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Homogenization of higher-order continua

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Following the well known technique FE^2-method for homogenisation as shown in Keip et al. [2] of complex materials with micro-heterogenous properties, we present a novel IGA^2-method, presented in Schmidt et al. [1], allowing the homogenization of higher-order continua. To be specific, we show a generalization of the work of Kouznetsova [4] on higher-order material models towards second and third order continua on both scales.

Investigating the microscopic structure we make use of representative volume elements ($\mathcal{RVE}$), attached at every macroscopic material point. An energetic criterion on both scales is applied to derive suitable boundary conditions on $\partial\mathcal{RVE}$. For the discretization the IGA^2-method is introduced, adapting the principles of the FE^2-method. Furthermore, macroscopic stresses and their consistent linearization for the Newton-Raphson iteration are obtained. Eventually, the accuracy and behavior of the introduced framework for the homogenization of higher-order continua is demonstrated in a variety of benchmark tests. Here, we make use of second order formulations on fibre reinforced materials as introduced in Dittmann et al. [3] and show a simple multigrid solution scheme.

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