THEORETICAL AND NUMERICAL MODELING OF SOLID-SOLID PHASE CHANGE: APPLICATION TO THE DESCRIPTION OF THE THERMOMECHANICAL BEHAVIOR OF WELDED STEEL

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In this paper, we present a theoretical and numerical study of a continuous model of solid-solid phase change. We develop the aspect of phase mixture following the model of Reuss. The phases can coexist inside the Representative Elementary Volume (REV). At the macroscopic scale, they are considered as finely mixed. Each phase is represented by a phase fraction and a local deformation strain. Individual strains are related to the total deformation strain by the average of phases. Both reversible and dissipative phase changes are considered. In the case of reversible phase change, it is shown that the elastic energy of the material can be obtained by convexifying the energy functions of existing phases. In the dissipative case, it is shown how the behaviour of the material can be made stable by developing evolution equations deriving from an adequately chosen dissipation potential.

As an application, we present a thermo-mechanical and metallurgical coupled model allowing the description of the behaviour of welded steel. In the proposed model, the non-linear thermo-mechanical behaviour of each phase is treated independently and the macroscopic behaviour is derived within the developed framework. The influence of transformation plasticity (TRiP) is also taken into account. These models have been implemented into COMSOL Multiphysics and numerical simulations were carried out. The obtained numerical results show very good agreement against experimental results taken from literature.