Nonlinear homogenization of composite and porous materials: some resent results

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We consider representative volume elements (RVEs) of microstructures made of a matrix material in which several solid inclusions and/or pores are embedded, and subjected to boundary conditions. The main objective of homogenization is to compute the effective response of equivalent homogeneous RVEs. There are full-field and mean-field methods to solve the problem. The former are accurate but computationally expensive, the latter are easier to use and several orders of magnitude faster, but they are based on simplified assumptions and do not give access to detailed micro-fields. For nonlinear problems, mean-field models need to define linear comparison composites (LCC), which we briefly review in this talk. For composites, we focus on a recent LCC derivation method, called incremental-secant, and we present verified predictions for elasto-plastic and elasto-viscoplastic composites, under small and large deformations, with and without damage coupling, under non-monotonic loadings. For a porous plastic matrix, we present a recent homogenization method which combines the Gurson solution for a single cavity with a secant LCC method at the RVE level, to account for the presence of multiple cavities in the RVE. We present verified predictions for different porosity levels. In this talk, some results are also presented on combining full-field and mean-field homogenization for a matrix material in which misaligned short fibers and cavities are embedded. The talks ends with some remarks regarding multiscale simulation of heterogeneous structures.