

Novel techniques and recent applications for image-based modelling and FE-based homogenisation

Kerim Genc PhD

Simpleware Inc.

Phone: (571)-222-4169

Email: info@simpleware.com

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Abstract

Image-based modeling represents a valuable technique for obtaining quantitative information from scans of materials acquired from sources such as Computed Tomography (CT) and Focused Ion Beam Scanning Electron Microscopy (FIB-SEM). However, it is often a challenge to link visualization, analysis and image processing workflows with the generation of robust numerical models for Finite Element (FE) simulation.

This presentation will focus on how software techniques developed at Simpleware Ltd. (Exeter, UK) are solving these challenges; the presentation will particularly focus on the integration of image-based modeling workflows for Materials Science applications such as composites, rocks and industrial components. Unique methods for multi-part mesh generation from segmented image data will be covered, as will options for directly exporting models to commercial and open source codes for extended or more complex simulation.

Attention will be paid to recent advances in using FE-based homogenization techniques to calculate effective material properties within Simpleware-developed software; this includes the application of an integrated FE-based homogenization tool for calculating stiffness and elasticity (the Simpleware +SOLID module), thermal and electrical conductivity and molecular diffusivity (the Simpleware +LAPLACE module), and absolute permeability (the Simpleware +FLOW Module). This will also cover the unique benefits of using the software to control mesh density without loss of features, even for multi-part and highly complex topologies. The paper will also introduce the latest developments in software techniques, including homogenization of 1-or 2-dimensional samples, allowing valuable information to be gathered from thin samples, such as those typically produced by FIB-SEM techniques. The strengths of this approach for calculating effective properties, including a reduction in computational demands and model size, will be explored through several recent examples.

The work presented will emphasize the ease and simplicity of Simpleware software techniques for generating effective material properties from image data for multiphase

materials, as well as for exporting meshes for simulation in more specialist tools. Integrating multiple image-based modeling stages whilst ensuring compatibility with FE solvers therefore allows both expert and non-expert engineers and scientists to effortlessly and efficiently exploit the valuable information captured by imaging techniques.