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Multi-mechanism models: Present state and future trends

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ABSTRACT

The paper gives a review of the main features introduced in the multi-mechanism models, of the present possibilities and of further developments.

In the two last decades, various materials and mechanical effects were studied using multi-mechanism model types. Particular attention was given to the possible link between the mechanism definitions and the physical deformation sources. The main results of these works are first recalled. Propositions of future development for the multi-mechanism models are finally given.

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1. Introduction

Finite element design of critical structures requires reliable constitutive models to describe the stress–strain response of the material. Along the two past decades, numerous plasticity models have been developed and modifications or new formulations are currently being proposed. These works have been realized on three types of models:

- The so-called unified models (mainly the Chaboche's models) in which all the deformation sources are considered together and only their mean effect is taken into account through a single inelastic strain. This is performed, for example, McDowell (1995); Ristinmaa (1995); Jiang and Kurath (1996); Basuroychowdhury and Voyiadjis (1998); Taheri and Lorentz (1999); Yoshida (2000); Bari and Hassan (2000); Abdel-Karim and Ohno (2000); Bari and Hassan (2001); Bari and Hassan (2002); Leclère et al. (2004); Vincent et al. (2004); Abdel-Karim (2005); Kang et al. (2006); Yaguchi and Takahashi (2005); Kang (2008); Moosbrugger et al. (2008); Rahman et al. (2008); Kang et al. (2008); Abdel-Karim (2009); Chen et al. (2009); Berisha et al. (2010).
- The crystallographic models in which physical ingredients are represented as texture, local stresses or strains in the grain ... These models deal mainly with scale transition rules, such as classic self-consistent schemes. A non-exhaustive list of models includes the works of: Hill (1965), Berveiller and Zaoui (1979), Weng (1980), Molinari et al. (1987), Lebensohn and Tomé (1993), Cailletaud and Pilvin (1994), Li and Weng (1997), Molinari (1999), Masson et al. (2000), Beaudoin et al. (2000), Paquin et al. (2001), Beaudoin and Acharya (2001), Sabar et al. (2002), Schurig and Bertram (2002), Gallée et al. (2007), Cailletaud and Sai (2008), Mercier and Molinari (2009), Hlilou et al. (2009), Abdeljaoued et al. (2009), Krishna et al. (2009) and Rousselier et al. (2009).
- The multi-mechanism models (subject of this paper) have took their inspiration from the two first approaches. The modifications of the models concern mainly (i) the scale transition rules for the stress localization and the strain homogenization (ii) the non-linear kinematic hardening rules and (iii) the isotropic strain hardening variables.

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