NUMERICAL - EXPERIMENTAL APPROACH FOR THE CORRELATION STRUCTURE DETERMINATION OF SHORT FIBER-REINFORCED COMPOSITES

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Fiber-reinforced composites produced by automated injected mold processes show probabilistic characteristics of the microstructure, which also influences the overall mechanical behavior on the component level. For the representation of the probabilistic distribution of the resulting material properties stochastic methods like random fields can be used [1]. Due to the fiber-reinforcement the distribution of the material properties is not only a function of the spatial coordinates but also a correlation exists, which is crucial for a sufficient representation of the material properties by random fields.
In this work an approach is presented to derive the correlation structure of the elasticity tensor components for linear-elastic material behavior by combining numerical simulations with experimental investigations. First the correlation structure of the whole elasticity tensor is determined by numerical simulations with respect to Hill's condition on the mesoscale [2]. Due to the simulation on the mesoscale the derived correlation lengths are of the same magnitude as the numerical model and are therefore, not suitable for the use on the component level [3]. To overcome this issue the spatial distribution of the Young's modulus is experimentally obtained by tensile tests in a second step. Based on the numerical and experimental results a transfer function is established, that allows one to project the correlation structure derived by numerical simulations on the mesoscale to the component level.
For validation of the presented approach the numerical simulations of a tensile test on the component level is conducted by representing the spatial fluctuation of the material properties with Gaussian random fields, that are discretized by using the resulting correlation structure and the Karhunen-Loève expansion.

References

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