Paper ID: 27689
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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Advanced Materials and Structures for High Temperature Applications (4)

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ROLE OF EFFECTIVE ABLATIVE MATERIALS IN THE HEAT SHIELD OF ROCKETS

Abstract

The heat management of re-entry vehicles and the protection of the rocket's payload and essential motors is an issue of practical and functional importance. Re-entry of a rocket depends on friction more than its power system which causes excessive aerodynamic heating and damages the Thermal soak lead resulting failure of the Heat shields. This has necessitated active research efforts on the need to have better and effective material usage. The heat shield of rockets is studied under two categories viz.,Thermal soak and Ablation. The present work focuses on ablation and attempts to explore the use of more effective ablative materials with lower thermal conductivities.

Ablation confines to the removal of material from the surface of an object by vaporisation, chipping or erosive processes. This results in the burning of the virgin metal in a controlled manner. The cross-section of a metal surface on which Ablation occurs is the reaction zone which primarily undergoes sacrificial erosion. It is under covered by the virgin zone made of reinforced plastics and the backup structure damage which leads to breakdown of heat shield. Ablation comprises of char produced by pyrolysis of the virgin metal and gases carrying heat. The charring process insulates the remaining solid metal and absorbs an additional amount of heat from the external surface. Ablation allows lesser heat to sink into the substrate and provides effective shielding by both conduction and convection.

The effective ablation is addressed by adapting organic ablatives like Thermoplastic Polyurethane Elastomer Nanocomposites (TPEN) since they are both effective heat and shock absorbers. The use of more effective ablative materials ensures minimum surface erosion and excellent thermal insulation of the substrate. The greatest advantage is that they have no upper service temperature limits and can bear virtually any operational temperature by controlled material degradation. Organic ablators are expected to perform better since they possess good resistance to both thermal and mechanical shock. The specific objectives of the work are

a.)To investigate effectiveness of using organic ablative material (TNEP) as a potential heat shield component.

b.)To identify the role of key controlling parameters.

It is expected to showcase higher potential in effective shielding by minimise the surface erosion of the rocket since it will allow lesser amount of heat to sink into the substrate. At present systematic case study is being carried out to investigate the role of using better ablative materials as effective heat shields.