DOLPHIN

Disruptive pemfc stack with n**O**vel materia**L**s, **P**rocesses, arc**H**itecture and optimized **IN**terfaces

Diffusion and Protective Coating

(Dena Kartouzian, ZSW)

Diffusion and Protective Coating

- Objectives:

Combine functionality of GDL substrate and traditional MPL into one layer

- shorten mass transport pathways to enable high reactant and sufficient water transfer
- minimize interface resistance from catalyst layer to EFC
- protect the catalyst layers from excessive mechanical stress to mitigate degradation
- Develop a method to transfer an MPL onto the electrodes of the EC

Micro Porous Layer (MPL)

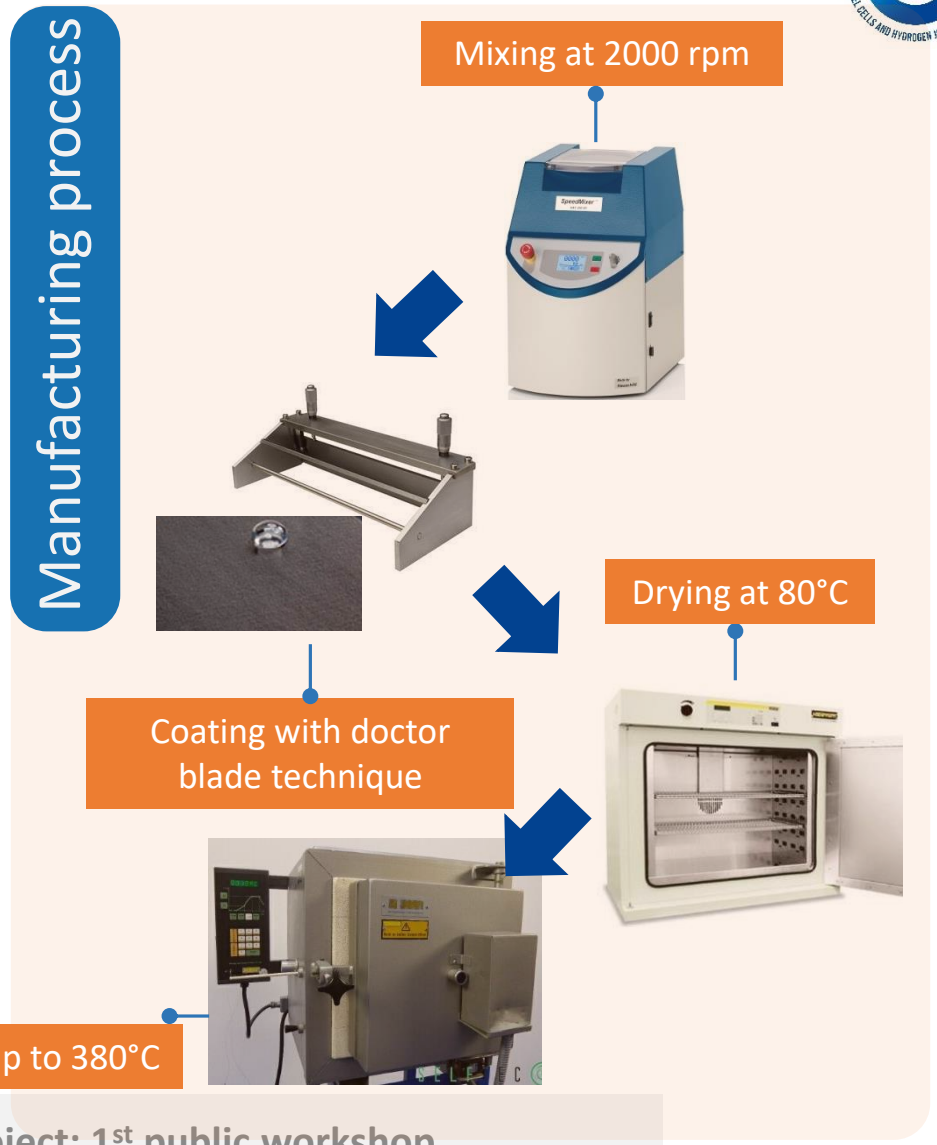
Manufacturing traditional MPL at ZSW

➢Ink Properties

Ink composed of					Ink / MPL properties
Carbon	Triton X-100	Methyl cellulose	DI Water	PTFE	PTFE* content (in MPL) **
					[wt.%]
					20

*PTFE Zonyl™ MPD 1700 (Chemours™)
**PTFE content in MPL assuming no components except carbon and PTFE remain after heat treatment.

- ➢ Coating onto a commercial GDL Substrate (available within the project)

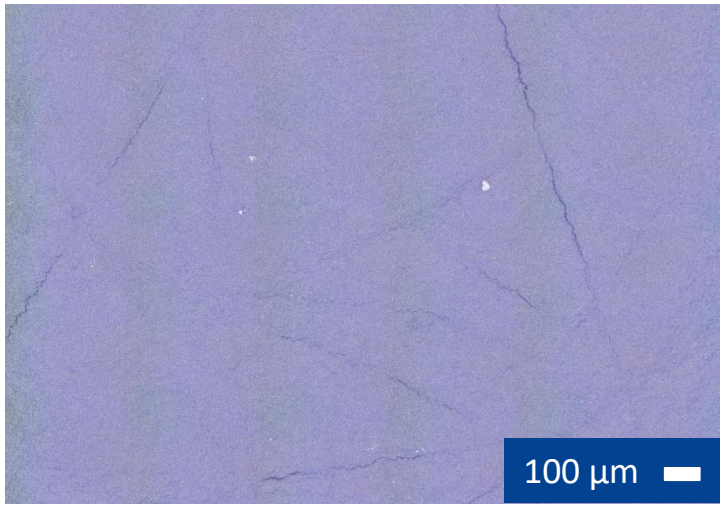


Diffusion and Protective Coating

MPL on Substrate

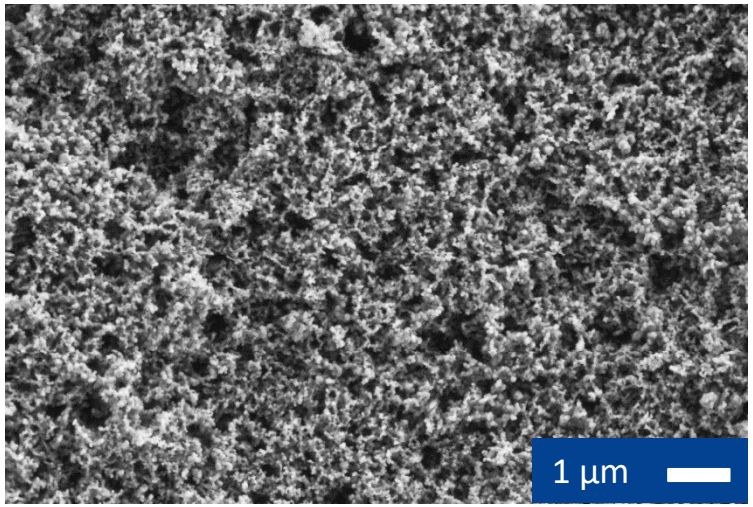
- MPL coated on GDL substrate:

Light microscope



Magnification: 137.5 X

SEM



Magnification: 30 kX

- ✓ Nearly homogenous surface is observed under light microscope
- ✓ The cracks on the surface are a result of the carbon fiber structure of the GDL substrate
- ✓ No agglomeration of ink components observable under SEM

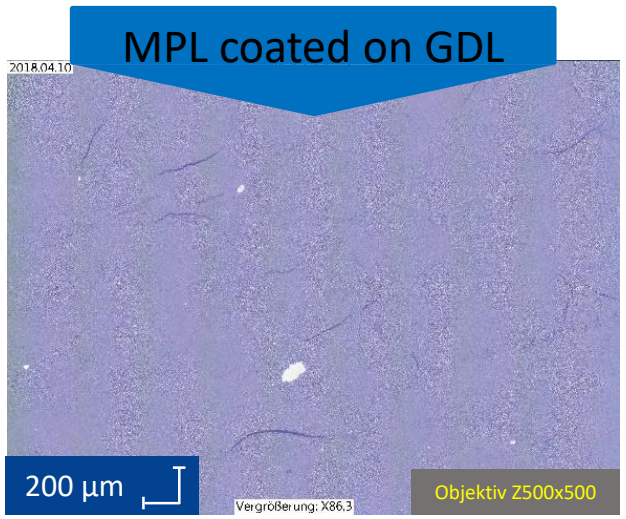
Stand-alone MPL

Manufacturing stand-alone MPL

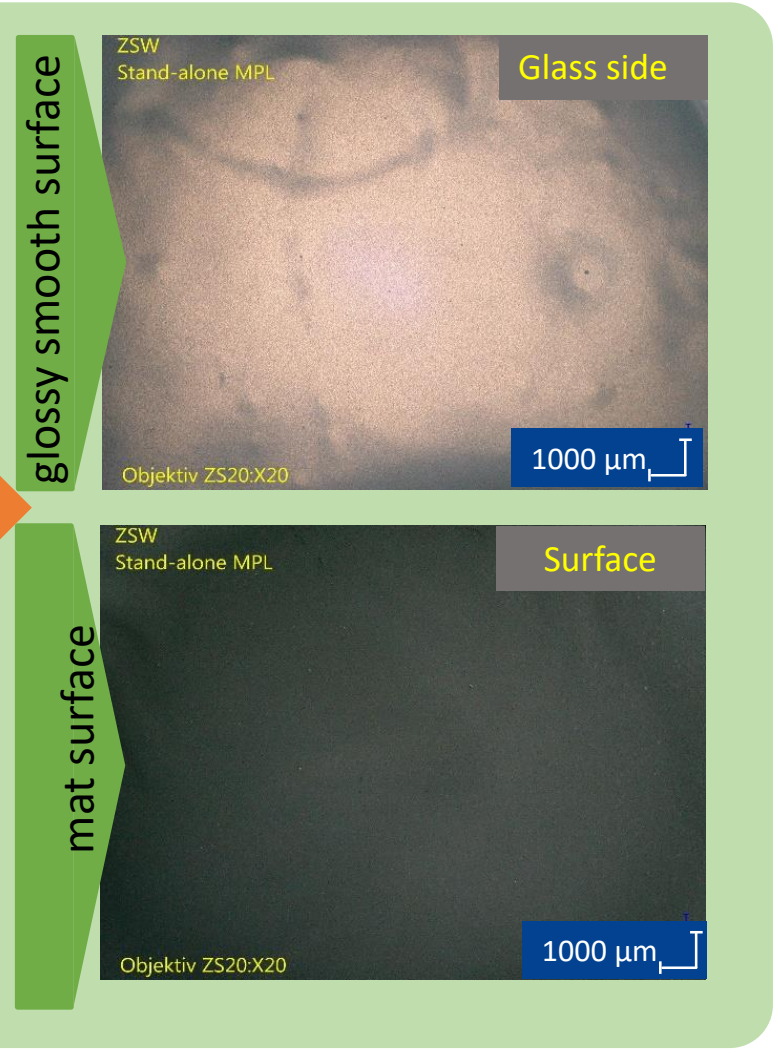
- MPL Coating on glas plate

Thickness $_{\text{stand-alone MPL}}$ = 25 µm
Thickness $_{\text{GDL-MPL}}$ = 213 µm

Optical microscope



Stand-alone MPL



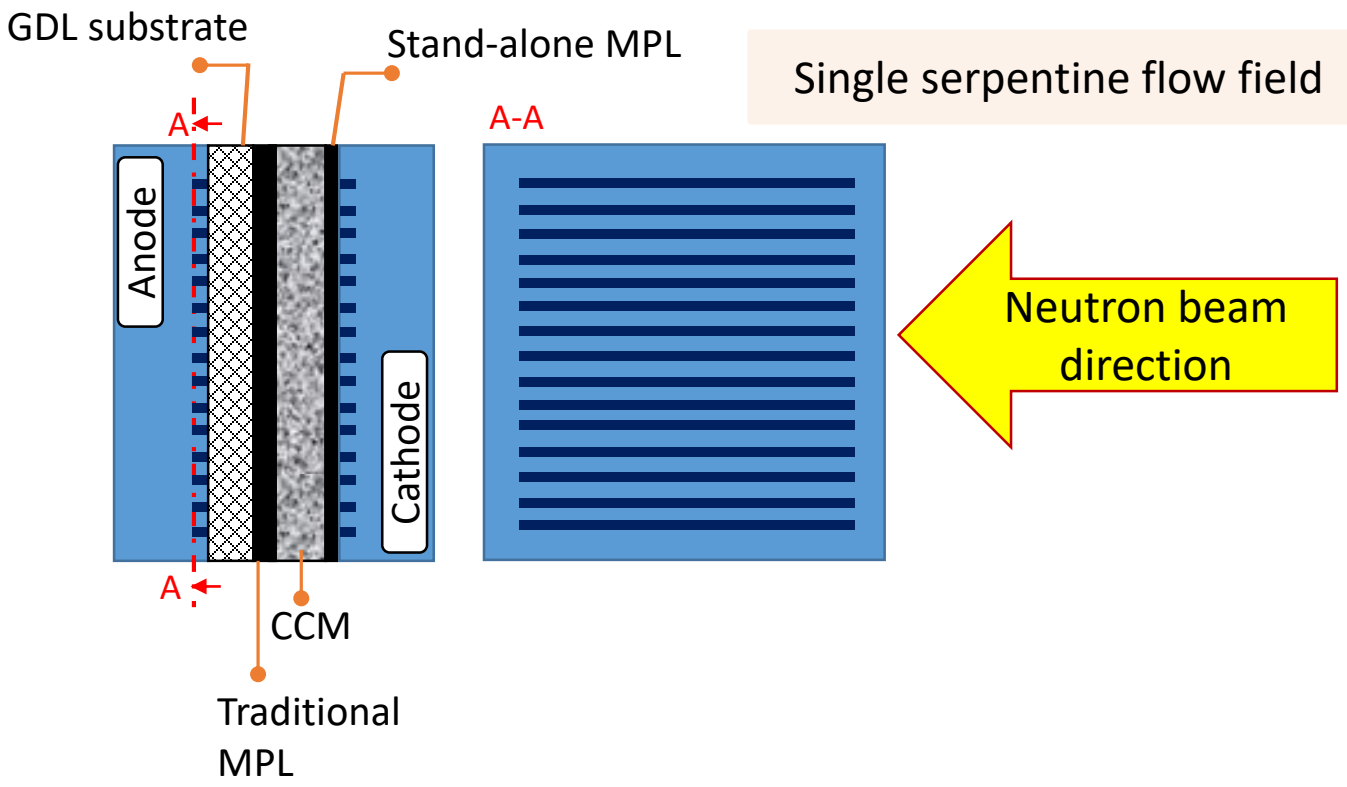
Neutron Radiography at ILL

Neutron Radiography Fuel Cell

- Specific CEA cell design [1] to facilitate the detection of the liquid water in the flow field channels and within porous media

Active area	1.8 cm²
CCM	DOLPHIN commercial reference
Anode GDL	GDL substrate + traditional MPL
Cathode GDL	Stand-alone MPL

➢ The reference cell with traditional GDLs on both cathode and anode will be investigated during the next measurement campaign



[1] J. Lee et al., "Neutron imaging of operando proton exchange membrane fuel cell with novel membrane," J. Power Sources, vol. 496, p. 229836, Jun. 2021.

Neutron Radiography at ILL

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European Commission

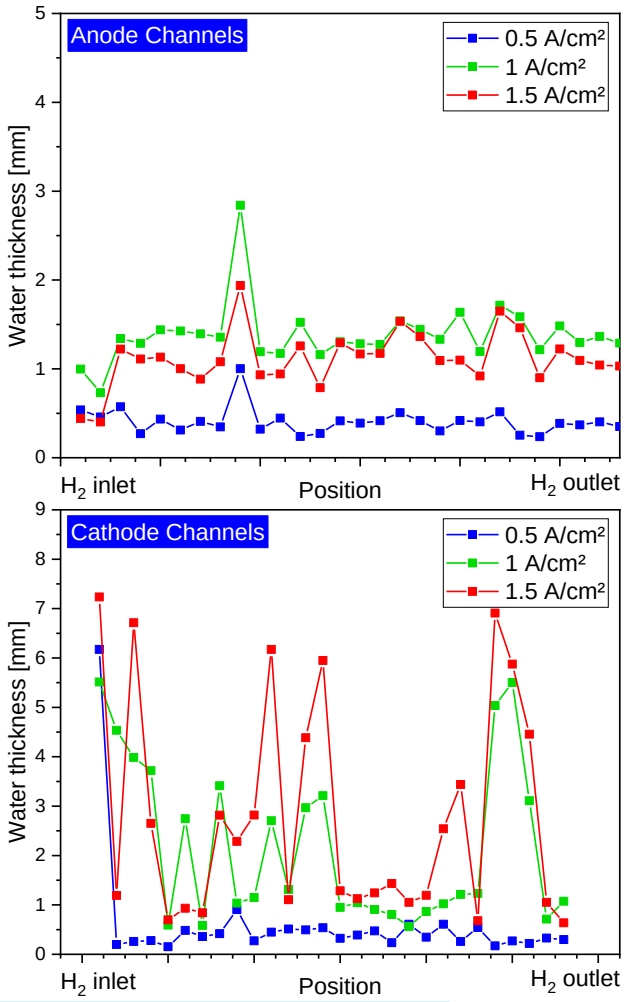
FCH

Test boundary conditions

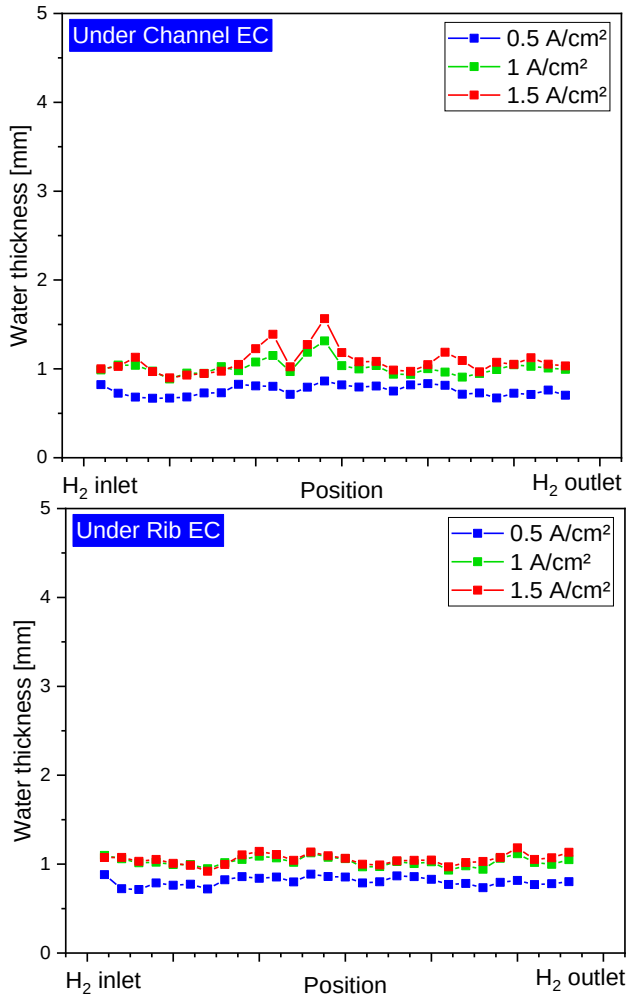
$P_{Anode/Cathode}$	2.5/2.2 bar
T_{Cell}	83°C
i_{min}	0.5 A/cm²
i_{med}	1 A/cm²
i_{max}	1.5 A/cm²

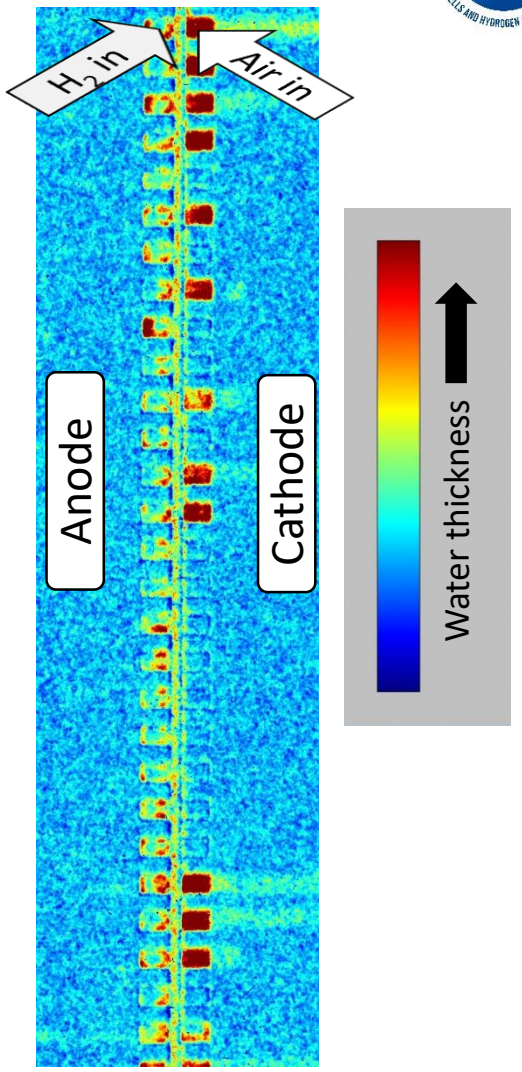
Water thickness

In channels



In EFC





Diffusion and Protective Coating

Micro Porous Layer (Automated spraying)

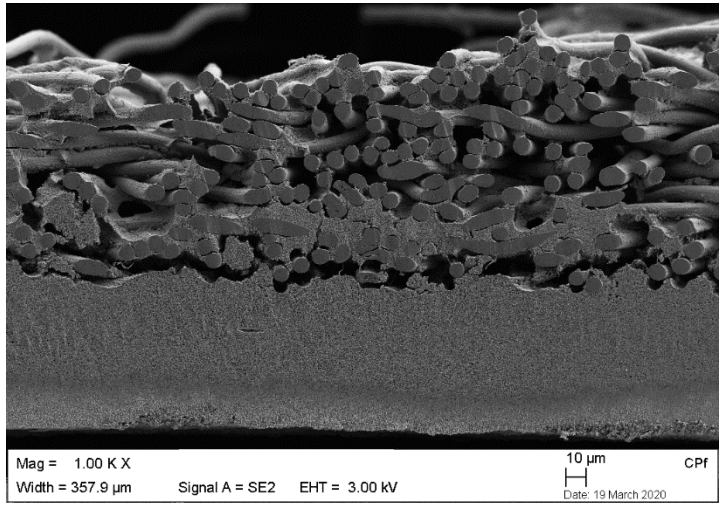
Moving toward new coating technique

Doctor blade

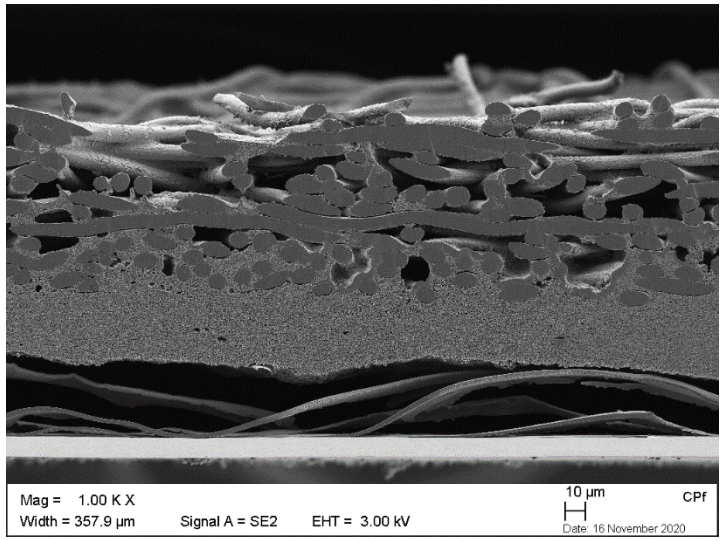
Step towards automatization

- Enhanced reproducibility
- Principle transferable to mass production
- Better process control
- Higher flexibility

Airbrush spraying

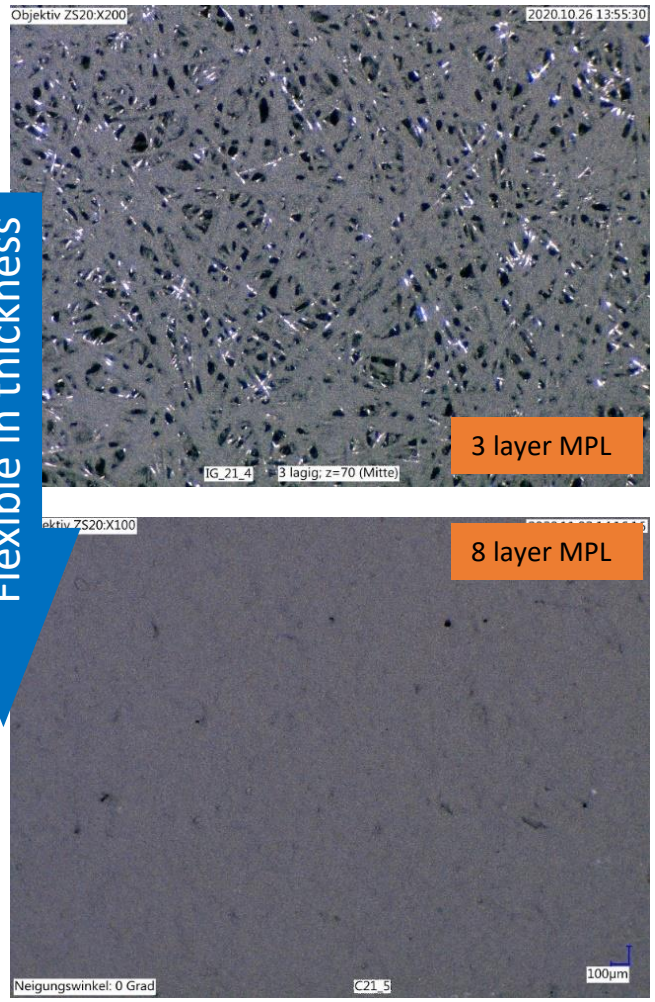


Established MPL

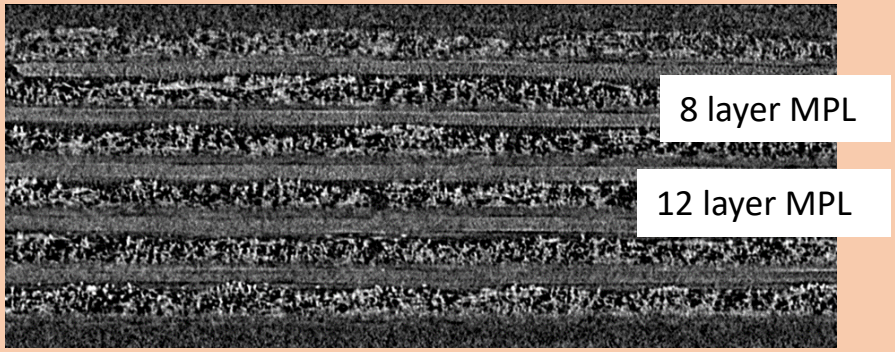


New MPL

Micro Porous Layer (Automated spraying)



Thickness evaluation through µCT measurements



Number of Layers	Thickness [µm]
8	25,6102363
12	38,1870253

- Each coated layer is approximately 3µm thick
  - Lots of flexibility to manufacture MPLs of different thicknesses
  - Manufacturing multilayer MPLs with varying properties of the layers (wettability, porosity)

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Thank you for your attention!

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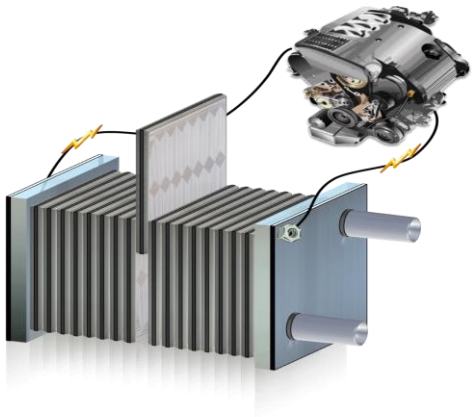

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DOLPHIN Project: 1st public workshop (cell and manufacturing technologies) - virtual – 18/06/2021