LIGHTWEIGHT INNOVATIONS

Technology Project Abstract:

PHASE 1 – TMP-3b: Processing for Assured Properties in Al-Li Forgings by Development, Application and Validation of a Localized Physics-Based Visco-plastic Model

Lead Industry Partner: United Technologies Research Center

Lead Research Partners: University of Michigan
Case Western Reserve University

Technology Pillar: Thermomechanical Processing

Project Summary

This two-phase project will develop, implement and validate a localized physics-based visco-plastic finite element model (FEM) to predict mechanical deformation response, damage evolution mechanisms, and fatigue properties of forged Al-Li alloys. Phase one will focus on the development and validation of the predictive tools for Al-Li forging's to predict the effects of the material processing parameters on the part anisotropic mechanical properties.

Technology Gap / Need

Past Al-Li in structural applications have had serious issues due to high planar anisotropy, unusual crack paths, and a lack of thermal stability. A new generation of Al-Li alloys provide weight savings and improved properties. To meet significantly higher performance requirements of commercial aircraft engines, improved analytical methods are required to determine which material properties are best suited for a specific structure and how best to achieve the required mechanical and damage tolerant properties during material processing.

Focus/Technology

Objectives of Phase one are:

(i) Develop and implement a non-isothermal multiscale crystal plasticity (CP) constitutive model applied for 3rd generation Al-Li alloys

(ii) Develop and implement a microstructure based CP FEA framework to predict the effect of materials processing and local morphology on the mechanical behavior of the components

(iii) Experimentally calibrate and validate the predictive model.

Project Benefits

New FEM toolkits to guide process optimization of forged Al- Li alloy components will reduce the amount of development hardware and processing trials required for developing the next generation of aircraft turbine engines. By optimizing processes and designs, they will lead to components with improved performance and weight savings.

Education & Workforce Impact

Case Western Reserve University, the University of Michigan and the Forging Industry Educational Foundation (FIERF) will lead the development of project education and training efforts. Various delivery mechanisms have been made available through FIERF including instructor-led, on-line, learn-at-home self-study, video courses and workshops.

Project Duration

Start: January 2016
End: December 2017

Funding

Total Project Value: $3.2M

Participants

Industry Partners

United Technologies Research Partners

Lockheed Martin

Research Partners

University of Michigan

Case Western Reserve University

The Ohio State University

Southwest Research Institute