Accepted Manuscript

A phase field model for damage in elasto-viscoplastic materials

P. Shanthraj, L. Sharma, B. Svendsen, F. Roters, D. Raabe

PII: S0045-7825(16)30326-7
DOI: http://dx.doi.org/10.1016/j.cma.2016.05.006
Reference: CMA 10964

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Please cite this article as: P. Shanthraj, L. Sharma, B. Svendsen, F. Roters, D. Raabe, A phase field model for damage in elasto-viscoplastic materials, *Comput. Methods Appl. Mech. Engrg.* (2016), http://dx.doi.org/10.1016/j.cma.2016.05.006

A Phase Field Model for Damage in Elasto-Viscoplastic Materials

P. Shanthraj[a,b,*], L. Sharma[a,c], B. Svendsen[a,d], F. Roters[a], D. Raabe[a]

[a]*Max-Planck-Institut für Eisenforschung, Max-Planck-Straße 1, 40237 Düsseldorf, Germany*
[b]*AICES, RWTH Aachen University, Schinkelstraße 2, 52062 Aachen, Germany*
[c]*Department of Mechanical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB, Eindhoven, The Netherlands*
[d]*Material Mechanics, RWTH Aachen University, Schinkelstraße 2, 52062 Aachen, Germany*

Abstract

A phase field method for brittle fracture is formulated for a finite strain elasto-viscoplastic material using a novel obstacle phase field energy model. The obstacle energy model results in a crack profile with compact support, and thus gives a more physically realistic description of the material behaviour at the vicinity of the crack tip. The resulting variational inequality is discretised by a finite element method, and is efficiently solved using a reduced space NEWTON method. The solution accuracy and numerical performance of this method is compared with a conventional phase field energy model for brittle fracture through representative examples, and a significant reduction in the numerical solution cost is demonstrated.

Keywords: Phase field, Viscoplasticity, Fracture, Finite deformation

1. Introduction

The prediction of crack initiation and propagation in microstructures in relation to its myriad configurations is of critical importance in the design of heterogeneous materials (Bouaziz et al., 2008; Ritchie, 1999; Koyama et al., 2014). Traditional methods to characterise material failure are expensive and slow as they rely heavily on experiments (Requena et al., 2014; Toda et al., 2008; Weiland et al.,

*Corresponding author. Phone: +49 211 6792-825, fax: +49 211 6792-333
Email address: p.shanthraj@mpie.de (P. Shanthraj)