

A massively parallel matrix free FE-based multigrid method for simulating the behavior of heterogeneous materials using large scale CT images

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Image-based modeling is interesting as it would allow for modeling a material accounting for all the complexity of its microstructure. In practice building a FE mesh from an raw image is very complex as the boundaries between the different phases are not sharp and a lot of micro-defects can be observed. To circumvent these difficulties, we propose to use the regular voxel mesh of the image as a computational mesh. The consequence is that the number of elements can reach 10 billion and a material property field has to be considered based on the image grey level. A multi-grid acceleration scheme is developed to solve linear elasticity and thermal conductivity problems. To deal with large images, a hybrid parallel implementation of a matrix free resolution strategy is proposed. Examples using real X-ray tomography images of composite materials illustrate the ability of the proposed strategy to perform image-based 3D FE analysis.