MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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THERMO-ELASTIC DISTORTION MEASUREMENTS BY HOLOGRAPHIC INTERFEROMETRY AND CORRELATION WITH FINITE ELEMENT MODELS FOR SIC CONNECTIONS/JUNCTIONS ON SPACECRAFT

Abstract

Scientific, earth observation and telecommunication spacecrafts are submitted to severe thermal environments while their mission performance requires more and more high stable structures.

Due to on-ground constraints, the verification by test of the performances of these stable structures is usually limited. However accurate prediction methodology and verification capability of thermal distortions becomes mandatory for ensuring the in-orbit performance objectives of future programs.

The main thermo-elastic contributors of the final stability performances are:

- Material and assembly physical properties knowledge (Coefficient of Thermal Expansion, Young modulus, Poisson ratio…)
- Modeling and simulation capabilities: temperature mapping, accurate thermo-elastic finite element models…
- Verification test performances: advanced measurement techniques are required to:
  - Characterize and determine the different main contributors to the final end to end performance
  - Perform accurate correlation.

In this study, material characteristics are assumed to be well known. The objective was to improve and develop analytical predictions and verification of thermo elastic distortions using sample testing for modeling correlation.

The samples have been chosen to be representative of the connections/junctions that can be encountered in stable structures on spacecraft and can have a dominant impact on the instrument stability. The results presented in this paper concern SiC/SiC and SiC/TA6V bonded and bolted samples.

For the tests, temperature variations between -20K and +15K from ambient have been applied to the samples. Thermo-elastic distortions have been measured with a holographic camera. This holographic camera can measure displacements in the range of 20 nm to 20 μm without physical contact with the samples.

The tests results have been compared to the predictions obtained by Finite Element Modelling. From this comparison modelling guidelines have been issued with the aim of improving the accuracy of computed thermo elastic distortions: the FEM predictions lead to quite good correlation with the test data, with most of the time less than 10% discrepancies.

A second phase to this study is planned. The objective is to implement all the benefits on improvement of thermo-elastic distortions predictions and verification achieved during the first phase on real spacecraft hardware.