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HETEROGENEOUS CONTINUUM THEORY

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We propose a new theory to describe multi-scale phenomena of heterogeneous materials with an arbitrary number of constituents. The heterogeneous continuum theory here proposed establishes a framework for homogenization of the heterogeneous continuum by performing a priori analysis of high fidelity micromechanical simulations, while still conserving more information than simply averaging the micromechanical response. This offers an alternative to the concurrent multi-scale methods introduced by Feyel and Chaboche [1], Kouznetsova et al. [2] and Belytschko et al. [3], that are limited by their high computational cost.

The theory is based on describing the strain profiles of each constituent such that the constitutive laws of each constituent are used rather than using a phenomenological law that has the heterogeneous behavior of the material embedded through fitted parameters that are challenging to interpret physically. This is believed to be of significant importance because it opens the way for modeling complex multi-scale phenomena based on simpler constitutive laws and on high fidelity analysis of the lower scale physics without compromising the computational cost of the simulations.

The theory was implemented in a finite element scheme and the results are encouraging since they were validated with classical micromechanical problems. Furthermore, the proposed method can be generalized to include plasticity as well as discontinuities which is considered to be promising.

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