Microstructure-based modelling of multiphase materials and complex structures

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Micromechanical approaches are frequently employed to monitor local and global field quantities and their evolution under varying mechanical and/or thermal loading scenarios. In this talk, an overview on important methods is given that are currently used to gain insight into the deformational and failure behavior of multiphase materials and complex structures. First, techniques to represent material microstructures are reviewed. It is common to either digitize images of real microstructures or to generate virtual 2D- or 3D-microstructures using automated procedures (e.g. Voronoi tessellation) for grain generation and coloring algorithms for phase assignment. While the former method allows to capture exactly all features of the microstructure at hand with respect to its morphological and topological features, the latter method opens up the possibility for parametric studies with respect to the influence of individual microstructure features on the local and global stress and strain response. Finally, solution techniques to solve micromechanical field problems formulated within the framework of periodic microfield approaches via the Finite-Element or the Fast-Fourier-Transform methods are outlined.

Several applications of these approaches will be presented. The examples comprise low and high strain behavior of multi-phase steels, calibration of constitutive material description, failure and fracture behavior of multiphase materials and the lifetime analysis of the aluminum wiring of semiconductor devices.

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