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LOWCOST-IC

D3.2 – Optimized Interconnect geometry for higher robustness

PROJECT INFORMATION

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DELIVERABLE INFORMATION

WP NO.	3
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DISSEMINATION LEVEL

PU	Public	
PP	Restricted to other programme participants (incl. Commission Services)	
RE	Restricted to a group specified by the consortium (incl. Commission Services)	
CO	Confidential, only for the members of the consortium (incl. Commission Services)	x

1 Design

The integration of thinner electrolytes in the current Sunfire Stack-design leads to cell cracks along the channel geometry of the flow field. An analysis showed, that this is related to a low stiffness of the clamping situation of the MEA. The distance between the cathode ribs on the flow field is too large for the stiffness of the MEA with thin electrolyte. This leads to a kinking of the MEA and therefore a higher probability of cell cracks.

Two possibilities were investigated to overcome this issue:

- Minimizing the distance of cathode ribs
- Reducing the maximum straight channel length

A design study was performed to define the design features, especially with respect to mechanical stability, producibility and costs.

A simulation for stamping of the flow fields showed, that conventional stamping is not suitable but hydroforming is.

In the proposed design (see figure 1) the distance of the cathode ribs is reduced by 25% and the maximum channel length is reduced by 90% due to a meandering structure. This leads to an increase of the stiffness, so that a MEA with a 60 µm thick electrolyte is being mechanically integrated as robust as a MEA within the former design (90 µm thick electrolyte).

Flow resistance at the air-side is increased by a factor 2.5, but since the absolute value is still low, this has a minor effect on the stack-properties.

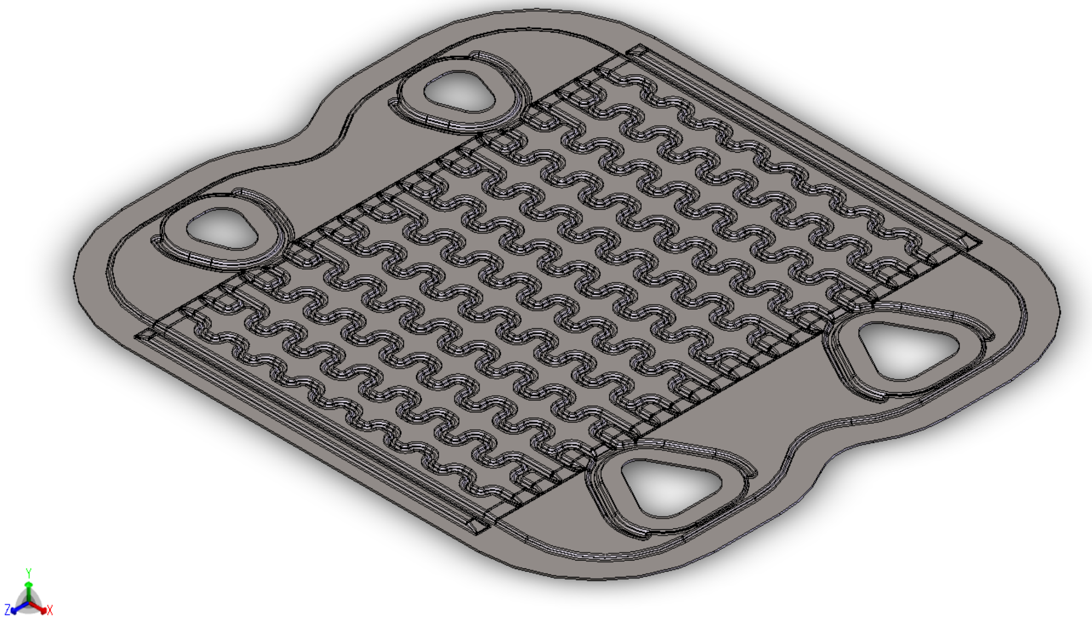


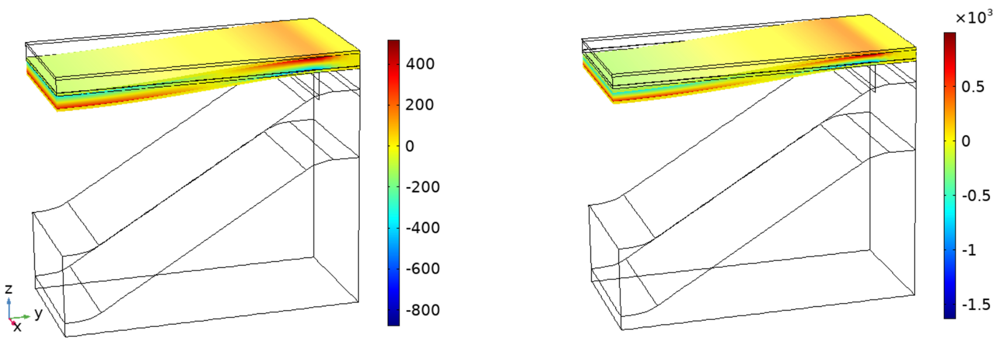
Figure 1 Flow field with rib-structure

2 Mechanical analysis

To analyze the impact of the new interconnect geometry a finite element model was constructed. Although the specific loading of the cell inside the stack is very complex to determine, it is known that the original thicker electrolyte support could withstand the load. Thus, the stress in the original geometry with the original electrolyte thickness serves as a reference to feasible stresses. The new geometries with the new electrolyte thicknesses can thus be investigated based on this reference.

In Figure 2 the stresses in the electrolyte at a reference load of 1 MPa for original geometry with the original 90 μm electrolyte and the new 60 μm thick electrolyte are shown. The stress level in the electrolyte increases by a factor of two, approximately. This could thus well be an explanation for the observed failures.

$h_{\text{electrolyte}} = 90\ \mu\text{m}$, $w_{\text{channel}} = 4.34\ \text{mm}$ | $h_{\text{electrolyte}} = 60\ \mu\text{m}$, $w_{\text{channel}} = 4.34\ \text{mm}$



$\tilde{\sigma}_{yy}^{\text{max}} = 515\ \text{MPa}$ | $\tilde{\sigma}_{yy}^{\text{max}} = 992\ \text{MPa}$

Figure 2 Stress level in the original 90 μm and new 60 μm thick electrolytes at a normalized load of 1 MPa in the original interconnect geometry.

In Figure 3 the stress level in the new 60 μm electrolyte while supported with cut-outs of the new interconnect geometry with different widths is shown. The stress level is reduced significantly as compared to the stresses in the new electrolyte over the original channel width (31 % and 66 %).

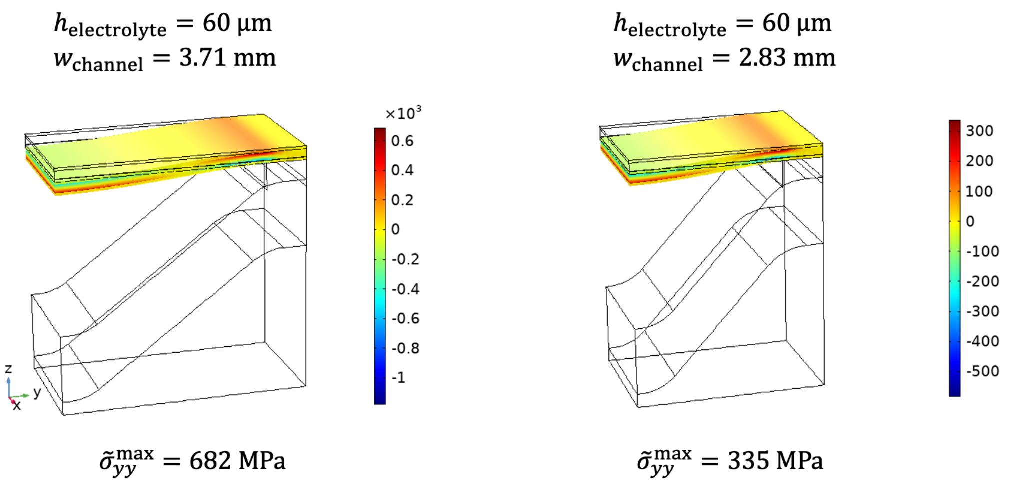


Figure 3 Stress level in cut-out from the new geometry of the interconnect with a 60 µm electrolyte.

The maximum stress in the electrolytes with different thicknesses spanning over channels with different widths are compared in Figure 4. Although the stresses in the electrolytes spanning over the new interconnect geometries is significantly reduced, then the widest new interconnect geometry with the new electrolyte thickness results in higher loads than in the original geometry with the original electrolyte thickness (32 % higher).

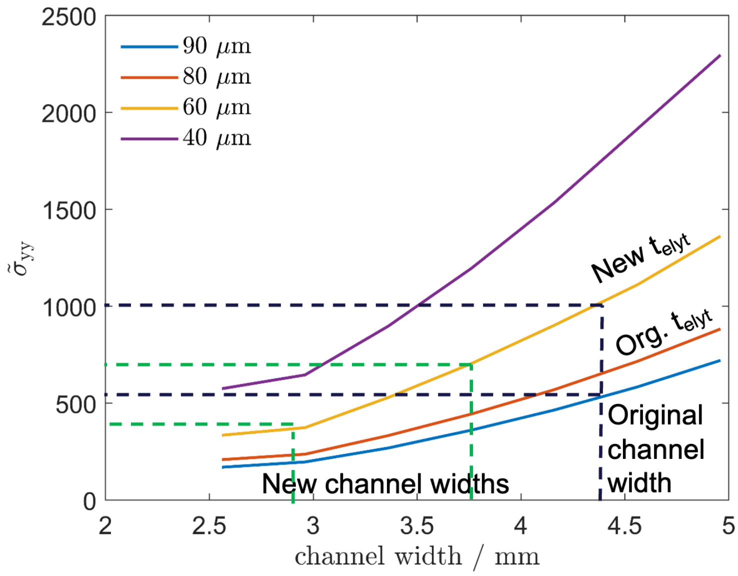


Figure 4 Maximum stress in the electrolytes with different thicknesses, spanning over channels with different widths.

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