TITLE: Predictive Simulations of Chemical and Structural Failure of Porous Ablative Materials

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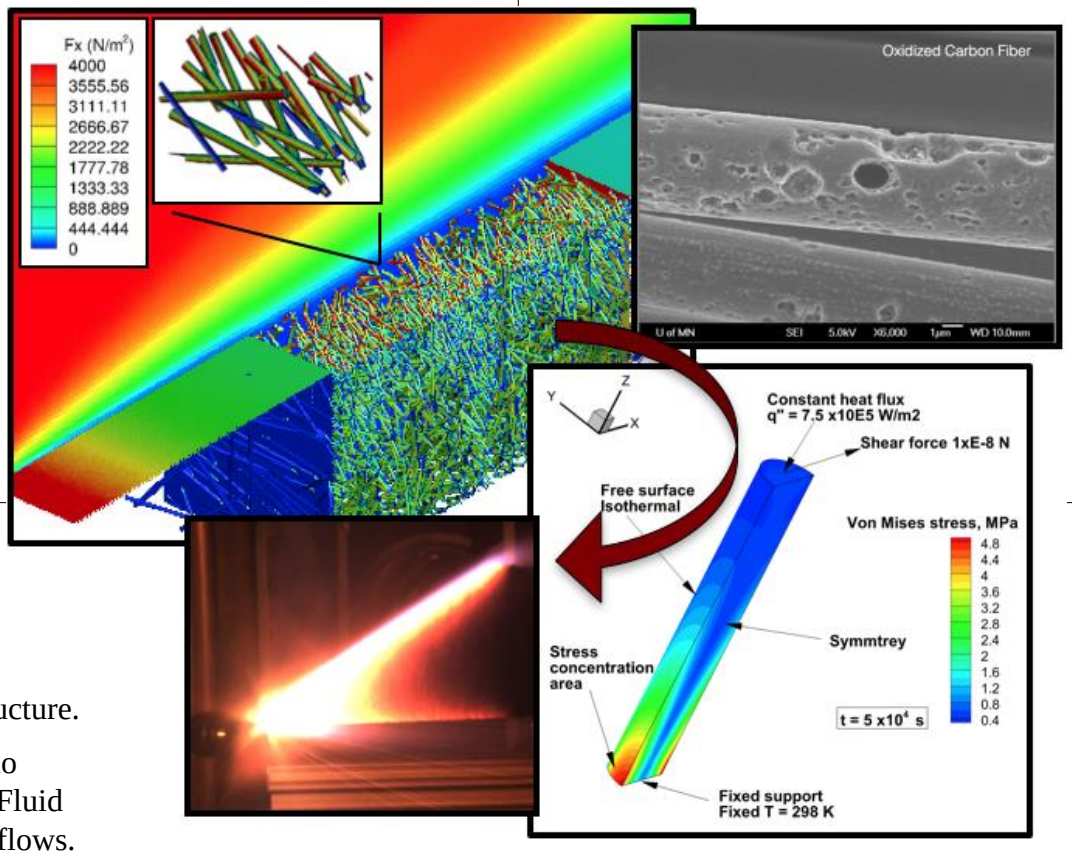
Research Objectives

The objective of this research is to develop a predictive modeling capability that couples thermochemical TPS response with its microscale *thermo-structural* response.

- Boundary layer simulations
- Thermo-chemical response of fibers
- Thermo-structural response of fibers
- Validation with spallation experiments



Molecular simulations of boundary layer flow at relevant hypersonic conditions (top-left) will provide the local chemical environment and structural loading for microstructure features. Microscale modeling of coupled chemical (top-right) and structural (bottom-right) response will enable prediction of spallation (bottom left) as well as computational design of TPS at the microstructure level.

Approach

X-ray micro-tomography and numerical design of microstructure.

Direct simulation Monte Carlo (DSMC) and Computational Fluid Dynamics of boundary layer flows.

Finite-volume thermo-structural simulations of microstructure.

Microscale structural response experiments.

Detailed carbon oxidation modeling, pitting, and microstructure evolution.

Potential Impact

The predictive modeling capability will enable precise assessment of TPS microstructure response, including complex processes such as spallation, and could ultimately be used in the *design* of new TPS materials at the microstructure level, such as new woven TPS currently under development at NASA.