

Master's Thesis

Experimental Analysis of the Compaction Behavior during Thermoset Automated Fiber Placement on Complex Geometries

Automated Fiber Placement (AFP) is a fully-automated manufacturing process for composite parts. A robot guided placement head lays up pre-impregnated (prepreg) tapes of carbon fiber reinforced plastic (CFRP) material onto a three-dimensional tool surface. During manufacturing a defined degree of compaction has to be achieved before the autoclave curing in order to minimize voids and fiber misalignments. This compaction is realized by the pressure applied during AFP lay-up and by additional vacuum debulking steps (see Figure 1). Especially vacuum debulking is a time consuming ancillary process with potential for optimization.

Therefore the goal of this thesis is to analyze the influence of different process parameters on the compaction during AFP lay-up and vacuum debulking. Lay-up trials with systematic variations of AFP and debulking parameters, lay-up designs, and geometries shall be performed. The influences shall be evaluated comparing changes in laminate thickness via 3D-scans, void content via chemical dissolution and fiber waviness via microscopy.

The work will be based on preliminary trials as published in [1]. A publication of the results of this thesis will be pursued and shall be supported by the student.

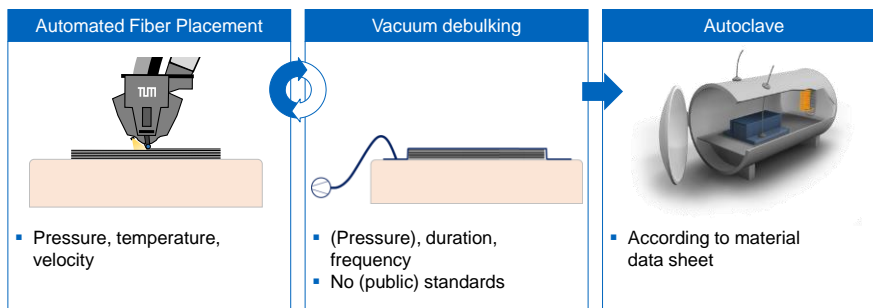


Figure 1: Compaction along the manufacturing process chain: AFP layup, vacuum debulking, autoclave curing [1]

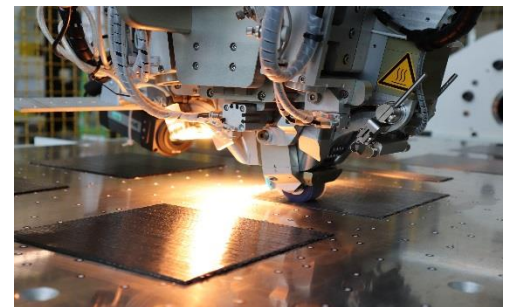


Figure 2: AFP lay-up trials at the Chair of Carbon Composites [1]

Research focus of the thesis

- Literature research on compaction behavior of composite materials
- Design and implementation of lay-up experiments
- Systematic evaluation of changes in laminate thickness, void content and fiber waviness
- Documentation and presentation in English

Requirements

- Basic knowledge in composite materials
- Interest in experimental work
- Self-initiative, motivation and structured work
- Support of a publication of the results

References

- [1] Engelhardt R., Brath K., Ebel C., Drechsler K.: Analysis of the Influence of Automated Fiber Placement and Vacuum Debulking on Thermoset Prepreg Compaction, The 29th Annual International SICOMP Conference on Manufacturing and Design of Composites (2018), Lulea, Sweden, available at https://www.swerea.se/sites/default/files/14_sicomp_engelhardt_ts-afp_compaction_0.pdf.

Starting date: Now

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