

Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Multiscale characterization of DP980 steels for automotive applications

Rumie, Annie, annie.ruimi@qatar.tamu.edu; F. Zhang, H. Lyu, D. Field, H. Zbib

ABSTRACT

Development has been organized as a "pipeline" that links the separate disciplinary efforts of groups housed in seven institutions spread across the United States. The main research steps are: high resolution three-dimensional (3D) imaging of the microstructure, statistical characterization of the microstructure, formulation of a probabilistic generator for creating virtual specimens that replicate the measured statistics, creation of a computational model for a virtual specimen that allows general representation of discrete damage events, calibration of the model using room and high temperature tests, simulation of failure, and model validation. Key new experiments include digital surface image correlation and ¼-m resolution 3D computed tomography imaging of the microstructure and evolving damage, both executed at temperatures exceeding 1500°C. Conceptual advances include using both geometry and topology to characterize stochastic microstructures. Computational methods include new probabilistic algorithms for generating stochastic virtual specimens and a new Augmented Finite Element Method that yields extreme efficiency in dealing with arbitrary cracking in heterogeneous materials. The challenge of relating variance in engineering properties to stochastic microstructure in a computationally tractable manner, while retaining necessary physical details in models, will be discussed.