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

EXTENSION OF FFT BASED MODELS TO INTERFACIAL AND NONLOCAL PROBLEMS

L. Sharma[1,*], R.H.J. Peerlings[1], P. Shanthraj[2], F. Roters[2], M.G.D. Geers[1]

[1] Eindhoven University of Technology, P.O. Box 513, 5600 MB, Eindhoven, The Netherlands.
[2] Max-Planck Institut für Eisenforschung, Max-Planck-Str. 1, Düsseldorf, Germany.
*l.sharma@tue.nl

Key words: *FFT-based Spectral Methods, Interfaces, Decohesion, Nonlocality*

FFT-based spectral methods have developed as an efficient alternative for modelling the micromechanics [1, 2]. Motivated by their obvious computational advantages, in this work, we propose their extension to interface modeling. The lack of interface elements in FFT methods is remedied by treating interfaces as volumetric bands (interphases). To model the kinematics of decohering interfaces, an eigen (damage) strain based approach is used. The fracture energy associated with the decohesion is embedded into the evolution equations of the opening strains. The softening character of these evolution equation causes localisation of strain, which necessitates the use of nonlocal approaches to regularise the strains uniformly within the band. We explore the implementation of two nonlocal approaches: gradient based damage [3] and integral averaging based damage [4]. Since the damage strains here model interfacial physics only, the integral equation for the former approach and the differential equation for the latter approach have to be solved on the interphase subdomain only. For the gradient damage based approach this is particularly challenging in a FFT setup due to the periodic shape functions. We use a contrast in the coefficients of the differential equation to mimic flux-free boundary conditions at the edges of the interphases. Both approaches are compared based on their ability to provide accurate scaling of fracture energy, kinematics and ease of implementation. Finally, an application a polycrystalline case in a crystal plasticity setup is also shown.

REFERENCES

[1] H Moulinec and P Suquet. A numerical method for computing the overall response of nonlinear composites with complex microstructure. *Computer Methods in Applied Mechanics and Engineering*, 157(1-2):69–94, 1998.

[2] Pratheek Shanthraj, Philip Eisenlohr, Martin Diehl, and Franz Roters. Numerically robust spectral methods for crystal plasticity simulations of heterogeneous materials. *International Journal of Plasticity*, 66:31–45, 2015.

[3] R. H. J. Peerlings, R. de Borst, W. A. M. Brekelmans, and J. H. P. de Vree. Gradient enhanced damage for quasi-brittle materials. *International Journal for Numerical Methods in Engineering*, 39(19):3391–3403, 1996.

[4] Zdeněk P. Bažant and Gilles Pijaudier-Cabot. Nonlocal Continuum Damage, Localization Instability and Convergence. *Journal of Applied Mechanics*, 55(2):287, 1988.