Coupling of micromechanical phi-model and plastic instability Marciniak-Kuczynski model for Forming Limit Diagrams predictions

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ABSTRACT

Developments of recent alloys constitute a response to environmental and energetic challenges, but lead to more and more complex mechanical behaviors making obsolete some classical design tools. Experimental procedures are well suited for the determination of forming limit diagrams (FLD). They are completed by theoretical approaches and numerical models to investigate sensibility of formability to material parameters, to simulate real non-linear loading paths and to design industrial processes.
A micromechanical approach based on the coupling of phi-model with Marciniak – Kuczynski strain localization method is considered here to take into account the influence of microstructure of polycrystalline metals on formability and to face out limitations of classical phenomenological models.
Viscoplastic phi-model is chosen for its capabilities to predict crystallographic textures with grain matrix interactions, with results that span from the upper bound (Taylor model) to the lower bound (Static model) approaches [1-2]. Marciniak – Kuczynski (M-K) approach is largely used by both academic and industrial laboratories [3-5]. This method is chosen here for its ability to deal with time-dependent media and for its simplicity to be coupled with advanced material modeling. Coupling of M-K and phi-model is then used for FLD applications of fcc metals under various values of phi which controls the strength of the interactions (from stiff to more compliant interaction) in the polycrystal.

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