Paper ID: 13313
oral
student

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Thermal/Fluidic Systems (7)

Author: Dr. Marta Albano
Sapienza University of Rome, Italy

Prof. Mario Marchetti
Associazione Italiana di Aeronautica e Astronautica (AIDAA), Italy
Prof. Oleg Alifanov
Moscow Aviation Institute, Russian Federation
Mr. Sergey Budnik
Moscow Aviation Institute, Russian Federation
Prof. Aleksey V. Nenarokomov
Moscow Aviation Institute, Russian Federation
Mr. Dmitry M. Titov
Moscow Aviation Institute (State Technical University), Russian Federation

COATING EFFECTS ON THERMAL PROPERTIES OF CARBON CARBON AND CARBON SILICON CARBIDE COMPOSITES FOR SPACE THERMAL PROTECTION SYSTEMS.

Abstract

Thermal protections systems (TPS) have been a challenge since the first space flights. The determination of the best material for TPS passes thorough years and years of development. From these studies it is evident that the Carbon Carbon (C\C) is the most promising material because synergistic effect exists between the fiber and the carbon matrix which results in high fracture toughness and wear resistance. But the most attractive properties of carbon-carbon composites are their high specific strength and modulus. The key factor for using this kind of material for re-entry vehicles is the high stability at high temperature, preserving its mechanical properties. However, most of these applications involve extended time periods in oxidizing environments. Unfortunately, carbon reacts rapidly with oxygen at temperatures as low as 770K and the composites are subjected to oxidation degradation. From this point of view C\C has to be modified in order to improve its thermal and oxidative resistance. The most common solutions are firstly to use silicon carbide into the carbon composites matrix (SiC composites) to make the thermal properties increase and secondly to make a deposition of coating on the surface in order to protect the composite from the space plasma effects. The main problem, when applying this second concept, is the thermal mismatch between coating and carbon substrate which results in cracking of the coating. More in general, these solutions change the properties of C\C thermal protection composites. In this paper C\C and coated C\C composites thermal behavior thorough plate thickness is studied and Thermal Expansion Coefficient (CTE) is determined. Moreover by the use of the inverse method heat capacity and thermal conductivity are also analyzed. 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 briefly described. This typology of study is performed also on CSiC (coated and not coated) in order to determine how much is the improvement of thermal behaviour. Burned and coated surface are also microanalyzed in order to study the crack formation and oxidation of the material surface.