Accepted Manuscript

A generalized cohesive zone model and a grain boundary yield criterion for gradient plasticity derived from surface- and interface-related arguments

Stephan Wulfinghoff

PII: S0749-6419(16)30253-4

DOI: 10.1016/j.ijplas.2017.02.006

Reference: INTPLA 2157

To appear in: *International Journal of Plasticity*

Received Date: 25 October 2016

Revised Date: 8 February 2017

Accepted Date: 10 February 2017

Please cite this article as: Wulfinghoff, S., A generalized cohesive zone model and a grain boundary yield criterion for gradient plasticity derived from surface- and interface-related arguments, *International Journal of Plasticity* (2017), doi: 10.1016/j.ijplas.2017.02.006.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

A generalized cohesive zone model and a grain boundary yield criterion for gradient plasticity derived from surface- and interface-related arguments

Stephan Wulfinghoff[a]

[a] *Institute of Applied Mechanics, RWTH Aachen University, Mies-van-der-Rohe-Str. 1, 52074 Aachen, Germany*
stephan.wulfinghoff@ifam.rwth-aachen.de

Abstract

In this work, new generalized interface models for gradient plasticity based on the dislocation density tensor are presented. The first one is a new generalized cohesive zone model which can be used for interface damage and delamination in gradient plasticity applications. The second one is a new grain boundary yield criterion with isotropic and kinematic hardening and a related flow rule, being formulated based on results from discrete dislocation simulations. The derivation starts from surface-related considerations, like in the work of Del Piero (2009), who starts with the virtual power of the external forces and then *derives* the principle of virtual power (Povp) rather than postulating it. Here, however, the formulation is carried out without using the notion of 'virtual power', although the derivation may as well be based on the Povp. Moreover, the derivation does not involve new micro force balance equations. In addition, the dislocation density tensor occurs rather as an outcome of the approach than as an ingredient. The discussion is closed by an example.

Keywords: gradient plasticity, size effects, interface, dislocations, cohesive zone

---

1 Introduction

Today, it is a well-established experimental fact that the strength of metal-based materials can be increased by refining the microstructure (Hall, 1951; Petch, 1953; Dunstan and Bushby, 2014) or, in case of micromechanical systems, the overall system size (Fleck et al., 1994; Dimiduk et al., 2005; Yang et al., 2012; Ziemann et al., 2015). Various continuum mechanical theories have been proposed that phenomenologically extend classical plasticity theories to account for this size effect. A famous example is given by the theory of Fleck and Hutchinson (Fleck and Hutchinson, 1997), where plastic strain gradients are used as approximation of so-called geometrically necessary dislocations (GNDs, Ashby, 1970). Different variants of the theory have been applied (e.g. Nielsen and Niordson, 2013) and the model is continuously further developed (Fleck and Willis, 2009b; Fleck et al., 2014). Currently, a major research topic is the investigation of the nature (energetic or dissipative) of generalized stresses, which are work-conjugate to the plastic strain gradients (Fleck et al., 2015; Lubarda, 2016). These and other strain gradient plasticity models are often based on the gradient of a scalar 'effective' or 'equivalent' plastic strain variable (Fleck and Willis, 2009a; Wulfinghoff and Böhlke, 2012; Mazière and Forest, 2015). However, models based on a scalar plastic variable may be problematic in certain situations (see Poh et al., 2011; Wulfinghoff et al., 2014). Moreover, the aforementioned models do not consider the plastic spin, which can lead to a poor desciption of the GND microstructure (Bardella and Panteghini, 2015; Poh and Peerlings, 2016). A more general framework has been investigated by numerous authors, which accounts for the gradient of the full plastic

Download English Version:

https://daneshyari.com/en/article/5016779

Download Persian Version:

https://daneshyari.com/article/5016779

Daneshyari.com