MATERIALS AND STRUCTURES SYMPOSIUM (C2)
New Materials and Structural Concepts (4)

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ABLATIVE, MECHANICAL AND THERMAL PROPERTIES OF CARBON/SILICON CARBIDE (C/SIC) FOR USE AS THERMAL PROTECTION SYSTEM.

Abstract

One of the main tasks related to the development of space vehicles and recoverable orbital satellites is the design of the thermal protection systems. During flight the thermal protection structure is submitted to very high thermal flux and temperatures in the reentry phase of a space mission. Thermostructural composite materials have been used in the aerospace industry in applications that require reliability and performance, under adverse conditions of operation, as intense thermal fluxes, temperature gradients, pressure, mechanical and vibrational loads. In this work, Carbon/silicon carbide (C/SiC) reradiative composite was processed by polymer impregnation and pyrolysis route. This material will de used as the thermal protection system in the Brazilian Reentry Satellite (SARA). The base material was a Carbon Fiber Reinforced Carbon composite using a thermosetting resin (phenolic resin), which was carbonized at 1000oC and graphitized at 2500oC. The graphitized material was infiltrated by a silicone polymer (Starfire.RD212) and pyrolysed at 1000oC. Two cycles of silicone polymer infiltration and carbonization were carried out. Thermal properties, ablative and mechanical properties of the samples were investigated. The ablative experiments were carried out in the Laboratory of Process and Plasma of the Technological Institute of Aeronautics (ITA). The plasma torch was coupled to a convergent-divergent nozzle in order to produce supersonic flow inside the vacuum chamber (3,2 m3). The chamber environment corresponds to an altitude of 40km (inside pressure in the chamber of 2,3 torr), enthalpy of 14 MJ/kg and a heat flux of 2,2 MW/m2. The diameter of the section under test was 16mm and the flow velocity corresponds to 3,8 Mach. The mass loss, the ablation heat and the surface radiometric temperatures of the samples were evaluated as a function of the exposure time. Also, the material emissivity and the thermal diffusivity were determined. The microstructural aspects were investigated by Scanning Electron Microscopy (SEM). The composition of the sample surface was investigated by X-ray diffraction (XRD) and EDS, before and after plasma treatment. The tensile strength of the CRFC-SiC composites were evaluated at room temperature in an Instron machine and the shear strength was evaluated using the Iosipescu test.