Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: CFDMPS
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Type: Oral
Status of corresponding author: Student
For student corresponding author: student member of one of the following:
AIAA

Title

Numerical Investigation of the Effects of Structural Property Variability on the Material Response of a Fibrous Ablator

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Abstract

Ablative materials are often used as thermal protection systems for spacecraft entering a planet's atmosphere. One common material used in this application is a phenolic-impregnated carbon ablator (PICA). The material is composed of carbon fibers surrounded by phenolic resin. While, this material appears homogeneous on the macroscale, the orientation of the fibers leads to the material having large variations of mesoscale properties. These variations require a deviation from the typical approach of using effective material properties in material response solvers. In order to properly capture the effects of variability it is necessary to use distributions of properties. However, these property distributions are still an unknown quantity, though there has been some work to create an approach to find some structural properties for FiberForm, the precursor substrate for PICA [1,2]. This work leverages recent improvements in this approach to explore the effects variability, in both In-Plane and Though-The-thickness Young's Moduli, has on the structural response using the KATS framework. KATS contains coupled material response and structural response solvers in which a new orthotropic structural response model was developed to calculate the displacement and stress fields within these materials. This investigation utilizes both the boundary conditions and iso-Q geometry from ablation workshop test case 3.2 [3] to examine these effects. This work is a first step in addressing the scatter that has been observed in real-world cases around model prediction [4].

References

[1] Seif, M., McDaniel, S., Beck, M., and Martin, A., "Stochastic Modeling of Elastic Behavior of Fibrous Ablators," AIAA Scitech 2021 Forum, 2021, p. 1585
[2] McDaniel, S., Seif, M., Fu, R., Beck, M., and Martin, A., "Development of Stochastic Model for Fibrous Ablators," AIAA Scitech 2021 Forum, 2021, p. 1473
[3] van Eekelen, T., Martin, A., Lachaud, J., and Bianchi, D., "Ablation Test-Case Series 3: Numerical Simulation of Ablative Material Response: Code and Model Comparisons," 6th Abaltion WorkShop, 2014.
[4] Panerai, F., White, J. D., Cochell, T. J., Schroeder, O. M., Mansour, N. N., Wright, M. J., and Martin, A., "Experimental measurements of the permeability of fibrous carbon at high-temperature," International Journal of Heat and Mass Transfer, Vol. 101, 2016, pp. 267–273