MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Advancements in Materials Applications and Rapid Prototyping (9)

Author: Dr. Roberto Gardi
CIRA Italian Aerospace Research Centre, Italy, r.gardi@cira.it

Dr. Giuseppe Pezzella
CIRA Italian Aerospace Research Centre, Italy, g.pezzella@cira.it
Dr. Stefania Franchitti
CIRA Italian Aerospace Research Center, Capua, Italy, s.franchitti@cira.it
Dr. Rosario Borrelli
CIRA Italian Aerospace Research Centre, Italy, r.borrelli@cira.it
Dr. Carmine Pirozzi
CIRA Italian Aerospace Research Center, Capua, Italy, c.pirozzi@cira.it
Dr. Vincenzo Quaranta
CIRA Italian Aerospace Research Centre, Italy, v.quaranta@cira.it
Ms. Barbara Tiseo
CIRA Italian Aerospace Research Centre, Italy, b.tiseo@cira.it
Mr. Giovanni Bruno
CIRA Italian Aerospace Research Centre, Italy, g.bruno@cira.it

ADDITIVE LAYER MANUFACTURING FOR ENTRY CAPSULES.

Abstract

CIRA is designing and realizing the structures, mechanisms and Thermal Protection System (TPS) of a capsule conceived for the demise observation of upper stages of various launch vehicles. The purpose of the project is to produce a completely autonomous capsule able to sustain re-entry and devoted to the study and observe the demise of launch vehicle stages. The analysis of the re-entry data on objects re-entering the atmosphere will help in accurately predicting break-up altitudes, debris trajectories and ground impact footprints. These analyses are therefore critical not only for mission success, but more importantly for improving public safety aspects of such re-entry scenarios. Once in orbit, the capsule will remain connected to the launcher stage during the first part of the re-entry, and will separate when launcher when its host starts to disintegrate. In a fall towards the Earth, it will continue making measurements and at the same time relay its measurement data to ground. The capsule must be constructed such that it will be able to withstand the hostile conditions of the launch, the re-entry and close-by disintegration of the launcher. The project is halfway its duration. The Engineering Qualification Model (EQM) has been realized and the Proto-Flight Model (PFM) manufacturing shall start in April . Because the tight schedule, the small size of the capsule, about 30 cm in diameter, CIRA has selected a rapid prototyping system for the manufacturing of the EQM and PFM too. The structural parts of the PFM shall be made in Titanium alloy, using the Electron Beam Manufacturing (EBM) capabilities owned by CIRA. This technique permits to generate very complex shapes at the same cost of simple shapes. This permits the designer to achieve higher shape and structural efficiency. The paper shows how the peculiarities of the ALM are exploited and how the "think-additive" approach is interpreted for this manufacturing case. In particular, the paper describes some of the design solutions aimed to minimize the need of post fabrication machining. All the internal structures needed for the accommodation of the payload are "grown" from the inside of the capsule, in shapes that would be nearly impossible for traditional manufacturing techniques.

The EQM has been realized partially by polymeric rapid prototyping system, in order to create an effective mock-up. The PFM shall be realized entirely in titanium alloy by EBM.