
Durability Analysis on Solar Energy Converters containing Polymeric Materials



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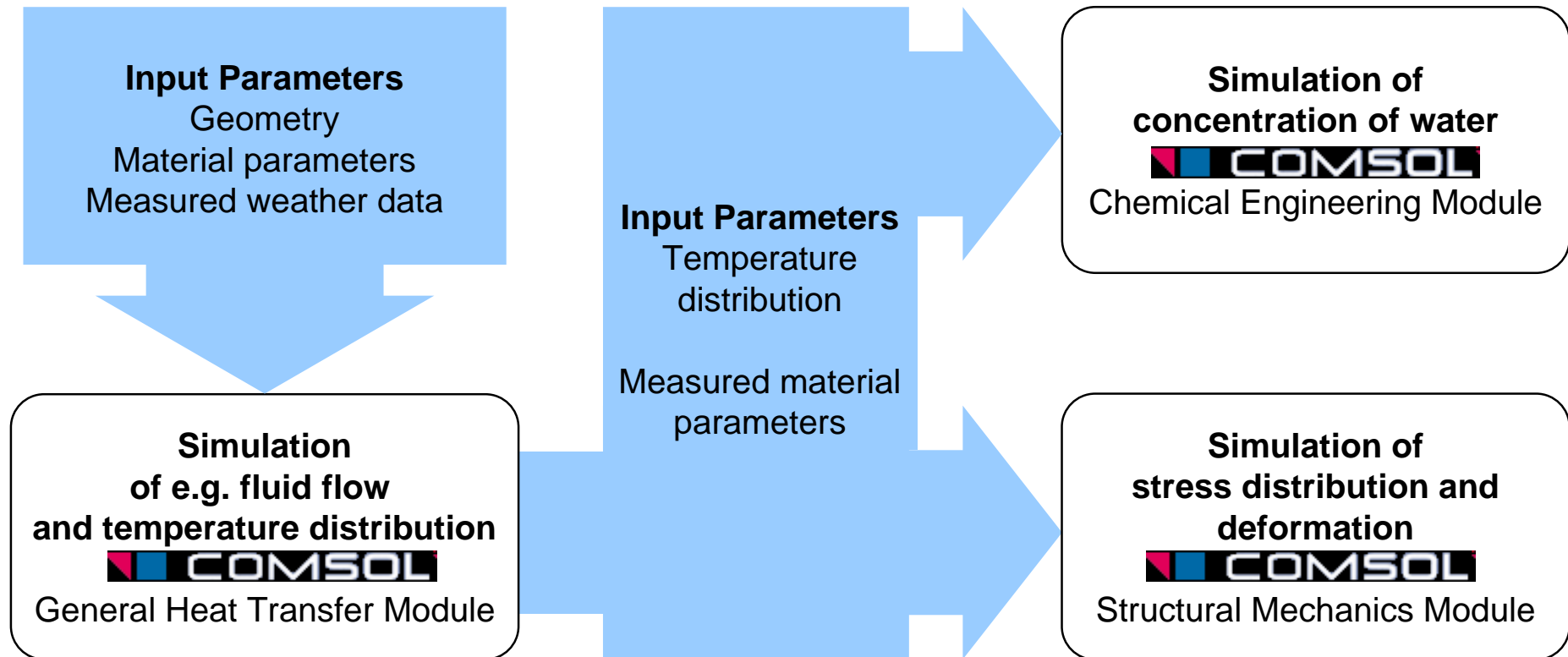
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Content

- Durability analysis
 - Accelerated testing to estimate degradation processes
 - Problem: Limits of acceleration, measurement of certain parameters
 - Simulation, **Example:** Mass transport of water within photovoltaic modules

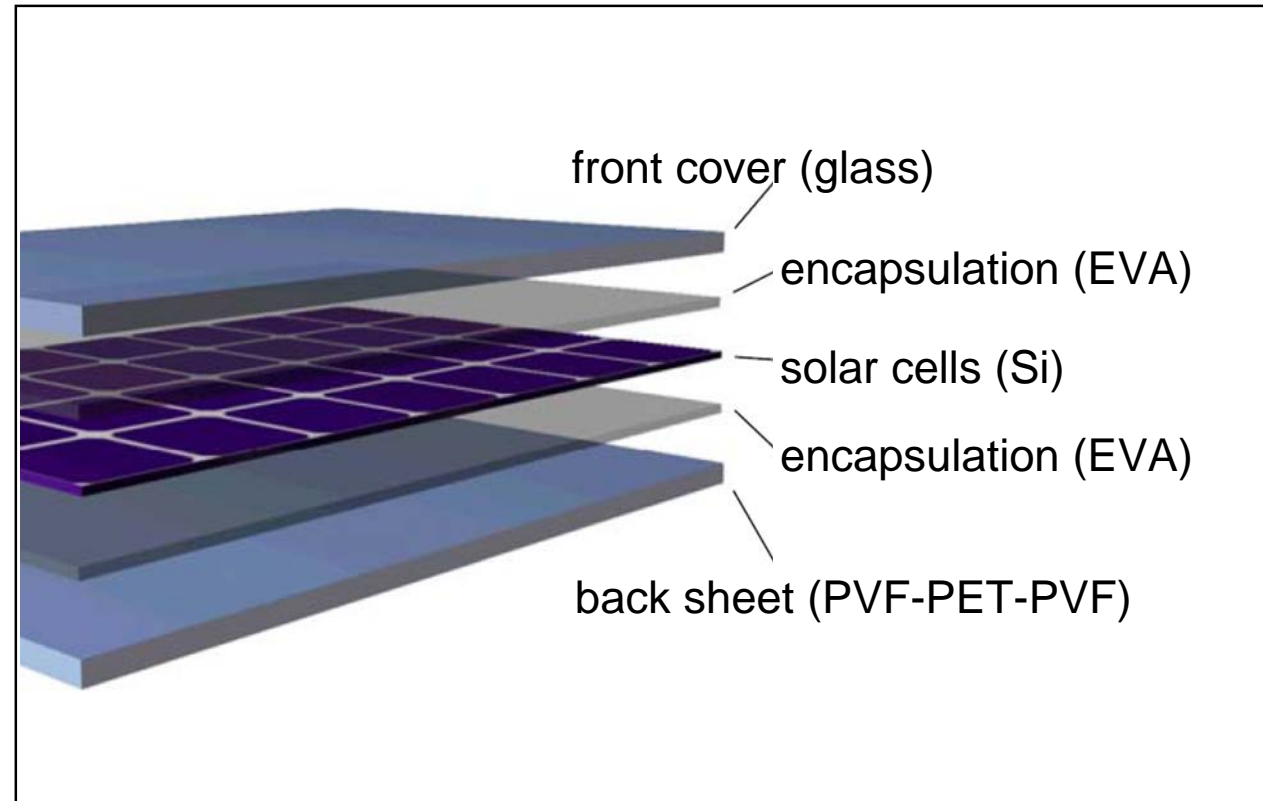
- Virtual product qualification
 - New approaches for product design
 - Problem: Performance of materials during operation conditions
 - Simulation, **Example:** Calculation of mechanical loads on polymeric collectors

Multiphysics Simulation Approach



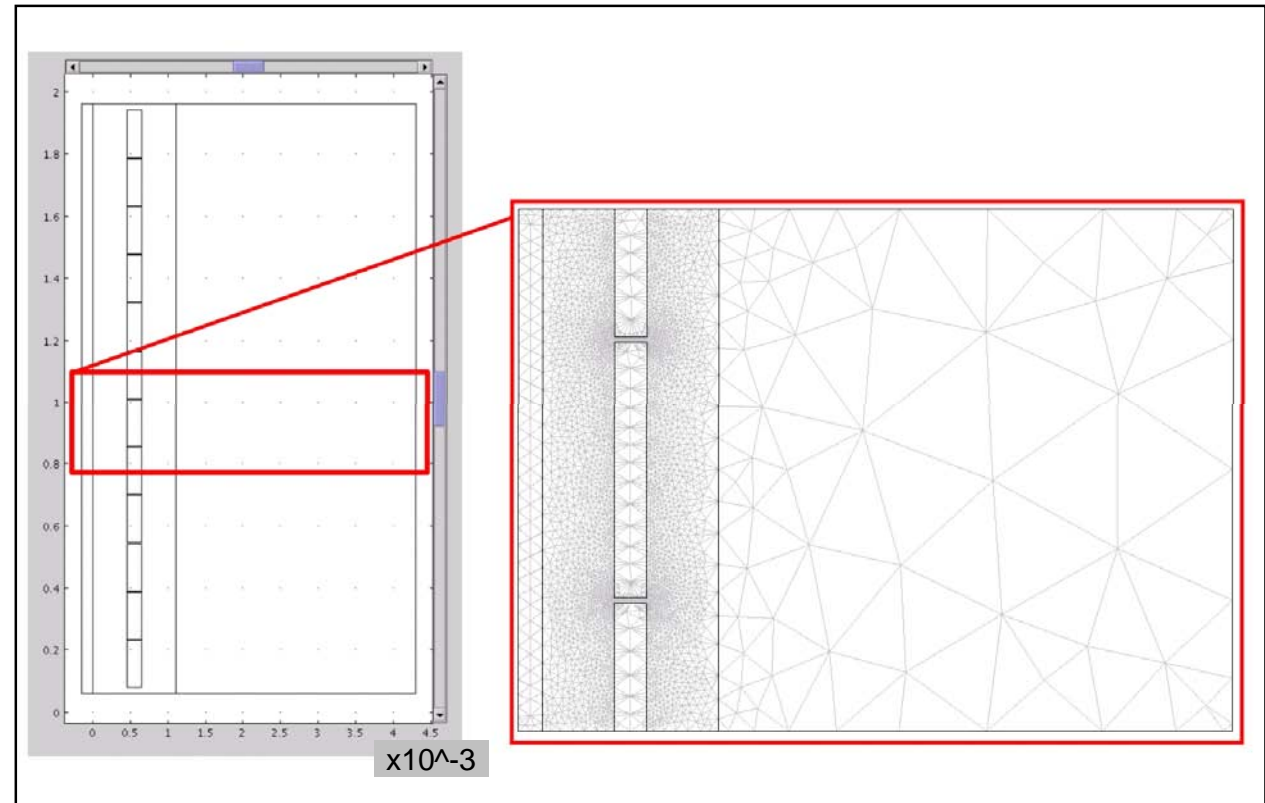
Mass transport of water within photovoltaic modules

- Mass transport of water is an essential reason for degradation of photovoltaic modules
- Micro climate inside module has to be calculated
- Given climates
- Given materials and geometries

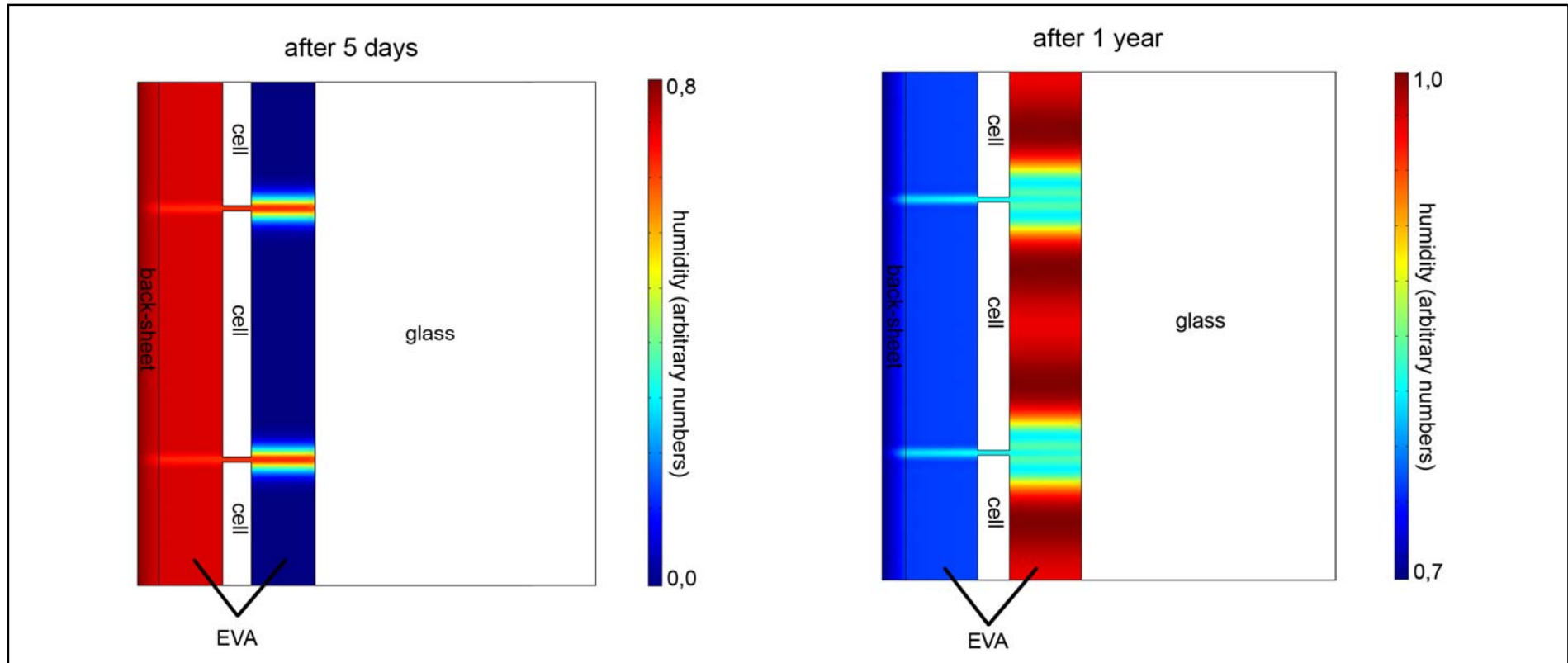


Geometry and Mesh of 2D-Model

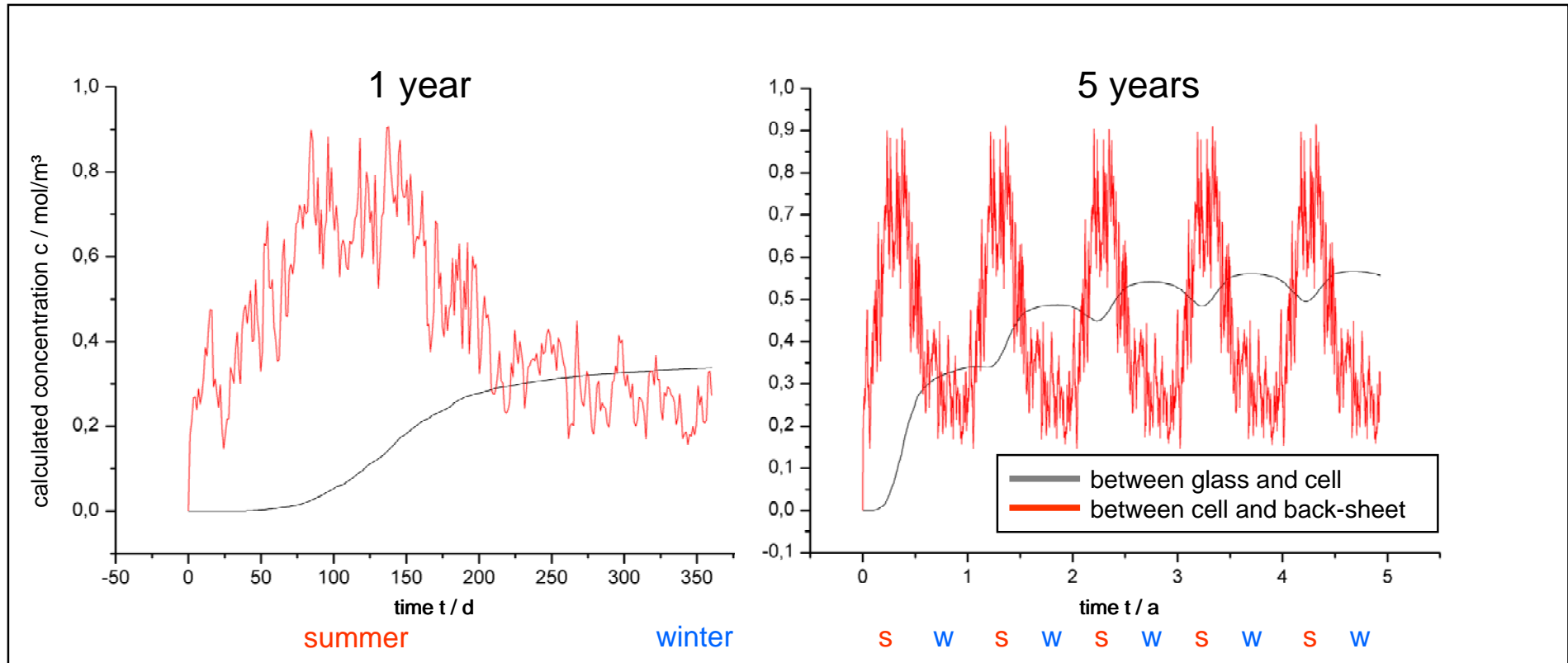
- Cutout of two cells
- Results of analysis of parameter sensitivity
- Very high resolution of mesh required between cells
- Finite stretching of elements possible



Results of the 2D simulations – Freiburg, Germany

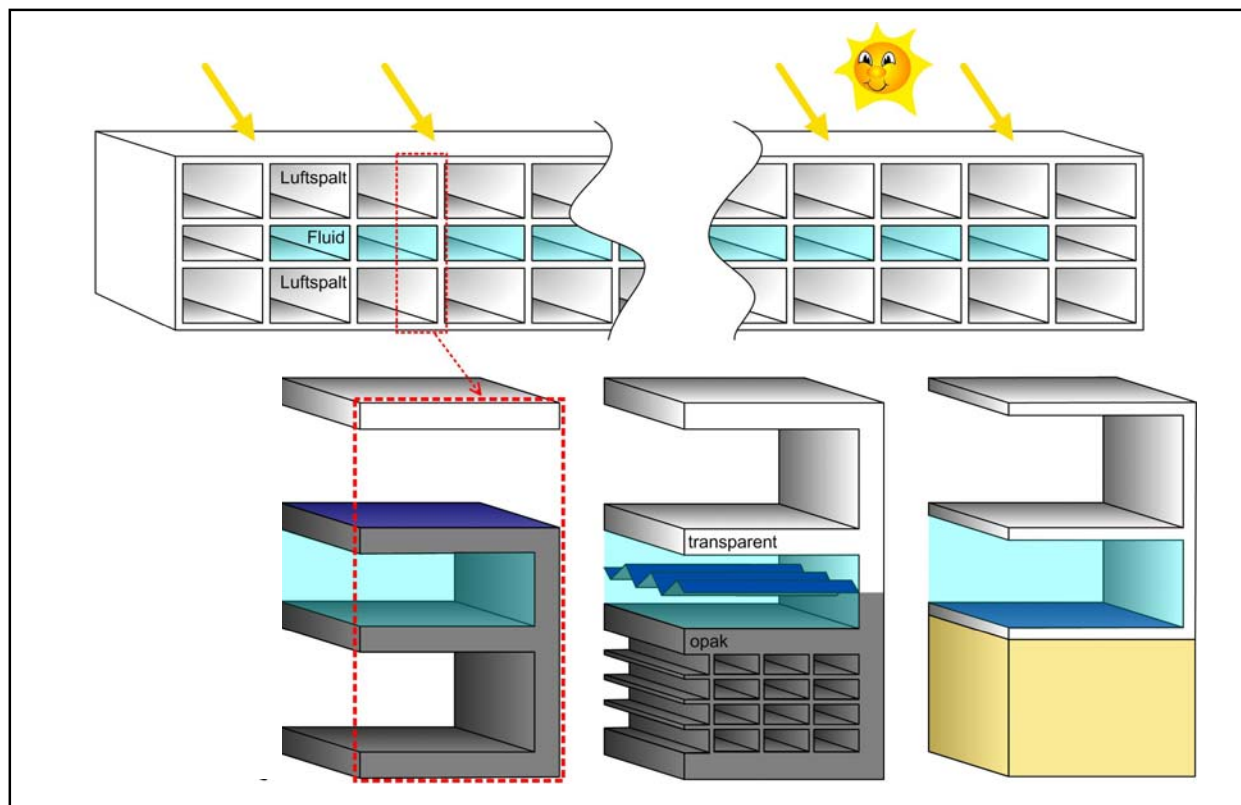


Results of the 2D simulations – Freiburg, Germany



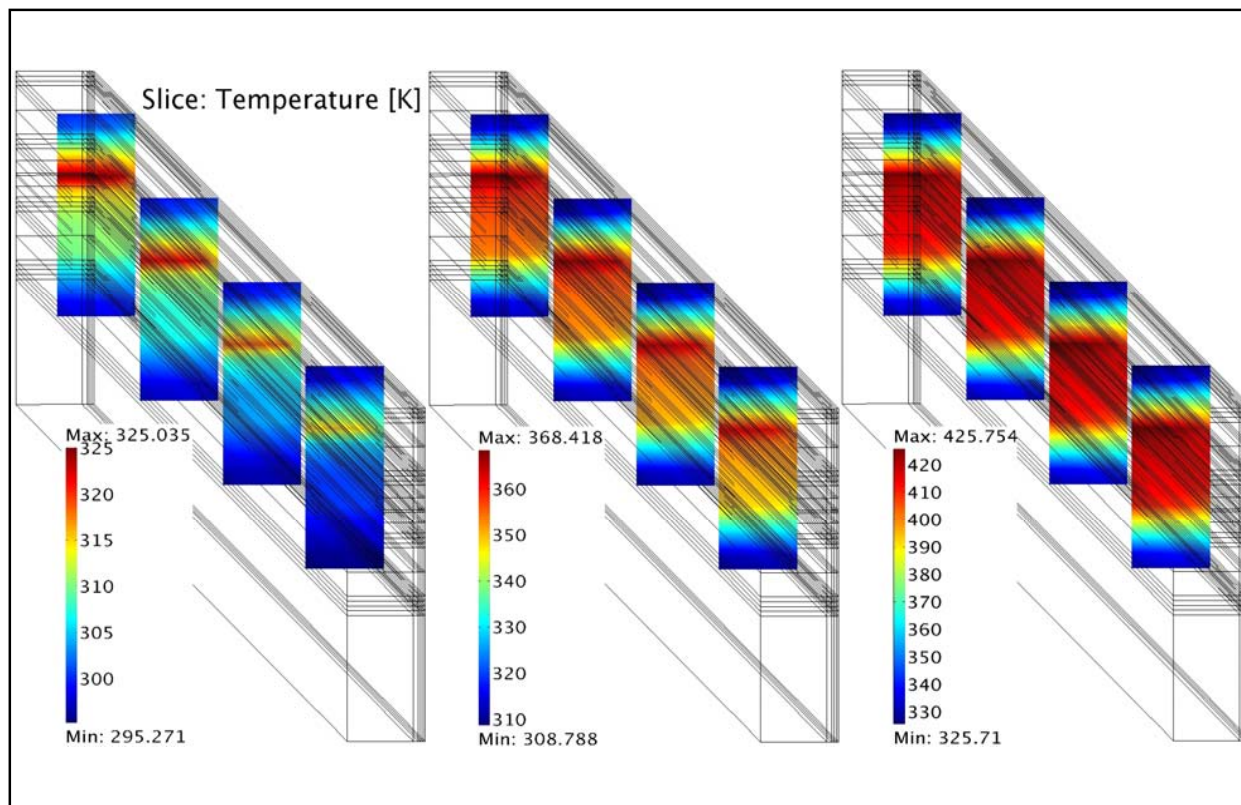
All polymeric flat plate collector - considered geometry

- Cost reduction
 - Substitution of materials
 - Integrated design
- Triple wall-sheet
 - Integrated Design
 - Extrudable
 - Front cover
 - Back insulation
 - Holohedral absorber



Temperature distributions and levels

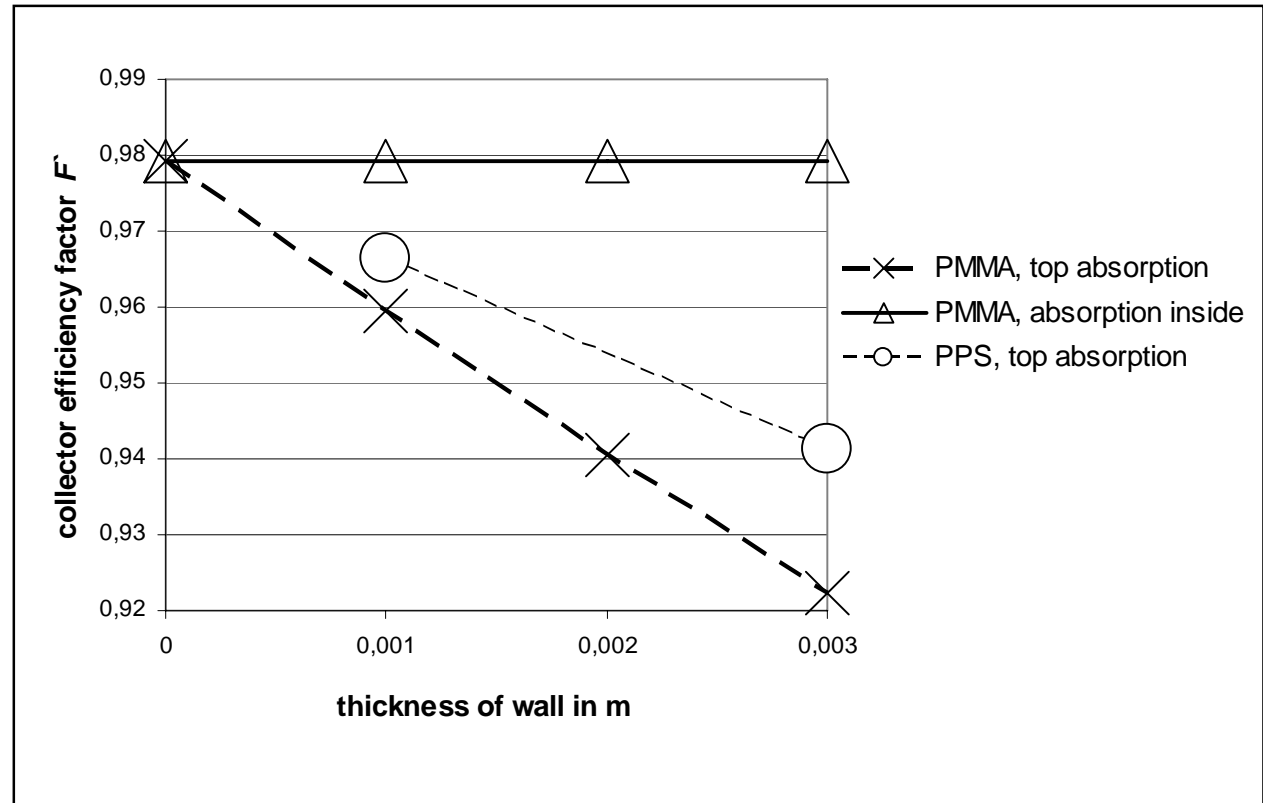
- High temperature gradient in wall with absorbing surface
- Typical stagnation temperatures
- Collector without stagnation protection calls for high performance polymers



Heat transfer capability of absorber

Variation of wall thickness and material

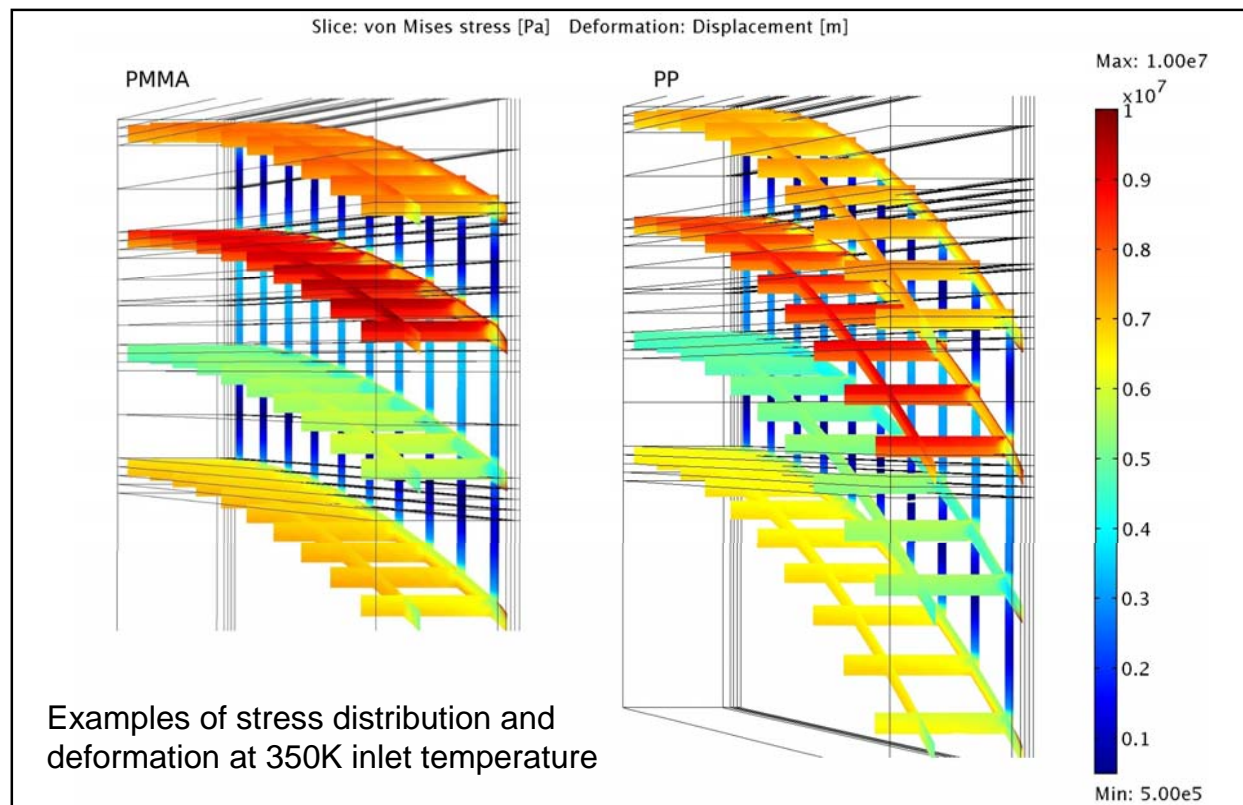
- Big influence of wall thickness and thermal conductivity of wall material
- Still acceptable collector efficiency factor at wall thickness 3mm



Thermo-mechanical loads

Variation of material and thickness in 3D model

- Max. stresses at absorbing layer
- Max. stresses below valid stresses for all considered configurations
- Downwards bending of the collector due to uneven thermal expansion



Summary

- Calculated efficiency of polymer collectors can even be higher than of conventional solar thermal flat plate collectors
- Deformation of integrated collector design has to be considered
- Outlook: Inclusion of change of material parameters over time
 More precise modeling of thermal losses
- Development of concentration of water strongly depends on climate and materials
- Long time periods are needed until max. water concentration is reached
- Outlook: Inclusion of change of material parameters over time
 Simulation over 25 years



Thank you for your attention.