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Multiscale Simulation of Multiphase Materials

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Many materials show a multiphase composition and have a distinct microscopic structure. Examples of multiphase materials are saturated or partly saturated porous material like soil, concrete but also steel and biological tissue like cartilage or bone. Their substructures are e.g. pores, fibres with different orientations or cells which can be influenced by biochemical reactions.

The high complexity of those kind of material makes it reasonable to consider homogenization approaches and multiscale techniques in order to find an effective modeling access for the numerical simulation. This is even more the case since modern experimental methods as CT-scanning or MRI imaging give us the opportunity to get a deep insight into the microscale structure.

Thus, we will present a combined multiphase-multiscale approach for the description of those kinds of materials. The method is based on the well-known Theory of porous media (TPM), a continuum mechanical homogenization approach founded on the mixture theory in combination with the concept of volume fraction, cf. [1, 2]. Depending on the material, we will combine the TPM with reasonable multiscale techniques such as FE^2, POD-ODE, or the Phase Field method. Examples of use are the description of microscale driven anisotropic perfision of a porous material [3], the liver function-perfusion behavior [4], and the steel solidification.

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