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GRAIN CLUSTER METHOD FOR MULTISCALE SIMULATIONS OF MULTIPHASE STEELS

Sergio Turteltaub[1,*], Sourena Yadegari[1] and Akke Suiker[2]

[1] Faculty of Aerospace Engineering, Delft University of Technology, P.O. Box 5058, 2600 GB Delft, The Netherlands, {S.R.Turteltaub,S.Yadegari}@tudelft.nl
[2] Department of the Built Environment, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands, A.S.J.Suiker@tue.nl

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The development of new multiphase steels with enhanced mechanical properties requires examining their response behavior by means of advanced numerical models that accurately account for complex microstructural characteristics. Direct numerical simulations (DNS) at the microscale, together with an appropriate averaging scheme, lead to a consistent scale transition for determining the overall behavior at the macroscopic scale. However, performing a DNS is often computationally expensive, which limits its applicability. A computationally less expensive approximate method, termed the Generalized Grain Cluster Method (GGCM), is proposed as an alternative. The GGCM relies on a set of simplifying assumptions for the distribution of the deformation field inside a grain while at the same time it minimizes the effect of discontinuities arising from the kinematical assumptions. This method, which is an alternative formulation of the Relaxed Grain Cluster Method [1], allows to study an aggregate of grains with arbitrary polyhedral shapes. A benchmark for the proposed multiscale framework is constructed by performing a set of DNSs on polycrystalline samples composed of multiple austenitic and ferritic grains (TRIP-steel). The mechanical response of the austenitic grains is computed by means of an elastoplastic-transformation model whereas a crystal-plasticity model for BCC lattices is used to simulate the elastoplastic deformations in the ferritic grains [2, 3]. Polycrystalline samples of increasing size are used to identify a representative volume element for the numerical homogenization procedure. The same set of samples is analyzed using the direct numerical simulations and the Generalized Grain Cluster Method. The macroscopic responses derived from these homogenization schemes are compared and the accuracy and numerical efficiency of the proposed method is pointed out.

REFERENCES

[1] Tjahjanto DD, Eisenlohr P, Roters F, *Mod.Sim.Mat.Sci.Eng.*, **18** (1) art 015006, 2010

[2] Tjahjanto DD, Turteltaub S, Suiker ASJ, *Cont.Mech.Therm.*, **19**, 399-422, 2008

[3] Yadegari S, Turteltaub S, Suiker ASJ, *Mech.Mater.* **53**, 114, 2012