An investigation of back stress formulations under cyclic loading - DTU Orbit (12/05/2019)

An investigation of back stress formulations under cyclic loading

A single material length parameter governs both the material size dependence and the predicted micro-structural behavior in most existing micro-structurally based continuum theories. As a consequence, smoothly varying field quantities are predicted which contrast recent years’ experimental observations. In a previous work by the authors, addressing this matter, two new back stress formulations were proposed, and demonstrated to offer novel modeling capabilities in the localization behavior of geometrically necessary dislocation pile-up under monotonic loading. However, the cyclic behavior of these formulations remains to be investigated. The present work studies the new back stress formulations, within a non-work conjugate type higher order strain gradient crystal plasticity framework, and demonstrates their performance through the idealized single slip simple shear case. At high values of the material length scale parameter, a seemingly anomalous cyclic response is observed when deviating from the conventional type back stress formulation. Similar observations have recently been reported in other numerical studies, and the present work offers a discussion of the physical justification of such material behavior. It is found that the properties of the adopted formulations, in fact, open the possibility for modeling complex material behavior, tied to the presence of long range internal stresses due to dislocation pile-up. Moreover, the present study extends the discussion on micro-structure predictions as a consequence of the adopted back stress models.

General information
Publication status: Published
Organisations: Department of Mechanical Engineering, Solid Mechanics
Corresponding author: Nielsen, K. L.
Pages: 76-87
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Mechanics of Materials
Volume: 130
ISSN (Print): 0167-6636
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
Original language: English
Keywords: Bauschinger effect, Crystal plasticity, Geometrically necessary dislocations, Size-effects, Strain gradient plasticity
DOIs:
10.1016/j.mechmat.2019.01.005
Source: Scopus
Source-ID: 85060241111
Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review