11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

A REDUCED-ORDER MODEL OF TITANIUM ALLOY FOR THE CONTROL OF MICROSTRUCTURE-SENSITIVE MATERIAL PROPERTIES

Abhishek Kumar[1], **Veera Sundararghavan**[2]

[1] PhD Student, Aerospace Department University of Michigan, Ann Arbor, abhiks@umich.edu
[2] Associate Professor, Aerospace Department University of Michigan, Ann Arbor, veeras@umich.edu

Key words: *Multi-scale modeling, Continuum Sensitivity Analysis, Polycrystal plasticity, Material-by-design, Forming process design*

A crystal-plasticity based constitutive model for the large deformation of polycrystalline materials with hexagonal crystal structure deforming by mechanism of slip only(no twinning) is developed. To account for the innite degrees of freedom of microstructural features, a model reduction on the micro-scale is introduced. Reduced-order models are developed to model the evolution of microstructure described by an orientation distribution function using a nite element discretization of the orientation space. Novel design problems are introduced for the control of microstructure based on realistic polycrystalline plasticity. Specically, a gradient based optimization framework is introduced using a multi-length scale continuum sensitivity method (CSM). The model reduction is extended to the sensitivity analysis and is a key element for the success of computational design of deformation processes. Numerical examples that highlight the benets of the continuum sensitivity method and model reduction are presented. Effectiveness of the developed computational scheme is demonstrated through computationally intensive examples that address control of properties such as Young Modulus and Strength.