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EVALUATION OF ULTRASTABLE CARBON/CARBON SANDWICH STRUCTURES JOINED WITH CERAMIC CEMENT

Abstract

The purpose of the study is to evaluate inorganic joining technology to bond Carbon/Carbon (C/C) sandwich (Carbon/Carbon skins to Carbon/Carbon honeycomb) with the aim to make ultra stable structures that could offer high level of stability requested by space science high performances instruments. Joining skins to honeycomb core through co-densification during the CVI process (Chemical Vapour Infiltration) which enables to consolidate the C/C structure, cannot provide an efficient bonding for large structures: there is a gradient of the carbon deposition from the edges to the centre of the panel, leading to a poor consistency of characteristics. Compared to usual organic joining technology, inorganic materials are at their early stage for space applications and present very promising characteristics: they are insensitive to moisture (no moisture-induced distortion as for organic bonding) and have a very low thermo-elastic sensitivity (Coefficient of Thermal Expansion $< 7.10^{-6}\,°C^{-1}$) ; in addition, they offer a competitive stiffness-to-mass ratio and can withstand temperatures of up to 350 °C without damages. Inorganic bonding process are also suitable for large structures applications (>1 square meter). Potential applications for this type of technology will be High Temperatures systems (high power radiators, large high power antennas, solar arrays...) and Hyper Stable systems (interferometric or aperture synthesis)

This ceramic bonding technology which has been developed can answer to the main requirements for the future ultrastable structures : by nature the coefficient of moisture expansion of the ceramic adhesive is null; a ceramic powder with a negative coefficient of thermal expansion has been added to a commercial graphite base adhesive in order to decrease its coefficient of thermal expansion; this addition of a ceramic powder has no detrimental effect on the good mechanical strength of the graphite base adhesive : the results in flatwise tensile tests are comparable to those obtained with organic bonding.

The scalability of this process has been demonstrated for a quite large sandwich panel: with an optimized cement application process, there is no scale effect on the mechanical strength, which was not the case for the previous inorganic bonding developments.

The results of the evaluation as well as manufacturing developments are presented in the paper.

This work has been performed with Politecnico di Torino for cement development, a laboratory of the University of Torino, which has a great competence in the preparation and characterization of glasses and ceramic matrix composites for several applications and thanks to ESA support.