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HIGH-PERFORMANCE THERMOPLASTIC COMPOSITE STRUCTURE FOR SUBORBITAL VEHICLES

Abstract

In the last years, the use of thermoplastic composites is one of the most attractive technology solution for aerospace structures. Those kind of materials offer important advantages compared to the widely used thermosetting composites and metal alloys, providing suitable mechanical properties in a large range of temperatures. The most interesting feature of thermoplastic materials is the potential of realizing complex geometry structures using thermoforming processes. Different parts can be melted together and reformed as a single part rather than be bolted or welded, thus obtaining an intrinsically better adhesion respect to the traditional assembly methods. The possibility to be melt and reformed without any loss of performance opens the way to be recyclable, thus lowering the waste of materials in forming process. In this paper, we present the feasibility study to realize a reinforced structure for suborbital vehicles by replacing the current metallic material with a thermoplastic composite one. This work is developed in the frame of the TP Complex project (N. A0320-2019-28147), a cooperative project between academia and industry, which aims at designing structural components with complex geometry for aerospace UAVs and suborbital vehicles subjected to significant thermomechanical stresses without the use of adhesives. The presented structure is a concave panel, made up by an external skin reinforced through four longitudinal stringers. At first, thermoplastic material was selected and carefully investigated from a numerical and experimental point of view. A multi-scale analysis was performed in order to assess their properties to be used in the thermomechanical finite element analysis. Thermo-structural analysis was performed on both metallic and thermoplastic parts for comparison. The results highlights that the thermoplastic composites materials represent the better solution for the case study. A prototype of the component is also presented.