Dynamic strain aging (DSA), strain localization and fracture in Al-Cu-Li alloys

Satyapriya Gupta[1], Vincent Taupin[1], Claude Fressengeas[1], Juliette Chevy[2]
[1]Laboratory of Microstructure Studies and Mechanics of Materials (LEM3), Metz, France
[2]C-TEC Constellium Technology Center, Voreppe, France

Recently developed Al-Li-Cu alloys are the result of increasing demand of light weight alloys which are essential to cut the fuel consumption and enhance the overall performance of the aircraft. Efficient usage of these alloys and extension in their application areas need some intensive research on microstructure-property and failure relationship. Therefore, we investigated the influence of crystallographic and morphological texture on the formation of early deformation bands, localization and subsequent failure of Al-Li-Cu alloys. To that end, we have adopted a crystal plasticity field dislocation mechanics model enabled with disconnection fracture mechanics [1]. Since the localization being significantly influenced by DSA observed in these alloys, plastic instabilities caused by dislocation solute interactions are taken into account by implementing a DSA module [2] into the crystal plasticity and fracture framework. All the field equations are implemented within finite element solver provided by Freefem++ software [3]. Finite element simulations are performed on both starting from simplified to realistic RVEs. Simulation results suggested a significant influence of texture and morphology on the early strain localization in presence of DSA in Al-Cu-Li alloys.

1. C. Fressengeas, V. Taupin, A field theory of distortion incompatibility for coupled fracture and plasticity, Journal of the Mechanics and Physics of Solids, Volume 68, August 2014, Pages 45-65.

2. C. Fressengeas, A.J. Beaudoin, M. Lebyodkin, L.P. Kubin, Y. Estrin, Dynamic strain aging: A coupled dislocation—Solute dynamic model, Materials Science and Engineering: A, Volumes 400–401, 25 July 2005, Pages 226-230.

3. Hecht, F. New development in FreeFem++. J. Numer. Math. 20 (2012), no. 3-4, 251–265. 65Y15