

Interfacial Design of Composite Ablative Materials
Advanced Cooling Technologies, Inc.

Technical Abstract

This Small Business Innovation Research (SBIR) project proposes the development of a computational software package to provide NASA with advanced materials development capabilities for existing and new ablative materials used in the next generation thermal protection systems (TPS) of space vehicles. This materials development software package (MDSAM) can be used to optimize properties (high strength and low thermal conductivity) for both the virgin material as well as the char that forms during the operating conditions. It will provide atomistic-level information on char evolution and the degradation of thermo-mechanical properties. The proposed MDSAM will consist of the following two modules: (i) an experimentally validated, atomistic-level simulation engine capable of predicting the role of interfacial structure on the resin-to-carbon process and (ii) atomistically-informed continuum-level thermo-mechanical performance analyzer for composite ablative materials subjected to transient pyrolytic conditions. The underlying methodology and the software package will be transitioned to NASA scientists working on ablative materials development. In addition to developing a computational software package, we will address open, unsolved problems in the literature to support NASA's ablative materials development requirements. In the course of developing this methodology, we will produce significant scientific results on pyrolysis and materials properties that will be important to NASA.

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Fiber-Coupled Spectrometer for TPS Materials
ElectroDynamic Applications, Inc.

Technical Abstract

EDA, Inc., in partnership with Penn State, has shown previously that the concept of embedding fiber optics within ablative TPS material has merit and should yield a successful implementation of a spectrometer "window" during a Phase-II development program. Optical instrumentation, such as optical spectrometers would provide benchmark data for fundamental flow, radiation, and materials modeling as well as provide operational correlations between vehicle reentry drag and radiation if implemented in a TPS flight test program. Without flight spectral data, and the appropriate modeling efforts, the power of prediction to assist in new heat shield design does not exist for reentry into other planetary atmospheres. This is a severe limitation for future space exploration missions which FiberPlug helps address.

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