Chair of Carbon Composites
TUM School of Engineering and Design
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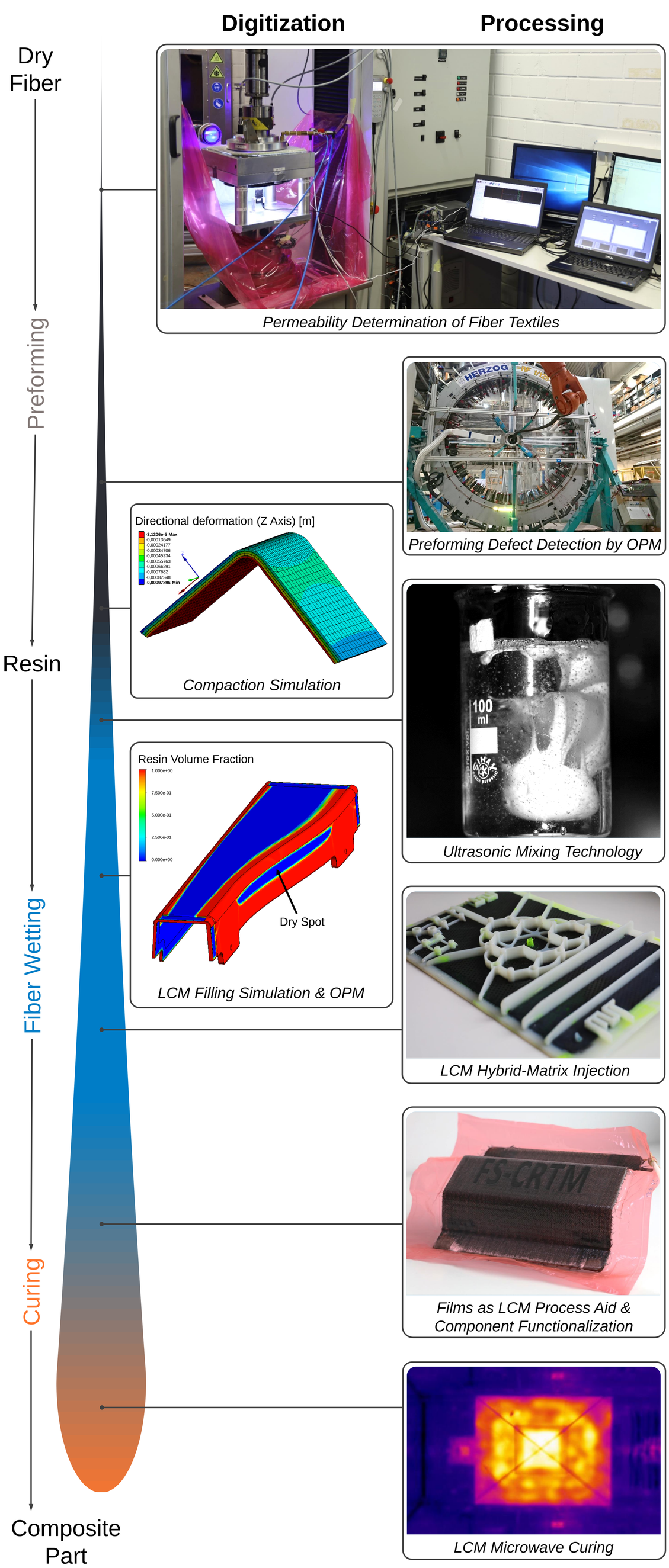
# Liquid Composite Molding (LCM) & Preforming

## Evolving Dry Preform Production & Pressure-Driven Impregnation




*Permeability Determination of Fiber Textiles*

*Preforming Defect Detection by OPM*

*Compaction Simulation*

*Ultrasonic Mixing Technology*

*LCM Filling Simulation & OPM*

*LCM Hybrid-Matrix Injection*

*Films as LCM Process Aid & Component Functionalization*

*LCM Microwave Curing*

*Fig. 1: Topics of the Research Field “LCM & Preforming”*

### The Research Field

The research field addresses the process chain of dry fiber preform production and pressure-driven impregnation with reactive resins.

### Guideline “Material Characterization for LCM & Preforming”

The characterization of semi-finished products forms the information basis for knowledge based engineering. A present challenge is the standardization of the measurement methodology and equipment. Benchmark studies with reference materials have shown that methodology and equipment around the world differ widely. The chair is part of previous and further studies and participates in the development of standardized measurement methodologies and equipment.

### Advanced Preforming & LCM Processes

By improving their robustness, sustainability and expanding their application field, preforming & LCM processes show great potential to fulfill future requirements on FRPs. In braiding, online process monitoring (OPM) enables the detection of small process anomalies and stops the process before errors (e. g. thread breakage) occur. For high mixing qualities of reactive resin systems with different component viscosities or high mixing viscosities (e. g. towpreg resins), ultrasonic mixing technology can be an innovative low-cost and low-maintenance solution. In-situ functionalization of FRPs is gaining in importance. By using a hybrid matrix injection in RTM with a modified secondary fluid, complex structural component functions can be generated efficiently. The integration of thermoplastic films in LCM, as process aids or component functional layers, enhances process efficiency and component functionality. Microwave technology can be used for fast, low-energy curing. The main challenge is the absorbent interaction of the LCM tool with the microwaves.

### Digitization of the Process Chain (Simulation & OPM)

The virtual optimization of preforming & LCM offers great economic savings potential. Virtual permeability characterization of fiber textiles is one focal point. Key improvement is the consideration of the microflow within the fiber rovings. In draping simulation, modeling the textile architecture on filament level enables the prediction of its formability and therefore the draping modelling on macroscopic textile scale. In compaction simulation of fiber preforms, their pressure & forming response behavior is investigated. By locally adjusting the friction between the mold and the preform, a homogeneous textile compaction without defects can be achieved. In filling simulation, the filling behavior of preforms is analyzed numerically in order to improve the actual filling robustness. Simulation process parameters can be injection pressures, closing speeds etc. By coupling these parameters with OPM, the actual filling behavior can be controlled and dry spots can be prevented. Moreover, a present challenge is the data coupling of numerical compacting & filling.

More information and contacts: