Phase-field modeling of thermomechanical porous-ductile fracture

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ABSTRACT

Phase-field methods to regularize sharp interfaces represent a well established technique nowadays. In fracture mechanics, recent works have shown the capability of the method for brittle as well as ductile problems formulated within the fully non-linear regime [1, 2].

In this contribution, we propose a novel framework to simulate porous-ductile fracture in isotropic thermo-elasto-plastic solids undergoing large deformations [3]. Therefore, a modified Gurson-Tvergaard-Needelman GTN-type plasticity model is combined with a phase-field fracture approach to account for a temperature-dependent growth of voids on micro-scale followed by crack initiation and propagation on macro-scale. The multi-physical formulation is completed by the incorporation of an energy transfer into thermal field such that on the other hand the temperature distribution depends on the evolution of the plastic strain and the crack phase-field.

Eventually, a number of numerical investigations show not only the possibilities of the approach for a multi-physical analysis of complex material behavior, but also the accordance with experimental results in terms of hardening, necking, crack initiation and propagation. Moreover, a further example based on third Sandia Fracture Challenge is applied to demonstrate the capability of the model for the prediction of three-dimensional fracture pattern in complex geometries.

REFERENCES

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