Accepted Manuscript

Title: Aero-thermo-chemical characterization of Ultra-High-Temperature Ceramics for aerospace applications

Authors: Raffaele Savino, Luigi Criscuolo, Giuseppe Daniele Di Martino, Stefano Mungiguerra

PII: S0955-2219(17)30852-X
DOI: https://doi.org/10.1016/j.jeurceramsoc.2017.12.043
Reference: JECS 11648

To appear in: *Journal of the European Ceramic Society*

Received date: 2-10-2017
Revised date: 18-12-2017
Accepted date: 21-12-2017

Please cite this article as: Savino R, Criscuolo L, Di Martino GD, Mungiguerra S, Aero-thermo-chemical characterization of Ultra-High-Temperature Ceramics for aerospace applications, *Journal of The European Ceramic Society* (2010), https://doi.org/10.1016/j.jeurceramsoc.2017.12.043

Aero-thermo-chemical characterization of Ultra-High-Temperature Ceramics for aerospace applications

Raffaele Savino, Luigi Criscuolo, Giuseppe Daniele Di Martino, Stefano Mungiguerra*

University of Naples "Federico II"

Department of Industrial Engineering-Aerospace Section,

80 P. le V. Tecchio, Naples, Italy 80125

* Corresponding author.

E-mail address: stefano.mungiguerra2@gmail.com

Abstract

Ultra-High-Temperature Ceramic (UHTC) materials, because of their high temperature resistance, are suitable as thermal protection systems for re-entry vehicles or components for space propulsion. Massive UHTC materials are characterized by poor thermal shock resistance, which may be overcome using C or SiC fibers in a UHTC matrix (UHTCMC).

The University of Naples "Federico II" has a proven experience in the field of material characterization in high-enthalpy environments. A hypersonic arc-jet facility allows performing tests in simulated atmospheric re-entry conditions. The Aerospace Propulsion Laboratory is employed for testing rocket components in a representative combustion environment. Ad-hoc computational models are developed to characterize the flow field in both facilities and perform thermal analysis of solid samples.

Current research programs are related to a new-class of UHTCMC materials, for rocket nozzles and thermal protection systems. The activities include design of the prototypes for the test campaign, numerical simulations and materials characterizations.

Keywords: Ultra-High-Temperature Ceramic Matrix Composites; Arc-jet experimentation; Rocket nozzles; Numerical simulations

1 Introduction

Ultra-High-Temperature Ceramic (UHTC) materials are assuming an increasing importance in aerospace research because their high temperature capabilities make them interesting to develop components for extreme applications, such as thermal protection systems of hypersonic or atmospheric reusable re-entry vehicles, specific components for propulsion, combustion chambers, engine intakes or rocket nozzles [1-4]. Indeed, UHTC materials are characterized by unique combination of properties, including melting points above 3500 K, high temperature strength and capability to manage and conduct heat when the service temperatures exceed 2200 K [1]. These characteristics allow UHTCs to work in thermo-chemically aggressive environments encountered in the most demanding space applications [4-8]. During hypersonic re-entry, shock waves in front of the nose tip and of the wing leading edges of the spacecraft cause the temperature to rise up to thousands of Celsius degrees, activating also gas dissociation/recombination reactions. On the other side, rocket nozzles, having the function to expand high enthalpy reacting gases, coming from the combustion chamber, are subject to chemical and mechanical erosion in presence of high pressures, in the order of tens of bars, and flame temperatures higher than 3000 K. At present, the structural materials for use