Dwight Look College of Engineering
Texas A&M University

Master/Ph.D. position available in Aerospace Engineering

Coupling between a microstructure-sensitive model and a phase-field model to predict the mechanical behavior/damage of a bi-phased materials: Application to Ni-based single crystal superalloy

A PhD position is available at Texas A&M University in the Aerospace department to work on the coupling between a phase-field and a microstructure-sensitive model to predict both the microstructural evolutions (coarsening, dissolution/precipitation, porosity, etc.) and the mechanical behavior/damage of a bi-phased material at high temperature (a Ni-based single crystal superalloy, for instance).

A phase-field model is a mathematical model for solving interfacial problems. The aim of the phase-field modeling is to describe the microstructure of the material at the mesoscopic scale by means of continuous fields. The evolution of these fields is governed by both elastic and chemical driving forces [1-3]. More recently, a plastic driving force was added to phase-field modeling [4]. This driving force was revealed to be necessary to simulate the directional coarsening occurring in Ni-base single crystal superalloys during long high-temperature mechanical tests, such as creep tests. This framework is able to predict many microstructural evolutions such as the directional coarsening of the strengthening phase, known as rafting, and the void nucleation and growth [5, 6].
On the other hand, microstructure-sensitive constitutive models were developed to predict the mechanical behavior and damage during complex thermomechanical loadings [7, 8]. This type of model explicitly takes into account microstructure evolutions (volume fractions, coarsening, dissolution/precipitation, etc.) to modify the mechanical behavior of materials by introducing internal variables.
A coupling between this two kinds of model was never done before, especially for thermomechanical loadings. Thus, softening and hardening will be introduced in the viscoplastic constitutive model by microstructure changes given by the phase-field model and *vice versa*. The ultimate goal of this research is then to do Finite Element Simulations to predict the entire microstructure (precipitation, coarsening, porosity, etc.) during thermomechanical loadings performed on specimens whose geometries produce multiaxial stresses.

Regarding the work environment, the Texas A&M University, created in 1871, is one of the top American engineering school in Aerospace (7th among the nation's top public undergraduate and graduate engineering programs, according to U.S. News & World Report). The Dwight Look College of Engineering is the largest college on the Texas A&M campus with more than 12,000 engineering students enrolled within the 13 departments whose 700 undergraduate and 150 graduate students in the Aerospace department.

The candidate should have obtained a Bachelor’s or a Master's degree with a strong background in materials science, mechanical engineering or any related field. A strong interest for numerical approaches is expected from the successful candidate.

An admissible application should include a detailed CV of the candidate, a full list of publications (if you have), a cover letter, and grade transcripts from prior education (BSc and MSc, or equivalent).
Applications should be sent via e-mail to J.-B. le Graverend (jbriaclg@caltech.edu).

[1] Boussinot G, Finel A, Le Bouar Y. Acta. Mater. 2009;57:921.
[2] Boussinot G, Le Bouar Y, Finel A. Acta Materialia 2010;58:4170.
[3] Wang T, Sheng G, Liu Z-K, Chen L-Q. Acta Materialia 2008;56:5544.
[4] Gaubert A, Le Bouar Y, Finel A. Philosophical Magazine 2010;90:375.
[5] Hu SY, Henager Jr CH. Acta Materialia 2010;58:3230.
[6] Rokkam S, El-Azab A, Millett P, Wolf D. Modelling and Simulation in Materials Science and Engineering 2009;17:064002.
[7] Cormier J, Cailletaud G. Mater. Sci. & Eng. A 2010;527:6300.
[8] le Graverend J-B, Cormier J, Gallerneau F, Villechaise P, Kruch S, Mendez J. Int. J. of Plast. 2014;59:55.