Karlsruhe Institute of Technology

Institute of Vehicle System Technology
Division Lightweight Engineering
Digitalisation in Lightweight Design

Pultrusion process simulation – modelling of the injection and impregnation chamber *

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* For more details, please refer to our ICCM conference paper.

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Motivation

- Fast-curing resin systems require closed injection pultrusion and accurate process design
- Simulation-based design of ii-chamber vs. experimental trial-and-error
- Process simulation enables visualisation of phenomena usually hidden inside the box

Method

- CFD simulations with OpenFOAM
- Moving fibres as porous medium
- Transient simulation

Sub-models

- Heat conduction
- Reaction kinetic
- Viscosity depending on reaction degree and temperature

Flow pattern

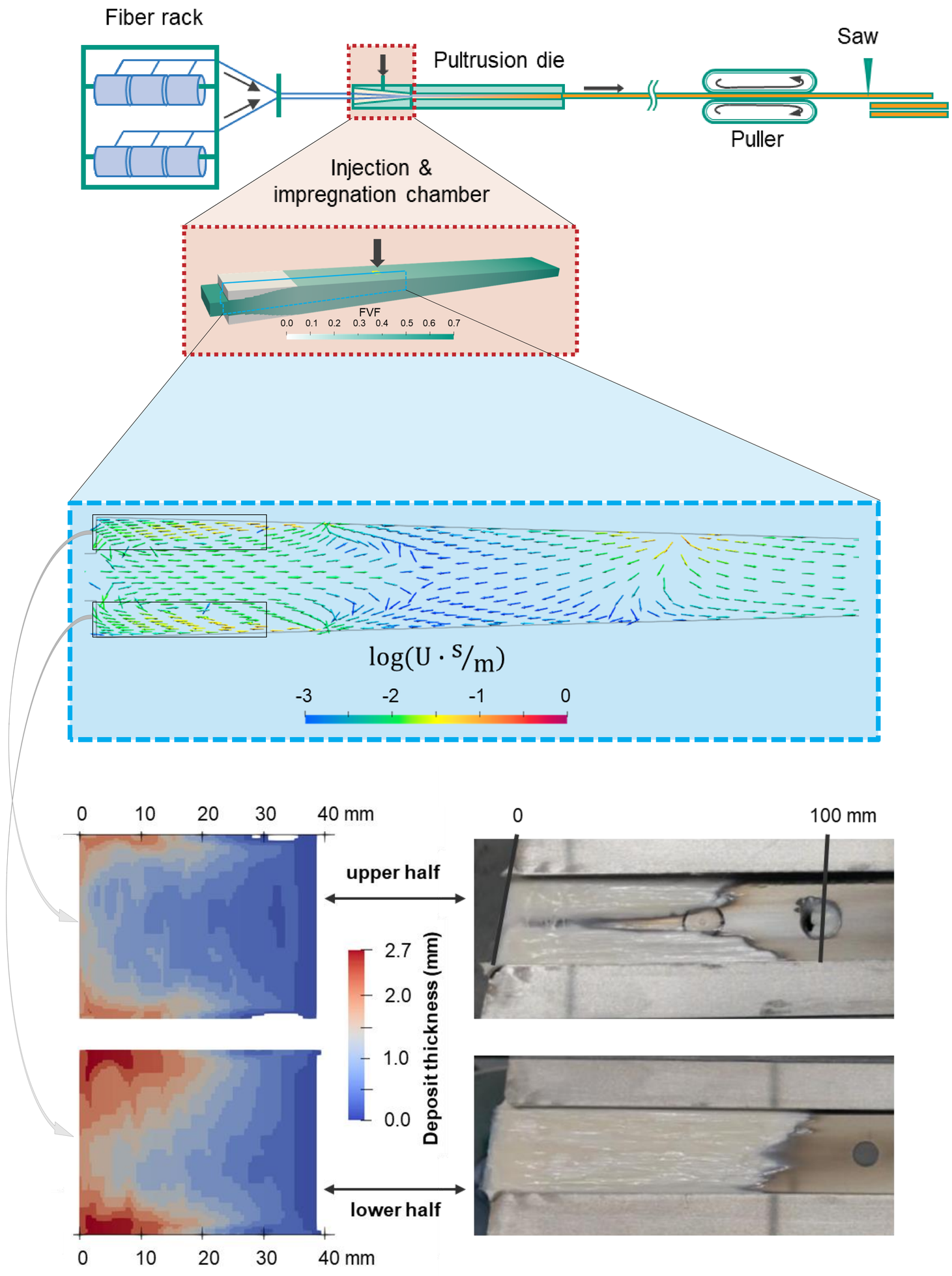
- Collision of opposing currents
  - Drag-induced flow
  - Pressure-driven backflow
- Flow recirculation within the pure resin areas
- Dead spots: recirculations constitute closed circuits

Deposit prediction

- Progressing resin reaction at dead spots leads to formation of deposits at the walls
- Deposits grow continuously over time
- An equilibrium is reached when the pure resin areas are filled with deposits
- Qualitative agreement with experimental observations

Conclusion and Outlook

- Flow field and deposit build-up can be predicted
- Experimental characterisation and validation still needed
- Consideration of impregnation can be added
- This will allow to optimise ii-chamber design



Comparison of simulated (left) and experimental (right) deposit thickness for upper and lower half of the ii-chamber. On the left, cells with reaction degree > 60% are captured.

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