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Model and Characterization of Ablative Composite Material Based on Cork and Silicone Rubber

A missile executing hypersonic flight through a planetary atmosphere is exposed to severe heating. This heating, caused mainly by the extreme viscous dissipation that occurs within hypersonic boundary layers, is liable to damage the missile unless it is protected by suitable (robust) thermal insulation. Different types of insulation are in use where the main common requirements are low thermal conductivity, resistance to ablation, low thickness and weight, as well as low cost of materials and their application to the missile surface. One popular material traditionally in use is cork. However, although this material meets many of the requirements, it is relatively expensive and difficult to apply to complex geometries sometimes encountered along missile surfaces. A new material currently under consideration involves a composite of cork and silicone, which is simple to apply (via a geometrically insensitive spraying procedure) and, at the same time, exhibits excellent thermophysical properties.

In this contribution a critical evaluation of the performance of the new cork/silicone composite will be presented. First, a model of the heating and ablation of an insulated missile surface, and its simplification, will be discussed. Next, results from experimental procedures for the determination of necessary thermophysical properties will be presented and critically evaluated. Following this, verification of the modeling approach will be demonstrated by comparing results from computational analyses of heating and ablation under high pressure (low altitude) and low pressure (high altitude) conditions, to those achieved in relevant arc-plasma wind tunnel experiments. Finally, the computational approach will be used to predict the performance of the new insulation material during realistic missile flight trajectories.