Bachelor's Thesis, Term Project, Master's Thesis

Advanced nonlinear simulation of short fiber reinforced composites

The use of short fiber reinforced composite materials enables to manufacture innovative structures in terms of structural performance and lightweight potential for the automotive industry. Injection molding technologies inherit some process-induced effects on the material properties, as the injection flow results in an inhomogeneous fiber distribution within the final part. Therefore, the injected composite material has a complex nonlinear multiscale behavior in terms of structural strength, crack initiation or damping. For that reason, this effect must be investigated thoroughly before injection molded components can be integrated into a structure.

In the frame of this thesis, a FEM-based framework should be developed to execute nonlinear virtual tests of tension, compression and shear of the composite material. That can happen through homogenization of the representative volume element (RVE) of the short-fiber material. The simulation targets may be nonlinear deformation, proper contact treatment, damage simulation or damping behavior (Abaqus Software). With such a platform, an innovative structural simulation method would be explored, motivated by injection molded composite applications from the automotive industry.

![Image 1: Crack simulation of composite RVE](image1.png) ![Image 2: Short fiber reinforced material unit cell](image2.png)

**Research focus of the thesis**

- Development of virtual characterization Abaqus-Python framework, focusing on nonlinear elastoplastic simulation setup for short-fiber composites
- Automation of exporting the homogenized structural properties (metamaterial)
- Parametric analysis with varying geometric parameters of fibers and cohesive zone properties
- Optimization of composite microstructure in terms of structural performance

**Requirements**

- First experience with structural mechanics and typical scripting environment (Matlab/Python or similar)
- Experience with a commercial software (Abaqus or similar) is beneficial but not required
- Language: German or English

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**Starting date:** flexible, homeoffice possible

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