Ductile fracture modeling with bimodal void distribution and transgranular fracture in the framework of physically based polycrystalline plasticity.

Gilles Rousselier*

* MINES ParisTech, PSL Research University, MAT-Centre des Matériaux, CNRS UMR 7633, BP87, 91003 Evry Cedex, France
e-mail: gilles.rousselier@mines-paristech.fr

ABSTRACT

The framework of physically based polycrystalline plasticity can now be used with reasonable computation time for simulations of laboratory experiments. The plastic and failure behavior can be modeled with a very small number of crystallographic orientations, between 8 and 15, depending on the material (*reduced texture methodology **RTM***). The plasticity model parameters *and* the reduced texture parameters (Euler angles and volume fractions) are determined from *mechanical* experiments through inverse optimization.

In this framework, the anisotropy and distortion of the yield surface, as well as non-proportional loadings are modeled (when damage and/or fracture are involved, local loading paths are highly non-linear, even if the specimen or structure is in proportional loading). Furthermore, complex ductile fracture mechanisms can be combined: *macroscopic* modeling of nucleation, growth, coalescence of micrometric voids, modeling *at the slip system scale* of sub-micrometric voids and/or crystallographic transgranular fracture without prior void damage. These mechanisms are observed for example in aluminum thin sheets and in steels.

It is applied to flat and axisymmetric notched tensile specimens. The experimental and numerical results are in good agreement with regard to fracture strains and locations as well as macroscopic/microscopic features. The effects of the secondary population of voids are discussed, in particular the effect of carbides-nucleated voids in low alloyed steels.

Keywords: Ductile fracture, Multi-Scale Modeling, Polycrystalline Plasticity, Bimodal Void Distribution, Transgranular Fracture

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