SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (1) (3)

Author: Mr. Michel BERDOYES
Airbus Safran Launchers, France

ABLATION EXPERIMENTAL CHARACTERIZATION AND NUMERICAL INVESTIGATION OF A 3-DIMENSIONALLY BUILT CARBON/PHENOLIC COMPOSITE FOR AEROSPACE APPLICATIONS

Abstract

Airbus Safran Launchers has developed a 3-Dimensionally Carbon/Phenolic Composite material (called Naxeco® Phenolic resin material), built from low cost, non-aerospace grade carbon fibers and a phenolic resin already used to make impregnated 2D ablative fabrics but modified to be compatible with the Resin Transfer Molding (RTM) process. The material is engineered to design low cost ablative free-standing parts such as nozzle cowl and exit cones or heat shields because of its unique high resistance against delamination. The first operational application is the qualified Vega-P80-first stage Nozzle and further applications on nozzles and Thermal Protection Systems (TPS) are under considerations today. Airbus Safran Launchers and Koo Research Group, Austin Texas, conducted an investigation to characterize the ablation behavior of Naxeco® Phenolic resin material. Historically, the method of analyzing the ablation of a material has been primitive: through visual inspection the material before and after exposure. However, Koo's research group has developed a sensing technique that enables ablation detection throughout the lifetime of the part, the "In-Situ Ablation Sensor" and a testing method, that enables the collection of optical diagnostics data, the Oxy-acetylene Test Bed (OTB). These tests exposed Naxeco® Phenolic resin material samples to heat fluxes of 350 W/cm and 1000 W/cm which respectively are representing thermal fluxes commonly calculated in nozzle cowl or exit cones and hypersonic vehicle TPS. This test program generated data from two optical imaging techniques, previously unused by Dr Koo's research group, in addition to the group's proprietary In-Situ Ablation Sensor and an infrared laser pyrometer. In the first series of tests (heat flux of 350 W/cm), quite no material surface regression was measured as it is observed on the SRM nozzle parts where this material is used. Under heat flux of 1000 W/cm, the material showed behavior in conformity with the ablative performance-versus-density law and demonstrated again a unique resistance against delamination (no inside pore pressure) as unfortunately observed with 2D carbon phenolic materials. In this paper, results of tests and of numerical modelings where samples were exposed to a heat flux of 350 W/cm and to 1000 W/cm are presented and discussed.