# A thermomechanically coupled finite-strain constitutive model for Iron-based Shape Memory Alloys accounting for coupling between phase transformation and plastic sliding

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## ABSTRACT

Iron-based Shape Memory Alloys (Fe-SMAs) present a specific behavior compared to NiTi and Cu-based SMAs related to a high coupling between plastic sliding and phase transformation inducing only a partial recovering of inelastic strain during heating. Few models in literature describe such specific behavior. However, they are formulated with the framework of small perturbations. Therefore, they cannot predict the effect of an applied high loading level inducing a larges deformations and rotations. Against this background, a new thermomechanical behavior law for Fe-SMAs, is developed with the framework of finite transformations. This law is an extension of Khalil et al. [1] small-strain model. Two important characteristic behaviors of the Fe-SMA, the phase transformation and the plastic sliding, are considered in the development of this model. Two internal variables, the volume fraction of martensite and the accumulative plastic strain, have been defined to integrate those latter specific behaviors. This model considers the classical multiplication of the kinematic deformation gradient into elastic and inelastic parts. The inelastic part is also decomposed into phase transformation and plastic slip related ones. The corresponding constitutive equations are solved with the Newton-Raphson method combined with an implicit integration scheme. Further, an exponential map approach is carried out to integrate the evolution equations. In order to validate this model, the numerical results have been compared with experimental results of Khalil el al. [2]. Obtained results are in a good agreement with the experimental data and enhance the small-strain model [1] by hardening enhancing the prediction of the nonlinear plastic hardening at high strain levels. Additional simulations with higher loading levels are discussed, showed that the present model well predict the Fe-SMA thermomechanical behavior in finite-strain.

## REFERENCES

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