On homogenization in finite strain thermoplasticity

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ABSTRACT

The paper addresses homogenization issues in analysis of thermoplastic deformation. Inspired by the strict thermodynamic setting developed for the finite thermoelastic deformations [1], extension to plastic strains is now provided. As the fundamental assumption, equality between the macroscale quantities (energy, entropy, dissipation, specific mass and thermoelastic heat) and the equivalent microscale quantities is enforced. This constraint naturally leads toward staggered solution at the microscale by means of a mechanical step and a thermal step. The numerical treatment of the mechanical microscale step is based on procedures described in [3, 4]. Homogenization of the stresses, the internal dissipation and the thermoelastic term provides macroscale counterparts. Thermal step takes steady state form and delivers the homogenized heat flux vector. It should be noted that the usual simplification is not pursued here, i.e. adoption of the adiabatic assumption is not exploited. With such assumption, thermal step would be completely avoided.

With these variables at hand, the governing macroscale problem is solved again by decoupling into a mechanical and a thermal step. This provides the configuration and the temperature field. Implementation is performed in the finite element software Abaqus. Performance of the procedure is demonstrated at an example.

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REFERENCES

[1] I. Temizer and P. Wriggers, "Homogenization in finite thermoelasticity", *J. Mech. Phys. Solids*, **59,** 344–372 (2011)

[2] C. Miehe, J. Schröder and J. Schotte, "Computational homogenization analysis in finite plasticity simulation of texture development in polycrystalline materials". *Comput. Meth. Appl. Mech. Eng.*, **171**, 387–418 (1999)

[3] M. Čanađija and J. Mosler, "A variational formulation for thermomechanically coupled low cycle fatigue at finite strains". *Int. J. Solids Struct.,* **100**, 388–398 (2016)

[4] N. Bleier and J. Mosler, "Efficient variational constitutive updates by means of a novel parameterization of the flow rule", *Int. J. Numer. Methods Eng*, **89,** 1120–1143 (2012)