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C/C-SIC CERAMIC MATRIX COMPOSITE ORBITAL THRUSTER DEVELOPMENT FOR HPGP OPERATION

Abstract

The field of orbital thrusters has been dominated by expensive and not readily available refractory metals such as Iridium-Rhenium and the accordingly expensive manufacturing done only by few companies worldwide (mainly US) in addition to the notorious ITAR export regulations. An alternative approach is pursued in this project. The CMC components for the orbital thruster are going to be produced at the Institute of Structures and Design of DLR in Stuttgart. The CMC material consists of commercially available carbon fibers which are embedded in a matrix of carbon and silicon carbide and it is thus referred to as C/C-SiC. The primary goal is: show the suitability of C/C-SiC CMC structures for High Performance Green Propellants 'HPGP' radiative cooled orbital combustor applications. The manufacturing is sequenced as follows: • The braided carbon fiber preform of the thruster is produced. The envisaged fiber materials are HTA40, T800 and XN80. For the braiding process a special tooling is necessary as the implementation of different materials for the throat section is foreseen, as this is the most critical area of the thruster being subjected to the highest heat loads, oxidation and abrasion. • Infiltration of the preform with phenolic resin. After curing, the thruster green body (CFRP) has to be trimmed. The part is then tempered at 240C to complete the polymerization process. It is essential to use a resin (e.g. phenolic) with high carbon yield in this step to create a matrix with sufficient carbon content in the subsequent step. • The CFRP composite is pyrolysed under inert atmosphere (nitrogen) at a temperature of 1650 C to convert the polymer matrix to amorphous carbon. The result is a porous C/C component. • Machining of the main body and adaptation of a C/C flange for the injector interface is fixed to the combustor with the help of a special carbon containing adhesive paste. • The C/C component is siliconized via melt infiltration. • The throat section is ground to shape with the help of specially designed diamond coated tools. The primary goal is: show the manufacturability and further the suitability of C/C-SiC CMC structures for High Performance Green Propellants 'HPGP' radiative cooled orbital combustor applications.