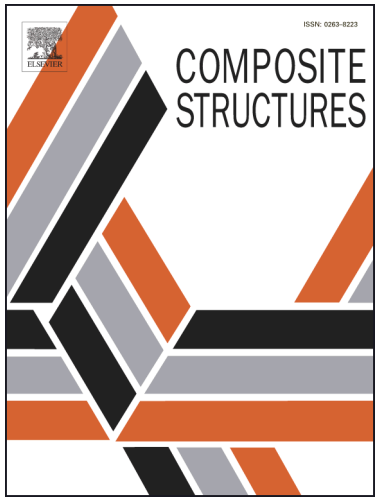

Multiscale Finite Element Modeling of Sheet Molding Compound (SMC) Composite Structure based on Stochastic Mesostructure Reconstruction

Zhangxing Chen, Tianyu Huang, Yimin Shao, Yang Li, Hongyi Xu, Katherine Avery, Danielle Zeng, Wei Chen, Xuming Su

PII: S0263-8223(17)33073-8
DOI: https://doi.org/10.1016/j.compstruct.2017.12.039
Reference: COST 9196

To appear in: *Composite Structures*

Received Date: 19 September 2017
Revised Date: 29 November 2017
Accepted Date: 15 December 2017

Please cite this article as: Chen, Z., Huang, T., Shao, Y., Li, Y., Xu, H., Avery, K., Zeng, D., Chen, W., Su, X., Multiscale Finite Element Modeling of Sheet Molding Compound (SMC) Composite Structure based on Stochastic Mesostructure Reconstruction, *Composite Structures* (2017), doi: https://doi.org/10.1016/j.compstruct.2017.12.039

Multiscale Finite Element Modeling of Sheet Molding Compound (SMC) Composite Structure based on Stochastic Mesostructure Reconstruction

Zhangxing Chen[1,2,†], Tianyu Huang[3,†], Yimin Shao[1], Yang Li[2], Hongyi Xu[2,*], Katherine Avery[2], Danielle Zeng[2], Wei Chen[3], Xuming Su[2]

1. Chongqing University, Chongqing, China, 400044

2. Research and Advanced Engineering, Ford Motor Company, Dearborn, MI, United States, 48121

3. Northwestern University, Evanston, IL, United States, 60201

† These authors contribute equally to this work

* Corresponding author: Dr. Hongyi Xu, hxu41@ford.com

Abstract

Predicting the mechanical behavior of the chopped carbon fiber Sheet Molding Compound (SMC) due to spatial variations in local material properties is critical for the structural performance analysis but is computationally challenging. Such spatial variations are induced by the material flow in the compression molding process. In this work, a new multiscale SMC modeling framework and the associated computational techniques are developed to provide accurate and efficient predictions of SMC mechanical performance. The proposed multiscale modeling framework contains three modules. First, a stochastic algorithm for 3D chip-packing reconstruction is developed to efficiently generate the SMC mesoscale Representative Volume Element (RVE) model for Finite Element Analysis (FEA). A new fiber orientation tensor recovery function is embedded in the reconstruction algorithm to match reconstructions with the target characteristics of fiber orientation distribution. Second, a metamodeling module is established to improve the computational efficiency by creating the surrogates of mesoscale analyses. Third, the macroscale behaviors are predicted by an efficient multiscale model, in which the spatially varying material properties are obtained based on the local fiber orientation tensors. Our approach is validated through experiments at both meso- and macro-scales, such as tensile tests assisted by Digital Image Correlation (DIC) and mesostructure imaging.

Keywords: SMC; multiscale; RVE; mesostructure reconstruction; orientation tensor