Micromechanical model for the simulation of creep deformation in Inconel 718

Eva M. Andrés[*,1], Ignacio Romero[1,2], and Javier Segurado[1,3]

[1]IMDEA Materials Institute, C/Eric Kandel 2, 28906 Getafe, Madrid, Spain
Tel.: +34 91 549 34 22; Fax: +34 91 550 30 47
E-mail addresses: evamaria.andres@imdea.org, ignacio.romero@imdea.org, javier.segurado@imdea.org
Web page: http://www.materials.imdea.org

[2]Department of Mechanical Engineering, Polythechnic University of Madrid
E.T.S. de Ingenieros Industriales, 28006 Madrid, Spain. E-mail: ignacio.romero@upm.es

[3]Department of Materials Science, Polytechnic University of Madrid
E.T.S. de Ingenieros de Caminos, 28040 Madrid, Spain. E-mail: jsegurado@mater.upm.es

ABSTRACT

A physically based model is developed to determine the creep deformation of polycrystalline wrought Inconel 718 (IN718) as a function of microstructure. Computational homogenization by means of the finite element analysis of a Representative Volume Element (RVE) of the microstructure [1] is used to simulate the macroscopic behaviour. Each grain behaviour is simulated by a Crystal Plasticity (CP) model especially developed here for IN718 creep deformation. The CP model depends on temperature and stress tensor and includes the relevant microscopic mechanisms leading to creep and monotonic deformation [2, 3]. Most of the crystal properties are obtained from experimental micro-testing or found in literature and the remaining parameters, non accesible though direct testing, have been determined from experimental results of polycrystal creep tests through an inverse optimization strategy. The influence of the microstructure (shape, size and orientation grain distributions) is accounted by the explicit introduction of such features in the definition of the polycrystalline RVE. Hence, the model is able to account for the effect of grain size, shape and distribution orientation in a natural way. The multiscale model predictions of the stationary strain rate of wrought IN718 are in general agreement with the experimental results for a range of temperatures and stress levels, and, at least, two different microstructures (grain size distributions).

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