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

Numerically robust and efficient two-scale FE-FFT-based finite strain crystal plasticity simulations of polycrystalline materials

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Key Words: *two-scale, FE-FFT, crystal plasticity, finite strains, polycrystals.*

The mechanical behavior of heterogeneous materials is dictated by physical, statistical and topological characteristics of the underlying microstructure. In order to capture such details in macroscopic finite element (FE) simulations, computational homogenization methods might be employed. Recently, the FE-FFT method [1] has been developed which seems to be a powerful and efficient alternative to the classical FE² approach. The algorithmic formulation and numerical solution of the macroscopic problem is based on FE method. The local problem is solved using fast Fourier transforms (FFT) and fixed-point methods [e.g. 2]. Composite [1] and polycrystalline materials [3, 4] have been modelled based on the FE-FFT method assuming small strain kinematics. More recently, the finite strain extension and application to composite materials has been documented by [5]. The present work deals with two-scale FE-FFT-based finite strain crystal plasticity simulations of polycrystalline materials. Two- and three-dimensional numerical examples indicate that the proposed scheme is characterized by numerically robust computations for relatively large time increments and rate sensitivity parameters as well as moderate overall computation times.

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