Material Modeling of Continuous Fiber reinforced Polyamid 6 manufactured via Fused Filament Fabrication

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Motivation

Polyamid 6 or Nylon, as it is often referred to, is commonly used in a variety of different products, such as textiles, tubes, pipes, or plates. Polyamids have further found their way into the world of 3D printing. One of the most well-known 3D printing processes is Fused Filament Fabrication. This process results in pronounced, process-related anisotropic material behavior, which needs to be characterized and understood to correctly predict the behavior of printed parts.

Objectives

- Carrying on investigations into the relationship between process-related temperatures and their influence on material parameters
- Development of a material model for describing the anisotropic behavior of FFF printed parts based on the prior mechanisms.

Theoretical background & experimental procedures

This anisotropic behavior is attributed in huge part to the quality of the bond between the polymer strands deposited next to each other during the printing process, which is characterized by the temperature-dependent movement of polymer chains across the interface between these polymer strands [1, 2], as visualized in fig.1. Furthermore thermoplastic polymers display pronounced viscoelastic material behavior, as displayed exemplarily with a stepwise relaxation test under tensile loading in fig.2. This behaviour is studied in a variety of different experiments including tensile tests, relaxation, melt rheology, DSC and dynamic testing (DMA).

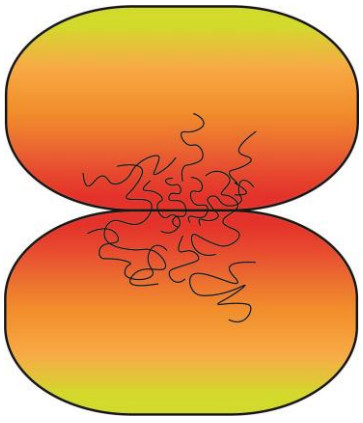

Fig. 1 Polymer chain movement across interface

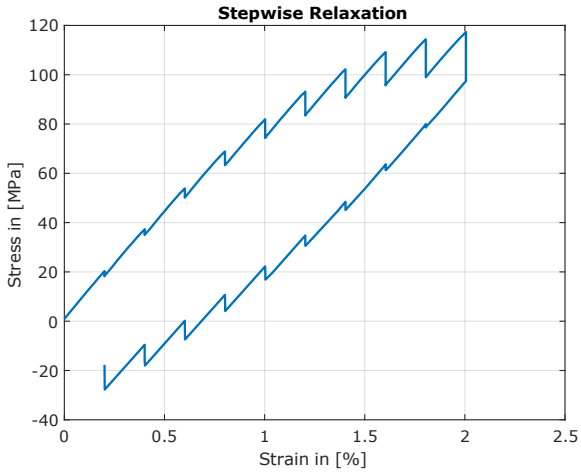

Fig. 2 Stepwise relaxation of short fiber reinforced PA6 under tensile loading

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References

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