# A two-scale homogenisation approach for fluid saturated porous media based on TPM and $FE^2-$Method

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Thinking about the description of porous materials, e.g. metal foam, human tissue, plants or sponges, we always have to take into account a global design composed of various substructures with different characteristics on a lower level. Examples of such substructures are pores which can be saturated with fluids or gases, fibres with different orientations or cells which can be influenced by chemical reactions. For the theoretical description of the behaviour, enhanced continuum mechanical models give promising approaches. Up to now, due to the high complexity, it has not been possible to simulate these systems with only one design model. Hence, it is necessary to think about techniques which simplify the model but still consider the essential characteristics.

It is clear, future applications will consider the discrete microstructure of materials. For example the topology can be received by CT-scanning and therefrom Representative Volume Elements (RVEs) can be designed. Therefore, we are preparing the Theory of Porous Media (TPM), see [1] and [2], for the usage in combination with the $FE^2-$Method, cf. [3] and [4].

This contribution will present a two-scale homogenisation approach for fluid saturated porous media with a reduced two-phase material model, which covers the behaviour of large poro-elastic deformation. The main aspects of theoretical derivation for the weak form, the lower level boundary conditions under consideration of the Hill-Mandel homogeneity condition and the averaged macroscopic tangent moduli will be pointed out and a numerical example will be shown.

Still, solving a coupled problem in $FE^2$ environment is extremely time consuming. Therefore, a parallel solution strategy is absolutely essential. Remarks on the investigation of High Performance Computation in this context will be given.

Finally, creating a suitable geometric model and finite element mesh for the macroscopic as well as for the microscopic structure of a real problem will be mandatory for the validation. Hence, we present the mentioned procedure of transferring CT images (.raw data) to a FE-model on an example of a concrete specimen.

## References

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[3] C. Miehe, *Computational micro-to-macro transitions for discretised micro-structures of heterogeneous materials at finite strains based on the minimization of averaged incremental energy,* Computer Methods in Applied Mechanics and Engineering, 2002.

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