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TESTING AND MANUFACTURING OF A HYPERSONIC ROCKET FINS

Abstract

This paper will address the testing and manufacturing of fins for a hypersonic liquid bipropellant rocket. The fins are essential for stabilizing the rocket under different aerodynamic loading conditions while allowing the vehicle and its payload to reach an altitude of 100 km. The testing comprises three different methods to understand the behavior of the fins under applied loads. The fins are constructed as a sandwich panel with two pre-impregnated carbon fiber face sheets epoxied with a foam core in the middle to create a stiff and light structure with attached leading and trailing edges (build-up of aluminum alloy sheet metal). The sample structure will be tested specifically to determine the structural integrity and to recognize failure conditions of these chosen materials. The three different testing methods that will be covered are the bending test, fastener pull-through test, and full-fin bending test. Through the bending test, mechanical properties such as flexural stiffness and strength of the sandwich construction will be determined. Performing the fastener pull-through test will assist in determining the tensile strength of the material with a stress concentration by pulling the fastener perpendicular to the thread axis. Finally, with the full-fin bending test, the flexural properties of the actual-sized fins may be determined. The two former tests will be performed on scaled-down sandwich samples (5-10 samples), while the latter test will be performed on two full-sized fins. Results achieved from these experiments will assist in optimizing the design if required. Following the tests, the dimensions and canted angle of the fin will be determined, and manufacturing can begin. The carbon face sheets will be manufactured using waterjet, the structural foam will be manufactured using a milling machine, following it the leading and trailing edges will be manufactured using a sheet metal bending machine. A prototype has been done, however, before making the full-scale fins, there will be improvements and new methods used to enhance the manufacturing of the fins' structure. One of the new improvements is to perform a CT scan to observe the density and porosity across the foam structure. Finally, different methods of manufacturing and their efficiencies will be compared.