TECHNISCHE UNIVERSITÄT
CHEMNITZ

Mechanical Engineering
Institute of Lightweight Structures
Department of Lightweight Structures
and Polymer Technology

Task for Project Work

Course of studies:	Merge Technologies for Resource Efficiency
Name, first name:	N.N.
Matriculation No.:	12345
Supervisor:	Dr.-Ing. Sascha Müller Dr.-Ing. Mario Naumann
Topic:	**Micromechanical Analysis of Thermally Induced Residual Stresses in Carbon Fiber Reinforced Plastics (CFRP) with Non-Circular Fiber Cross-Sections**

The project work is to be done as individual work in English or German.

Issue date:	00.00.2025
Duty date:	00.00.2025
Day of submission:	

Prof. Dr.-Ing. habil. Prof. h.c. Dr. h.c. Prof. L. Kroll
Supervising university lecturer

Explanation to the content of the task

The mismatch in the coefficients of thermal expansion between fiber and matrix leads to the formation of significant residual stresses within the composite during cool-down from the processing temperature. These residual stresses superimpose with external loads and can decisively influence damage initiation and thus the service life of the component. The fiber cross-sectional shape plays a crucial role in this context, as it geometrically governs the local stress distribution at the fiber-matrix interface.

In this work, representative volume elements (RVEs) are to be created using ANSYS Mechanical to quantitatively analyze the influence of the fiber shape on the amplitude and distribution of thermal residual stresses.

1. Research on the state of the art

- Research on the mechanisms of residual stress formation in FRP.
- Study of analytical methods for determining residual stresses (numerical and experimental).
- Identification of thermo-mechanical properties for typical carbon fibers and epoxy matrix systems.
- Research on existing RVE models, especially for non-circular fiber shapes.

2. Integration into the FEM program ANSYS

- Familiarization with ANSYS Workbench and ANSYS Mechanical.
- Parametric model generation of RVEs with different fiber shapes (circular, polygonal, lobular).
- Implementation of periodic boundary conditions (PBCs).

3. Numerical investigations using finite element analysis

- Performing thermo-mechanically coupled simulations to model the cool-down process.
- Analysis of the resulting stress fields in the fiber, matrix, and especially at the interface (normal and shear stresses).
- Visualization and quantification of stress concentrations at geometric singularities (e.g., corners).

4. Parameter studies

- Systematic investigation of the influence of the fiber cross-sectional shape and the fiber volume fraction on the maximum residual stresses.
- Comparison of the residual stress states with known failure criteria for the matrix and the interface.
- Assessment of the fiber shapes regarding their potential to minimize detrimental tensile residual stresses and to generate beneficial compressive residual stresses.

The task can be extended or shortened during working. The guidelines for the preparation of scientific work shall be taken into account. Discussions with other institutions and persons require the approval of the supervisors.