Modeling of the Thermoforming Process for Long-Fiber-Reinforced Thermoplastics

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Motivation

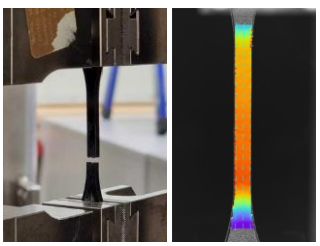
This research project focuses on developing a novel material model for a composite made of unidirectional fiber-reinforced thermoplastic tapes (UD-tapes), intending to correctly simulate the thermoforming process, which shall prevent a time- and cost-expensive "trial and error" process design.

Objectives

- Investigate experimentally visco-elastic, thermal and caloric properties of the material in its solid and melt state
- Develop a thermodynamically consistent, thermo-mechanically coupled, phenomenological constitutive model for the composite material at large strains
- Simulate the thermoforming process

Experimental Investigation

- The key aspect of this investigation is to measure the influence of the degree of crystallinity on the mechanical and thermal properties of the composite. Various tests include-



Tension test

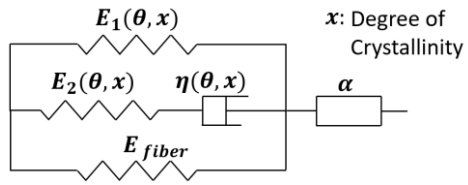
Dynamic Mechanical Analysis

Differential Scanning Calorimetry (DSC)

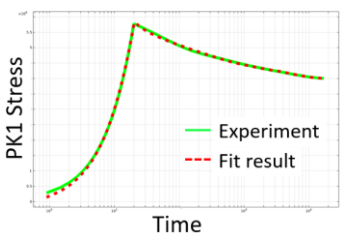
Thermal expansion mesurement

Thermal conductivity measurement

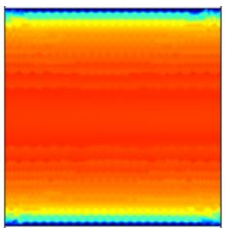
Material Modeling, Parameter Identification and Simulations



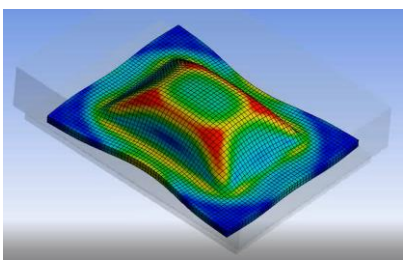
Model Framework



Parameter identification of finite-strain viscoelasticity based on relaxation test



Simulation of Crystallinity evolution in laminate during cooling



Simulation of thermoforming process

Acknowledgment

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References

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[2] Felder S, Holthusen H, Hesseler S, Pohlkemper F, Gries T, Simon W, Reese S (2019) Incorporating crystallinity distributions into a thermo-mechanically coupled constitutive model for semi-crystalline polymers. Int J Plast 132:102751