

Phase-field fracture in elastic-plastic polycrystals, analysis of FEM and FFT implementations

**Pedro Aranda Acuña¹, Ángel de Jesús Valverde González², José Antonio Reinoso Cuevas³,
Javier Segurado Escudero⁴**

¹ Department of Mechanical Engineering, University of Santiago de Chile, Chile. pedro.aranda@usach.cl

² Materials and Sustainability, Engineering Department, Loyola University Andalusia, Spain. ajvalverde@uloyola.es

³ Departamento de Mecánica de Medios Continuos y Teoría de Estructuras, Universidad de Sevilla, Spain.
jreinoso@us.es

⁴ Departamento de Ciencia de Materiales, Universidad Politécnica de Madrid, Spain. javier.segurado@upm.es

Paper ID: 378

[Symposium S8: Fracture, and damage of materials](#)

Abstract

A simulation framework is proposed for the elastoplastic fracture of polycrystals at the mesoscale based on the simulation of representative volume elements of polycrystals by means of the phase-field fracture (PFF) model and crystal plasticity. The method is implemented in two boundary value problem solvers, the Finite Element Method (FEM) and a Fast Fourier Transform based solver (FFT), using in both cases identical periodic boundary conditions and a staggered-based solution scheme. The framework is able to reproduce the basic features of elastoplastic fracture at this scale, showing localized plasticity at the crack tip and crack path changes during propagation from grain to grain. The results obtained using the two different solvers are convergent with the discretization, but their results using coarser discretizations present clear differences both in the macroscopic mechanical response and in the crack paths developed. It is found that the origin of the discrepancies is the representation of the initial crack as a row of elements/voxels with negligible stiffness, which enhances different energy localization around its tip. These differences are appreciated in elastic polycrystals but become more important when the elastoplastic response is considered. A phase-field crack-tip enrichment technique in FFT has been proposed to reduce the difference between both numerical approaches.

Keywords:

Phase field fracture FFT homogenization Crystal plasticity Micromechanics Elasto-plastic fracture Polycrystals