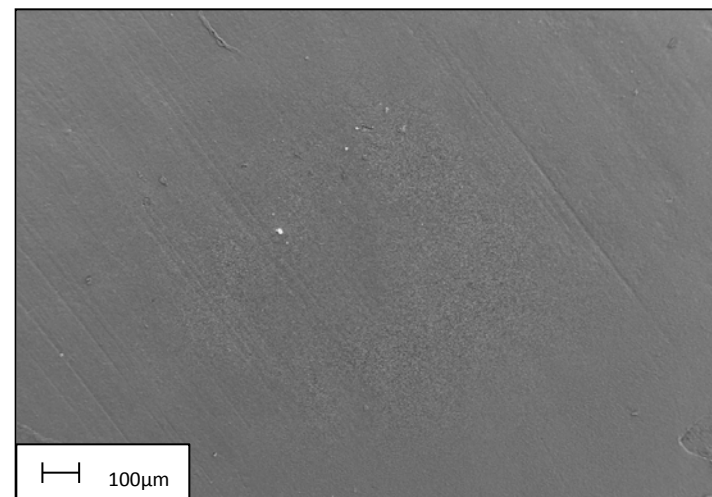
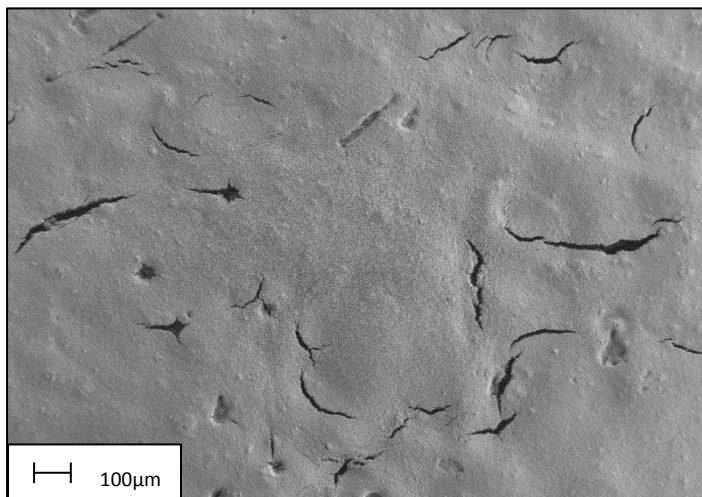


GDL assembly:

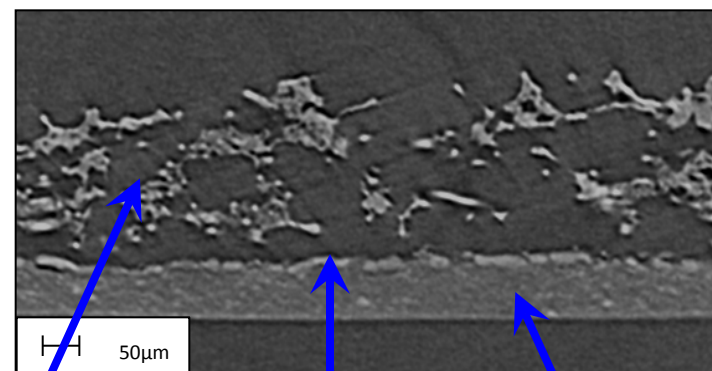
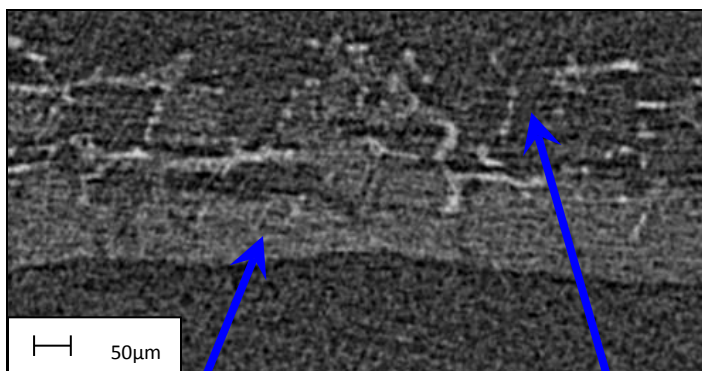
GDL25BC

In-house GDL

SEM:



CT:



MPL

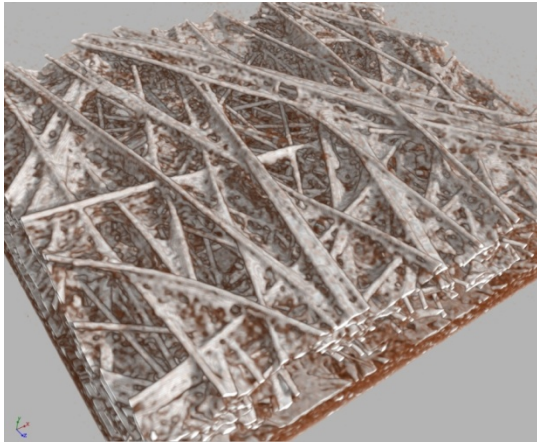
carbon fibers
(GDL25BA)

nonwoven

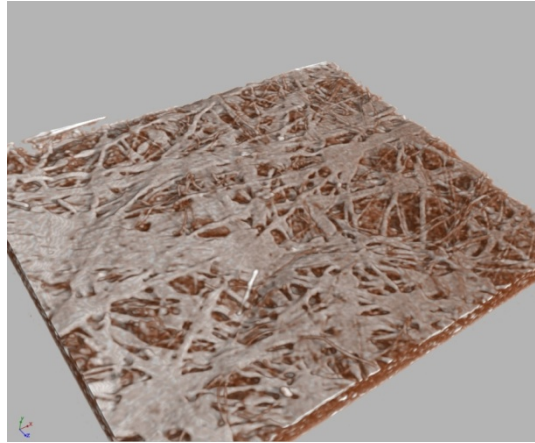
MPL



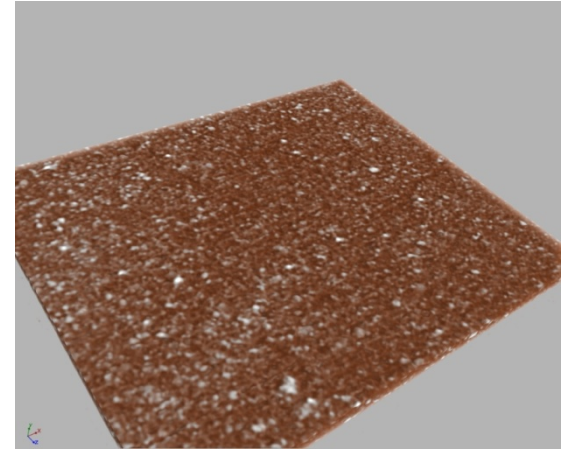
3D micrograph visualization of in-house GDL



macro porous carbon
fiber substrate



nonwoven of
synthetics



mixture of carbon
and PTFE



Variation in composition:

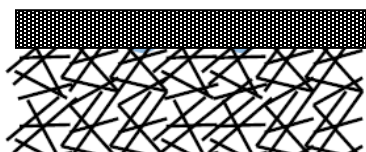
Sigracet
GDL25BC



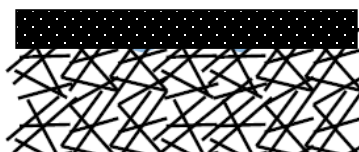
Sigracet
GDL25BA



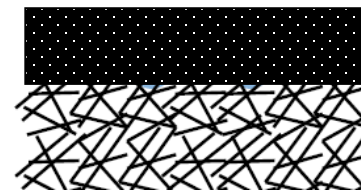
40% PTFE



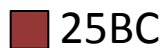
20% PTFE



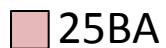
20% PTFE



Commercial GDLs



25BC



25BA

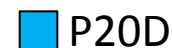
In-house GDLs



P40



P20

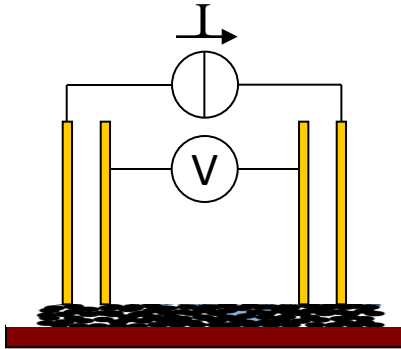


P20D

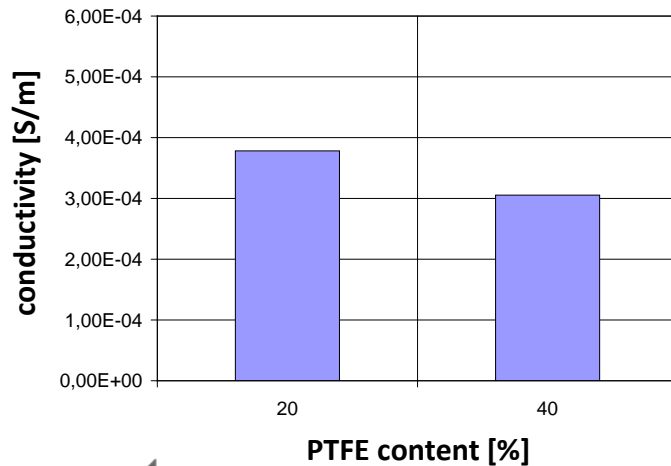


Characteristics of C/PTFE mixture:

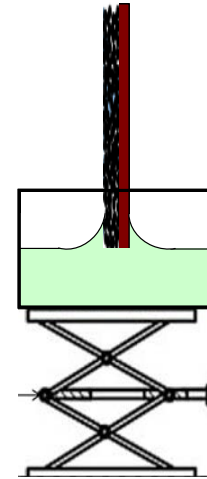
Electrical conductivity (in-plane)



4-point
measurement

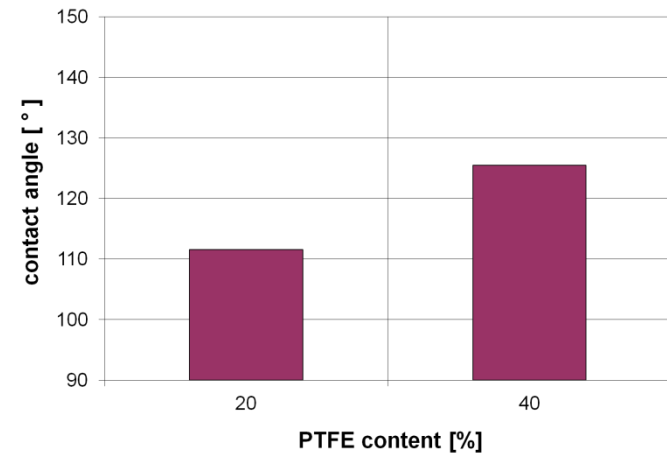


Hydrophobicity



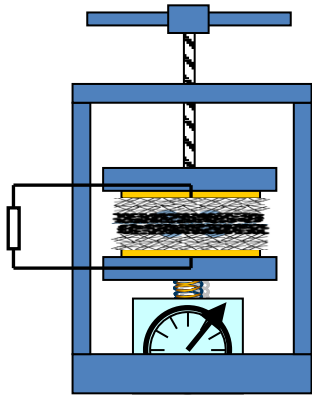
Washburn method

Calculation of water
contact angle
according to Owens-
Wendt

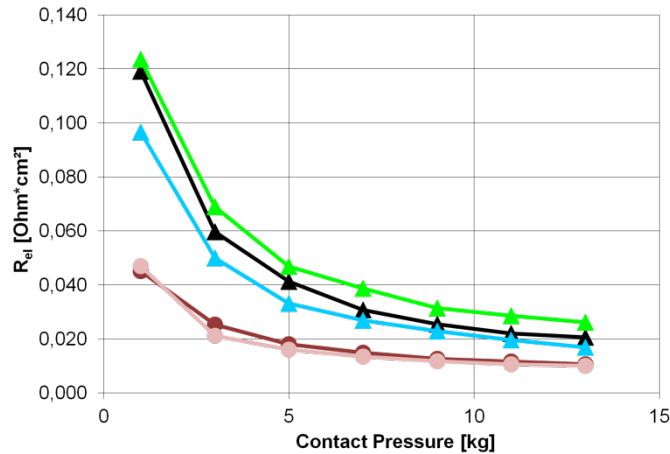


Characteristics of GDLs:

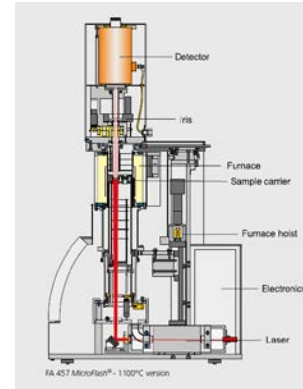
Electrical conductivity (through-plane)



2-point measurement

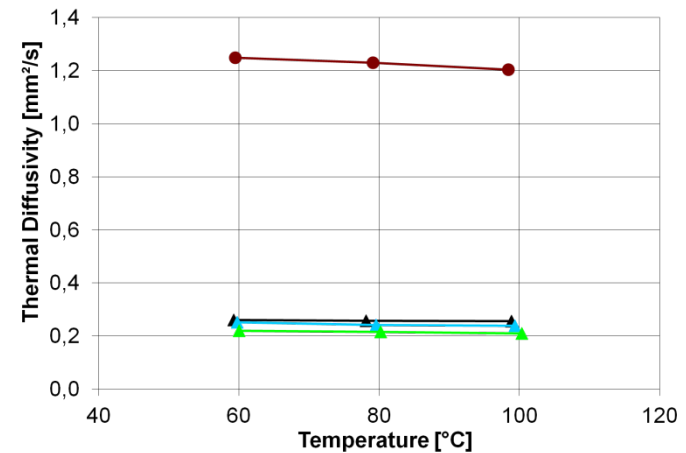


Thermal Diffusivity



Laser Flash Apparatus

LFA 457 MicroFlash® from Netzsch



Commercial GDLs

25BC

25BA

In-house GDLs

P40

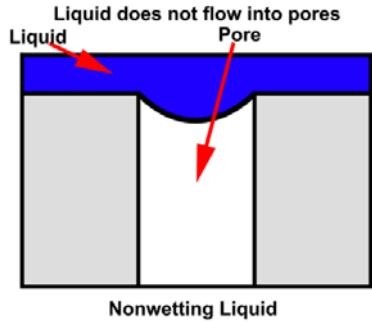
P20

P20D

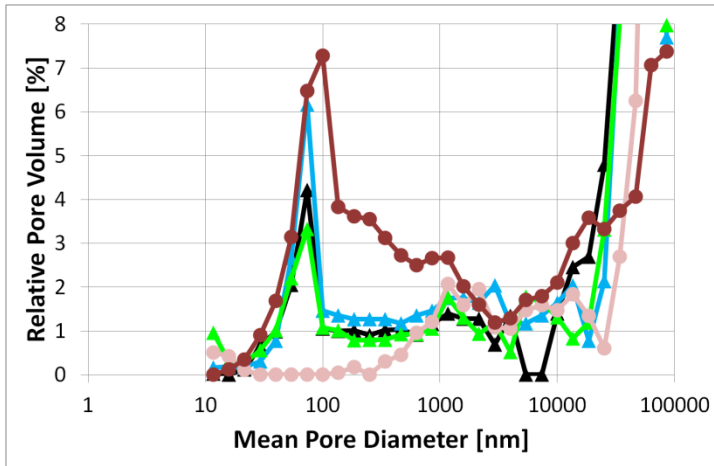


Characteristics of GDLs:

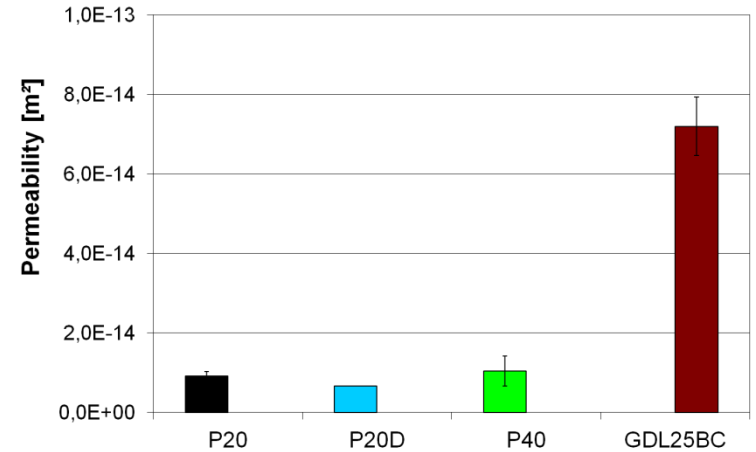
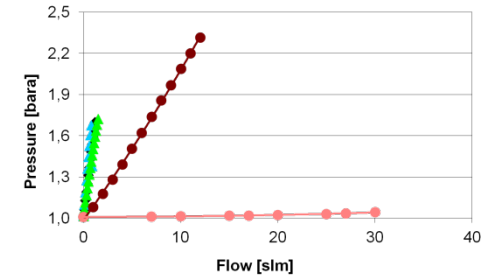
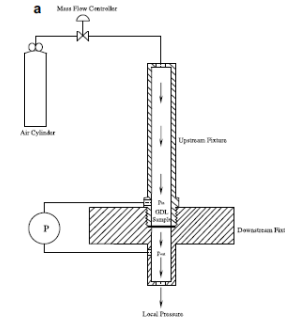
Porosity



mercury intrusion porosimetry



Permeability



Commercial GDLs		In-house GDLs		
■ 25BC	■ 25BA	■ P40	■ P20	■ P20D

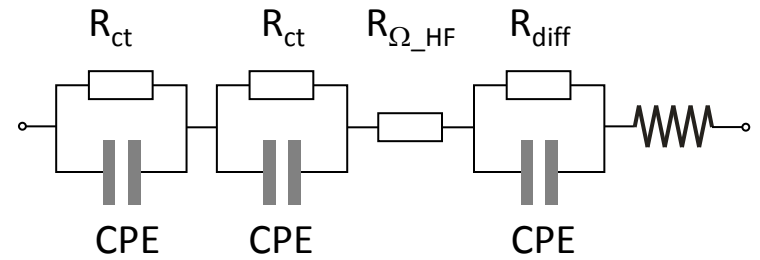
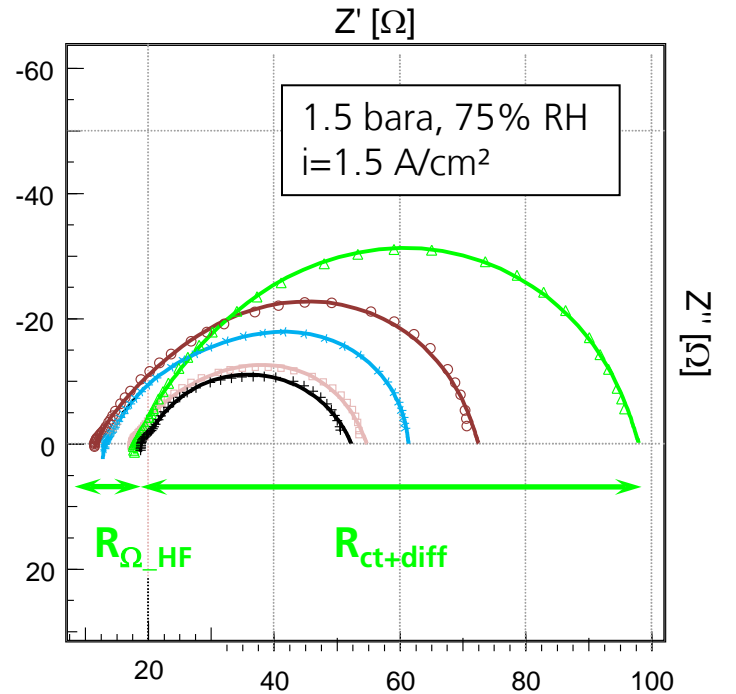
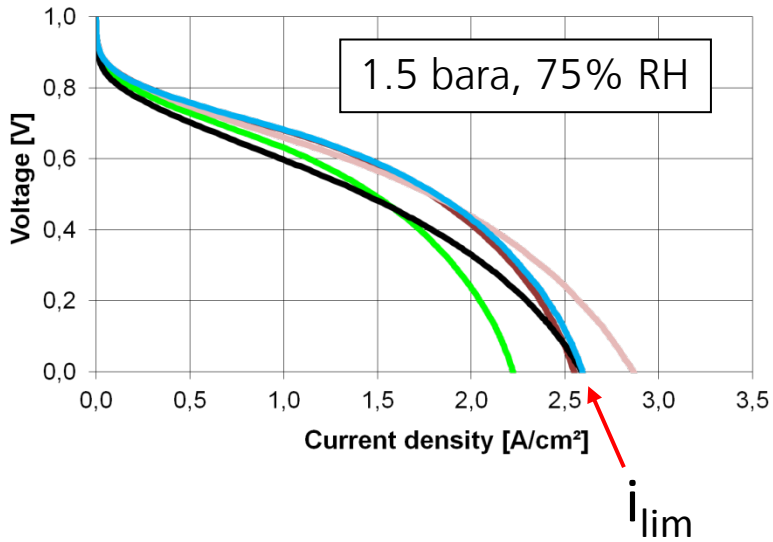


In situ characterization



In-situ characterization (5cm²):

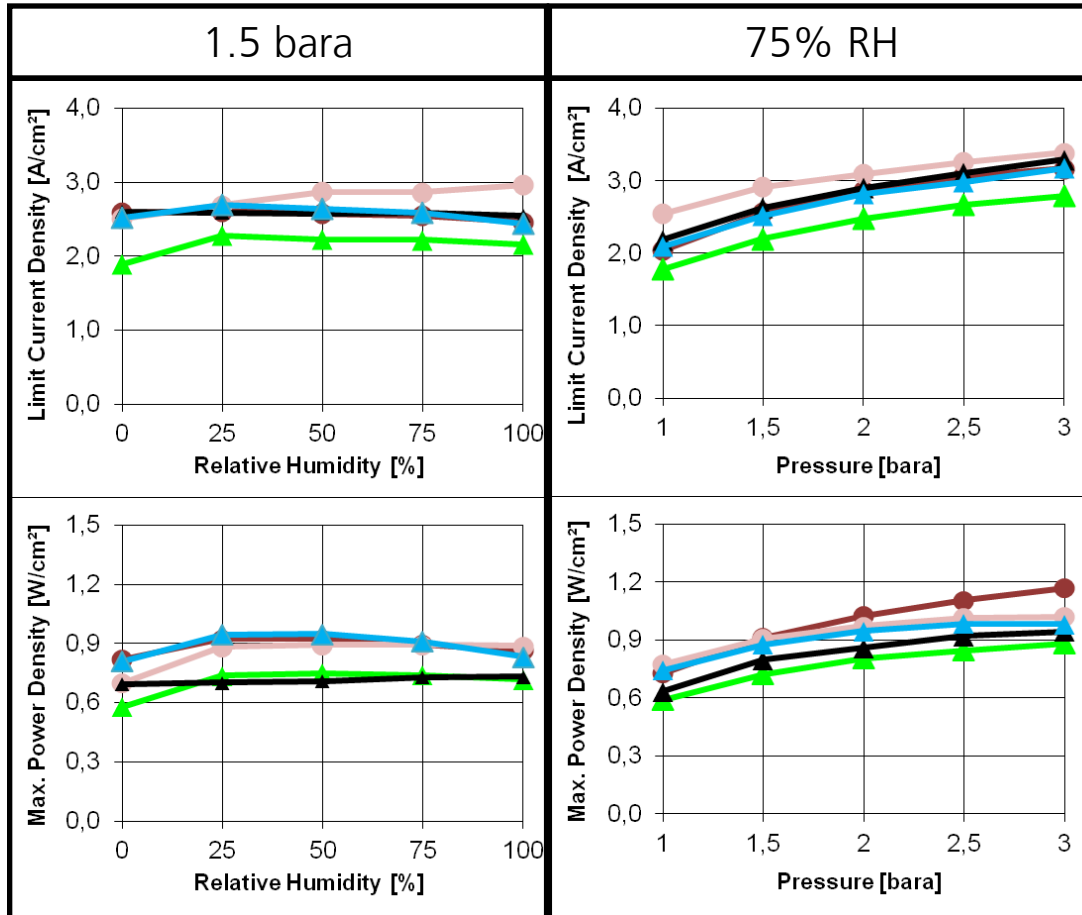
CCM: Gore Primea 57MESGA
 Anode: Sigracet GDL25BC from SGL Carbon
 Cathode: GDL variation



Commercial GDLs		In-house GDLs		
■ 25BC	■ 25BA	■ P40	■ P20	■ P20D



In-situ characterization (5cm²):

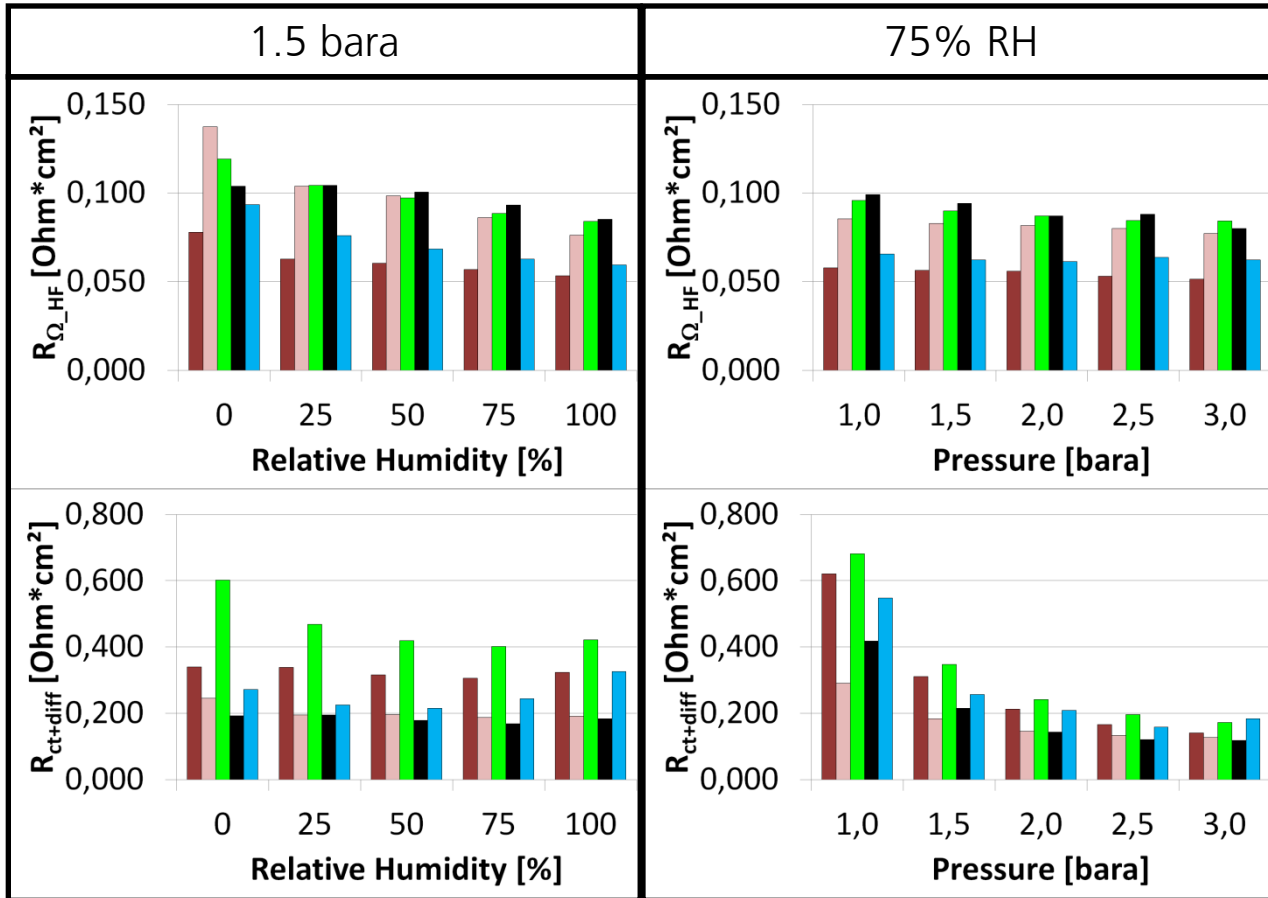


- w/o MPL: higher i_{lim}
- high PTFE content: low i_{lim} and P_{max}
- low PTFE content: higher i_{lim} , low P_{max}
- low PTFE content and double MPL thickness: higher i_{lim} , higher P_{max}

Commercial GDLs		In-house GDLs		
■ 25BC	■ 25BA	■ P40	■ P20	■ P20D



In-situ characterization (5cm²):



- w/o MPL: high R_{Ω_HF}
lower $R_{ct+diff}$
- high PTFE content:
high R_{Ω_HF} and $R_{ct+diff}$
- low PTFE content: high
 R_{Ω_HF} and low $R_{ct+diff}$
- low PTFE content and
double MPL thickness:
low R_{Ω_HF} and $R_{ct+diff}$

Commercial GDLs		In-house GDLs		
25BC	25BA	P40	P20	P20D



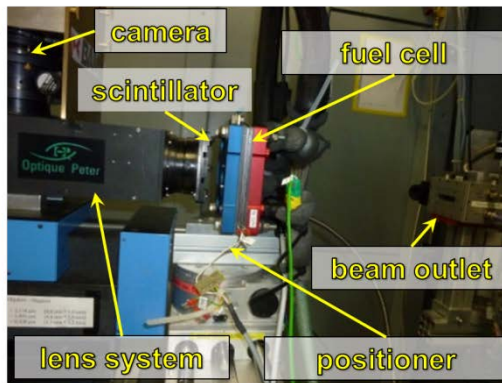
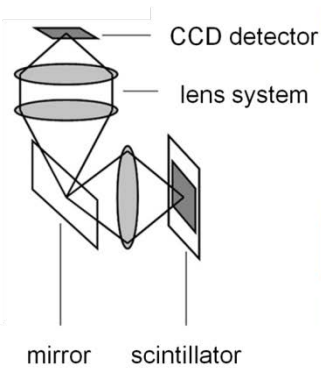
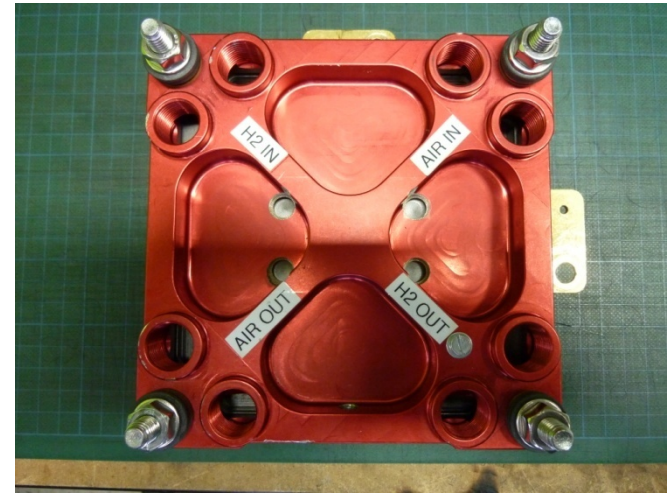
In situ radiography



Helmholtz-Zentrum Berlin Bessy II

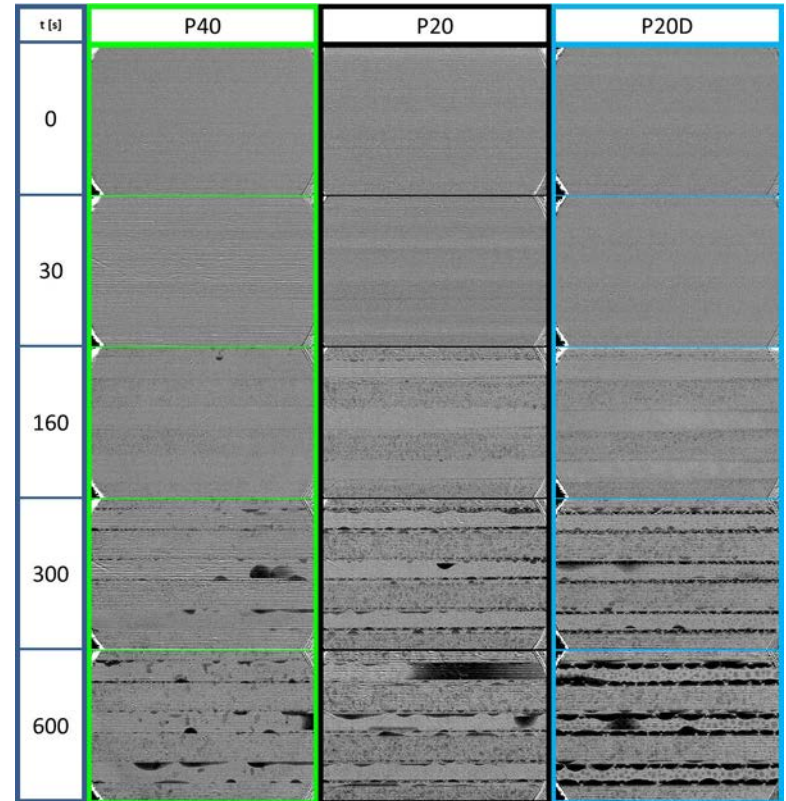
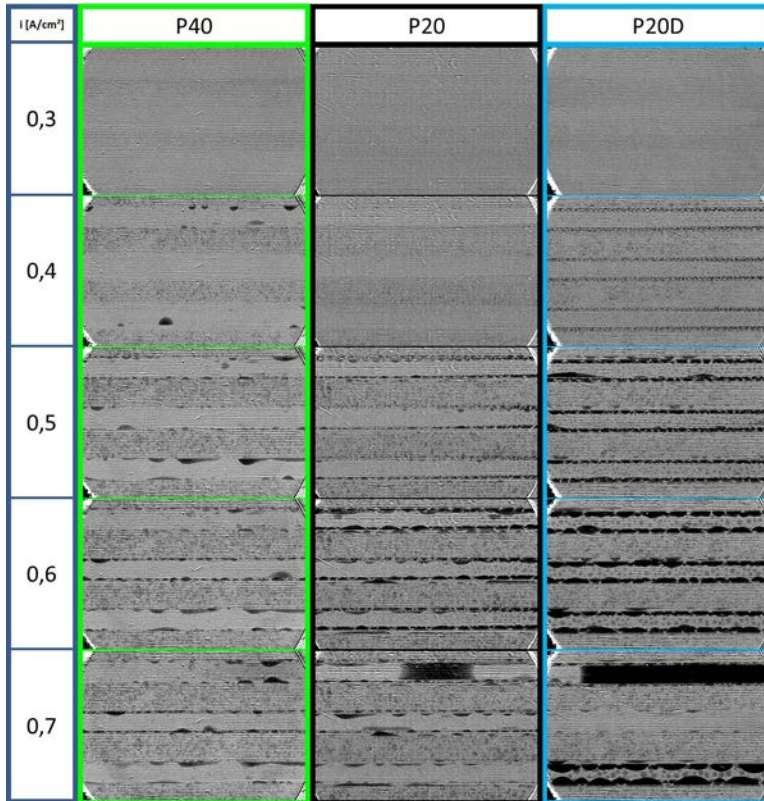
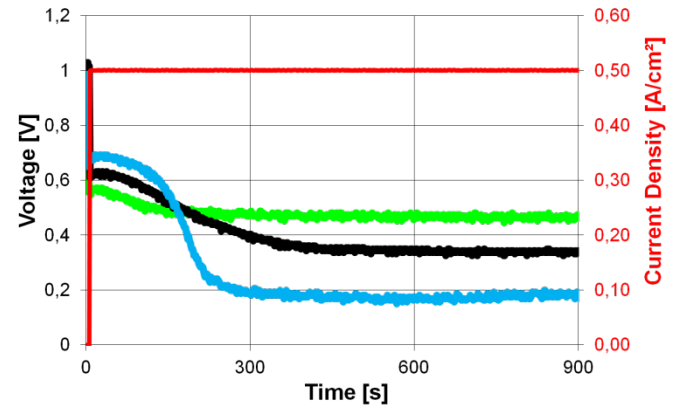
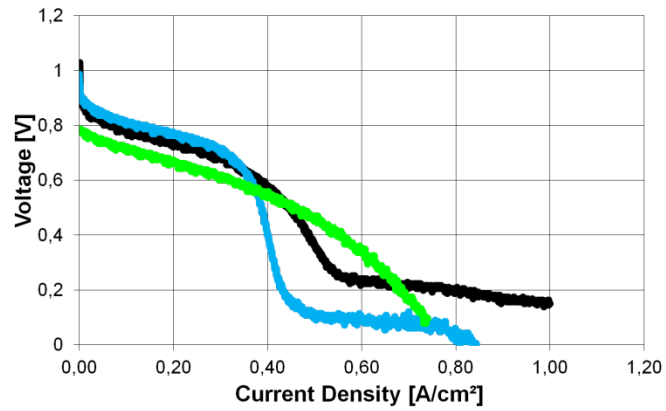


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In situ investigation of
water management of
in-house MPL





Summary and conclusions:

- The comparison of GDL25BC and GDL25BA shows that the ohmic resistance of the MEA decreases with a MPL and the maximum power density increases, in spite of constricted gas transport
- A high PTFE content and thereby increased hydrophobicity of in-house MPLs is disadvantageous for the electrical conductivity and the gas permeability of the MEA at the same time.
- A low PTFE content and a high thickness of in-house MPLs decreases the ohmic resistance. That lead to high power densities, but high humidity conditions constricts the gas transport strongly. This could caused by the increased appearance of liquid water that in the synchrotron tests could be observed.



Thank you for your attention

