6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

NUMERICALLY EFFICIENT IMPLEMENTATION OF RATE-INDEPENDENT GRADIENT ENHANCED CRYSTAL PLASTICITY

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Keywords: *Gradient Enhanced Elastoplasticity, Crystal Plasticity, Numerical Efficiency*

A convenient and natural way to incorporate size effects – like the well-known Hall-Petch relation – into crystal plasticity theory is to account for gradients of the internal variables. A novel numerically efficient algorithmic formulation for these gradient-enhanced crystal plasticity models is presented. This formulation also covers (standard) local crystal plasticity theory, cf. [1]. Two main problems encountered in numerical implementations of such crystal plasticity theories are: (a) determination of the active slip systems and (b) ill-posedness of the discretized constitutive model, if too many slip systems are simultaneously active, cf. [2]. An efficient formulation for solving such problems is presented in [3]. This formulation relies on the introduction of (i) nonlinear complementary functions in order to eliminate the inequalities characterizing rate-independent plasticity theory and (ii) a purely numerical viscous relaxation by means of an augmented Lagrangian. In this talk, the algorithmic formulation proposed in [3] is critically analyzed and significantly extended for gradient-enhanced crystal plasticity theory. Furthermore the resulting formulation is embedded into the framework of incremental energy minimization.

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