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Computational homogenisation of thermo-viscoplastic composites at large deformations

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By means of the FE^2-method, the effective behaviour of a heterogeneous lower scale is transferred to a rather coarsly discretised initial boundary value problem at an upper scale. In [4], the fully coupled two-scale finite element framework for thermomechanical problems from [1] is adopted and applied for thermoviscoplastic material behaviour in a geometrically linearised setting. This framework is now further extended to a geometrically non-linear framework for thermo-viscoplastic material behaviour at large deformations. The integration of the plasticity-related evolution equations is carried out by means of the Backward Euler method whereby the plastic incompressibility constraint is kept by means of an additional Lagrange multiplyer as outlined in [3]. A further challenge in homogenisation problems is the identification of an appropriate RVE which represents the underlying microstructure as good as possible as well as the boundary conditions which meet the micro-macro transition assumptions. Together with Hill-Mandel type criteria, periodic boundary conditions deliver the most natural results but go along with the necessity of entirely periodic RVE discretisations. This restriction is overcome by enforcing the periodicity in a weak sense. Therefore, the framework outlined in [2] is adopted for thermomechanically coupled problems. The performance of the extended framework is presented by means of representative examples.

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