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Non-Convex Homogenization of Inelastic Composites with Interaction of Material and Structural Instabilities on Different Scales

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An effective approach to the modelling of micro-heterogeneous materials is the homogenization method where a representative volume element (RVE) is attached to each macroscopic point. In the case of structural instabilities on the micro-scale the complexity of the problem substantially increases and classical approaches hit their limitations. Goal of the presentation is to clarify the relation between micro- and macro-instabilities and to point out a procedure of non-convex homogenization affiliated to these instability phenomena. Both of these aspects have recently been extended from results in nonlinear elasticity to the incremental setting of finite inelasticity by the authors. This extension bases on the treatment of the homogenization analysis within the context of an incremental variational formulation which provides a quasi-hyperelastic stress potential. A lack of quasiconvexity of the homogenized potential indicates for a priori micro-heterogeneous materials the occurance of structural instabilities on the micro-scale. This leads to the problem of non-convex homogenization where the RVE-size enters the homogenization procedure as an additional variable. The size effect of the RVE and the interaction between micro- and macro-instabilities are discussed in representative numerical examples.

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