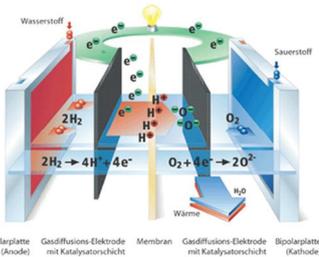


Polymer Electrolyte Fuel Cells



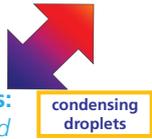
Chemical energy → Electrical energy
lightweight – mobile – emission free

The water management dilemma

Gas diffusion layers:

current limitation
Ideally dry
No blocked pores
High gas diffusivity
High cell performance

excess product water



cracks

Membranes:
Ideally humid

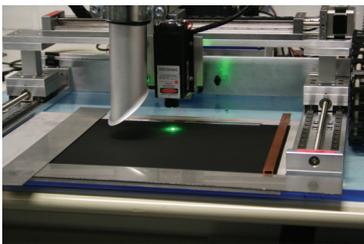
condensing droplets

complete flooding

High proton mobility
High current density possible
High cell performance

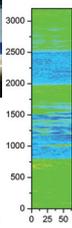
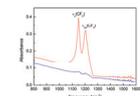
A balanced water management is critical for durability and performance. The GDL acts as passive transporter for charge carrier, gases and product water.

Laser ablation patterning



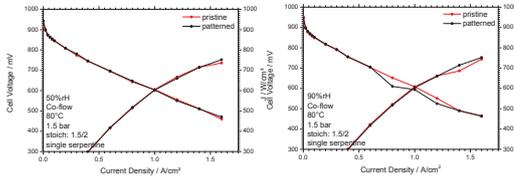
Upper: Programmable laser ablation

Right: IR mapping of C-F stretch vibrations across a patterning channel: local depletion of PTFE

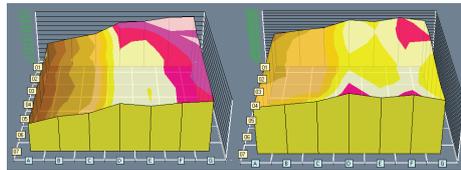


Patterned hydrophobicity by laser modification of PTFE-carbon composite in microporous layer (MPL) of GDL

Commercial CCM1 + GDL24BC

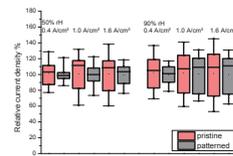


No impact on performance, on neither humidification level...

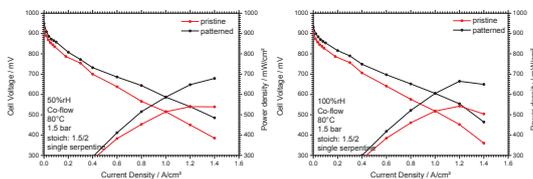


1.0 A/cm² 1.5 A/cm² 1.9 A/cm²

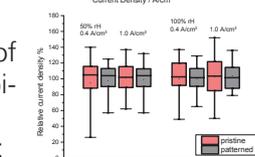
Current density distributions are more homogeneous!



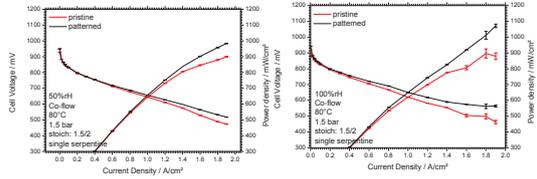
Commercial CCM1 + prototype GDL



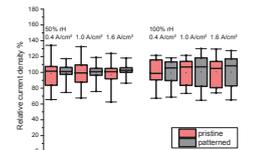
Surprisingly poor overall performance of this CCM+GDL combination, but distinct impact by patterning: Performance & homogeneity



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!

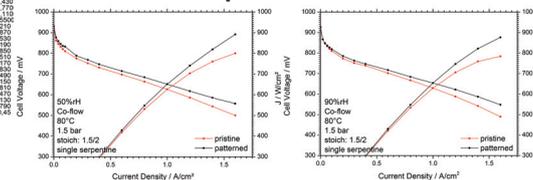
Acknowledgements

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IMPACT development + GDL25BC



10-15% performance gain
More pronounced at higher loads



Knowledge for Tomorrow

Wissen für Morgen

