Institute of Engineering Thermodynamics

Hydrophobicity Patterning of Gas Diffusion Media and Performance in Polymer Electrolyte Fuel Cells

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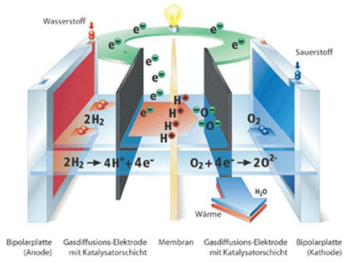
Polymer Electrolyte Fuel Cells



Chemical energy → Electrical energy
lightweight – mobile – emission free

The water management dilemma

Gas diffusion layers:
Ideally *dry*
No blocked pores
High gas diffusivity
High cell performance

current limitation

cracks

excess product water

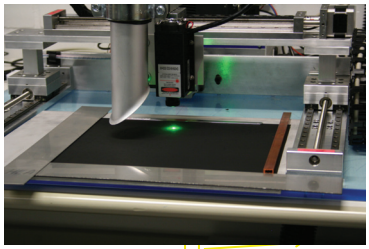
condensing droplets

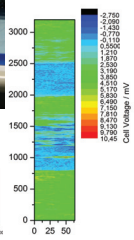
Membranes:
Ideally *humid*
High proton mobility
High current density possible
High cell performance

complete flooding

A balanced water management is critical for durability and performance. The GDL acts as passive transporter for charge carrier, gases *and* product water.

Laser ablation patterning



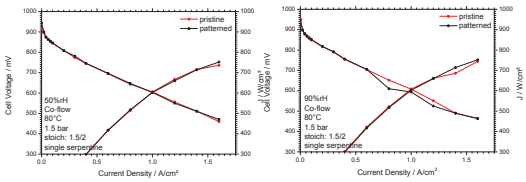


Upper:
Programmable laser ablation

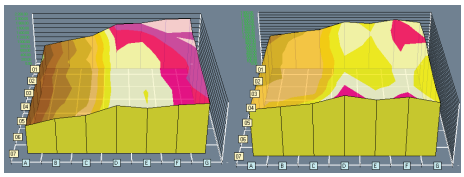
Right: IR mapping of C-F stretch vibrations scros a patterend channel: local depletion of PTFE

Patterned hydrophobicity by laser modification of PTFE-carbon composite in microporous layer (MPL) of GDL

Commercial CCM1 + GDL24BC

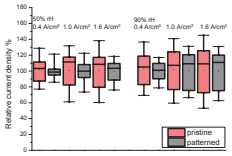


No impact on performance, on neither humidification level…

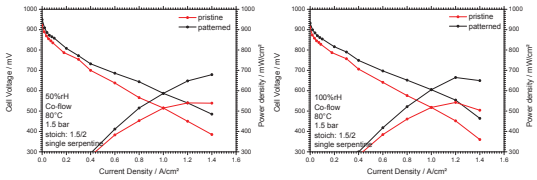


1.0 A/cm² 1.5 A/cm² 1.9 A/cm²

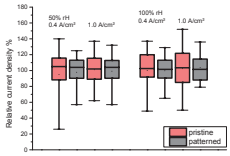
Current density distributions are more homogeneous!



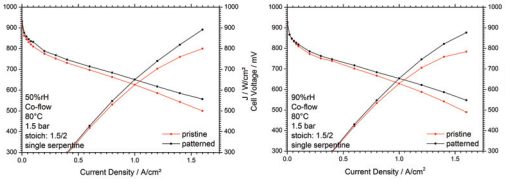
Commercial CCM1 + prototype GDL



Surprisingly poor overall performance of this CCM+GDL combination, but distinct impact by patterning: Performance & homogeneity

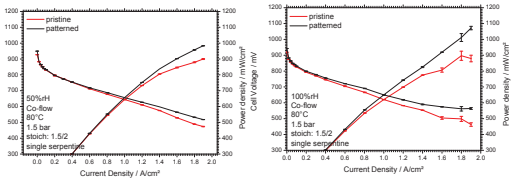


IMPACT development + GDL25BC

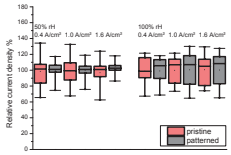


10-15% performance gain
More pronounced at higher loads

Commercial CCM2 + prototype GDL



Performance gain of up to +20% particularly at high loads & humidity
Better homogeneity mostly in 50% rH condition

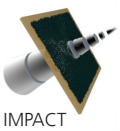


Conclusions

- Ablative laser patterning of the MPL can improve cell **performance**.
- Ablative laser patterning of the MPL can improve the **homogeneity** of the current density
  → less areas with extreme current density leads to longer life time.
- Patterned hydrophobicity improves the potential transport capability of the gas diffusion layers by adding local pathways.
- **Combination** of **CCM** (catalyst coated membrane) and **GDL** need to match – improvements in one component may not directly be transferred to other components!

Acknowlegdements

SGL Carbon is gratefully acknowledged for providing samples.
We are grateful to Dr. Daniel Garcia for experimental support.
The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for Fuel Cell and Hydrogen Joint Technology Initiative under Grants No. 303446 (IMPALA) and No. 303452 (IMPACT).



IMPACT

European Commission

FCH FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

IMPALA

Knowledge for Tomorrow

Wissen für Morgen

DLR Deutsches Zentrum für Luft- und Raumfahrt