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VERIFICATION AND VALIDATION FOR THE THERMO-MECHANICAL DESIGN OF ULTRA HIGH TEMPERATURE CERAMIC (UHTC) WINGLETS OF A RE-ENTRY SPACE VEHICLE

Abstract

The purpose of this paper is to investigate the so-called Verification and Validation (V&V) methodology for the thermo-mechanical design of Ultra High Temperature Ceramic (UHTC) winglets of a re-entry space vehicle, in particular temperature and stresses. The final objective of this job is to give a contribution to implement and evaluate the thermo-structural performance of a pair of a fibre reinforced UHTC winglets developed by CIRA. Therefore, the test-case consists of two winglets mounted on a carrier vehicle which will fly at Mach numbers approximately equal to 8 over the altitude range 27-32 Km (figure 1). In computational mechanics, the main objective of V&V leading to numerical and experimental works is to assess and improve the predictive capability of finite element models. The basic concepts as well as guidelines to define relevant verification and validation tests have been described by Roache [1] and Oberkampf et al. [2]. A numerical study has been performed. Five different numerical models have been considered. The verification stage, including convergence studies, concludes that a solid model with 1 mm element size mesh is the "just necessary" model to be used for the test-case to correctly reproduce the physics at different boundary conditions. A validation stage, involving numerical and experimental tests, has also been planned to evaluate the predictive capability of the developed numerical model. The two winglets as well as the whole vehicle have been manufactured and the numerical prediction will be fully validated by experimental tests in Plasma Wind Tunnel (PWT). Test results will be object of further publications.

Keywords : Sharp Hot Structure; Scramspace; Verification and Validation; Finite Element Models;

References [1] Roache P., Verification and validation in computational science and engineering. Hermosa Publishers, Alburquerque, New Mexico, USA, (1998). [2] Oberkampf W.L., Trucano T.G., Hirsch C., Verification, validation, and predictive capability in computational engineering and physics. Applied Mechanics Review, (2004), 57 (5), 345-384.