MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Advanced Materials and Structures for High Temperature Applications (4)

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CARBON / CARBON HIGH THICKNESS SHELL FOR HYPERSONIC VEHICLES.

Abstract

The use of laminated composite shells in many engineering applications has been expanding rapidly in the past four decades due to their higher strength and stiffness to weight ratios when compared to most metallic materials. Composite shells now constitute a large percentage of recent aerospace or submarine structures. When shell structure is applied to space , the most challenging structure are the aeroshell used for the wing leading edge and nose of vehicles. The temperature extremes on these components brought the technology on development of ceramic materials able to withstand the harsh re-entry environment conditions. These structures are both aerodynamic and thermal protection systems. There are multiple options for dealing with the severe thermal environments encountered during hypersonic flight. Passive, semi-passive, and actively cooled approaches can be utilized.

Among passive technology Space Shuttle Orbiter elevons are the best example of reusable technology which does not use liquid coolant for thermal control. The use of liquid coolants is efficient but there is an increase of weights and failure risks. The aim of this paper is to study a shell structure for space applications such as leading edges of a re-entry vehicle. The aim of the structure is to be reusable, lightweight and thin. This first study will focus on thermal environment. Starting from a defined geometry, a prototype will be manufactured. Thermostructural behavior of the structure will be analyzed by numerical analysis and tests. Thermal properties, such as thermal conductivity and heat capacity, will be studied by the use of the inverse method. A robust numerical approach, such this inverse method, is one of the best for this problems as many parameters concur for the determination of properties. Such approach permits to perform the parametric and structural identification of the model. These procedures are presented including both experimental investigation and methodical-numerical aspects. Special test equipment and

the regularizing algorithm for solving the ill-posed inverse heat conduction problem are described. In the frame of thermal properties determination, a verification and prediction of thermocouple error will be performed. Developed in the frame of this work the experimental and theoretical methodology for complex data acquisition of unsteady thermal state of the prototype of shell structure is proposed.