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

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A NEW REUSABLE THERMAL PROTECTION SYSTEM CONCEPT FOR EARTH ATMOSPHERIC RE-ENTRY

Abstract

Future developments on thermal protection systems demands original and robust approaches able to perform under extreme mission conditions. The present research, as a result of the European FP7 space project SMARTEES (recently concluded), addressed the development of advanced ceramic composites structures for reusable thermal protection systems. The solution is based on a novel reusable TPS architecture which can withstand these harsh conditions during earth atmospheric re-entry from LEO. A proof-of TPS design is was provided within the project, having the Crew Transfer Vehicle/Advanced Reentry Vehicle (CTV/ARV) as reference mission, where different scenarios were envisaged at the front and backshield. The SMARTEES concept has been the result of the completion of the validation of the TPS performance and the achievement of a Technology Readiness Level of between 3 and 4. A new tile design incorporated the integration of advanced ceramic and sandwich structures at different levels:

SiC and ZrB2/SiC protective multilayers, thermo-structural ceramic matrix composite sandwich (Cf/SiC) with ceramic foams as insulating core, titanium alloys stand-offs. The TPS concept was aided by material modeling and thermal analysis. A computed tomography technique is used to obtain a real model of each part of the system. The thermo-mechanical characterization of this part was carried-out over different temperature ranges (RT-1800°C). This helped to obtain an accurate and realistic simulation of the insulation capability of the system. The output of this work allows calculating critical design parameters (aerial mass, thickness, etc..), resulting in two types of technological sample design (I.e. tiles of 150 x 150 mm2) The technology sample was tested in a relevant ground facility simulating the re-entry thermal conditions. The testing was based on a step-wise approach, were subassemblies and full samples were cyclically tested. This step has given insight into the overall performance of the TPS, identifying the heat flux limits and the degradation mechanisms and assessing the efficiency of the thermal insulation and the heat fluxes into the sub-structure of a spacecraft. The ground testing outputs will have been reviewed in comparison with the outputs of TPS requirements and environment specifications. The space sector may take advantage of the novel reusable TPS technologies, since there is a high potential for its use in cargo and crew space return vehicles, i.e. for a cost effective, safe and reliable return from the international space station (ISS). For more details see www.smartees-project.eu