Master’s Thesis

Experimental quantification of process induced residual stresses in flat laminated thermoplastic composites

Residual stresses inherently arise during the manufacturing process of laminated thermoplastic fiber reinforced composites, most prominently due to the mismatch of coefficients of thermal expansion and degree of crystallinity. In general, one can distinguish between residual stresses on micro level (fiber and matrix) and macro-residual stresses developing on laminate and structural level. Approaches to model relevant mechanisms during cooling of thermoplastic composites based on the classical laminate theory and finite element solutions exist in numerous publications. However, results are rarely validated with experimental data. Various testing methods to quantify residual stresses are reported in literature, including non-destructive and destructive test procedures. As one of the oldest but reliable approaches, the layer removal method is reported to deliver robust results if applied adequately. By measuring the development of strains and curvature as thin layers are successively removed from one surface of a laminated composite, the pristine strain/stress profiles in the laminate can be derived applying linear-elastic composite mechanics. This linear elastic model has already been developed in previous research and will be applied in this thesis. The aim in this thesis therefore is identifying a robust and accurate experimental approach to quantify macroscopic residual stress and strain levels.

Figure 1: Results from residual stress model, layer removal and compliance methods (Ersoy et al. 2000)

Figure 2: Curvature measurement of specimen (Obermayer et al. 2019)

Research focus:
- Literature review on experimental methods for residual stress quantification
- Pre-evaluation and choice of preferred methods (and potentially screening tests)
- Residual strain measurement for different laminates with the aforementioned mechanical model
- Documentation and presentation of results

Requirements:
- Experience in composites manufacturing
- Knowledge of composite mechanics, e.g. classical laminate theory
- Interest in conduction experimental work
- Thesis can be ether written in German or English

Starting date: instantaneously

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