



MULTISCALE SIMULATION OF FIBER REINFORCED COMPONENTS

1 *μCT image of short glass fiber reinforced PBT with characteristic middle layer*

2 *Computer model of a short glass fiber reinforced PBT, generated with the software tool GeoDict*

3 *Computed effective stiffness in thickness and longitudinal direction*

Fiber reinforced plastic components are essential in different applications as e.g. in automotive or medical engineering. In the project MuSiKo we develop multiscale simulation techniques for reinforced components.

For microstructured materials, the macroscopic deformation and failure behavior significantly depends on the microstructure, which is influenced by the manufacturing process.

For fiber reinforced polymer matrices as for example polybutylen terephthalat (PBT) matrix failure, fiber breakage or delamination may occur. In order to predict these effects often a pure macroscopic analysis is not sufficient. Thus, very complicated phenomenological models are required, which are only valid for certain failure scenarios.

Joint research project MuSiKo

In the BMBF joint research project MuSiKo we develop efficient multiscale simulation techniques in consultation with scientists from the universities of Kaiserslautern and Saarbrücken as well as the Karlsruhe Institute of Technology. The abbreviation MuSiKo stands for “Adaptive Approximation Techniques for the Multiscale Simulation of Nonlinear Composite Behavior”. The industry partners Robert Bosch GmbH and Siemens PLM Software are supporting the research project.

The applied multiscale approach is based on a coupled solution of the macroscopic and the microscopic problem. Only the characteristics of the matrix the fibers as well as the local orientation of the fibers have to be determined as input parameters for the simulation. The mechanical behavior at the level of component results in the averaged microscopic values.

Process chain for glass fiber reinforced plastics

In the project MuSiKo which has successfully been finalized in 2017 we carried out the complete process chain for glass fiber reinforced PBT in cooperation with our partners – from the measurement of the plastic properties and the determination of the fiber orientation by means of μCT up to the multiscale simulations. The simulation results are validated via suitable experiments at the component level.

With assistance of these simulation techniques, it is possible to optimize the injection molding process (e.g. the temperature or injection point) with regard to the functionality of the components.