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INVESTIGATION OF PASSIVE TO ACTIVE OXIDATION TRANSITION ON ULTRA HIGH TEMPERATURE CERAMICS

Abstract

This paper presents the preliminary results of the investigation on Passive to Active Oxidation Transitions (PAT) of different SiC-based Ultra High-Temperature Ceramics (UHTC). The project is a cooperation between the Department of Aeronautics and Astronautics at the University of Tokyo (UT) and the Institute of Space Systems (IRS) at the University of Stuttgart. The different materials have been sintered via spark plasma sintering at UT combining HfB2, ZrB2, SiC and ZrC powders with grain size ¡ 5 m. UT features a Laser-Driven Plasma Wind Tunnel (LDPWT) capable of generating steady-state Ar/O2 mixture flows reaching mass-specific enthalpies about 7.7 MJ/kg. The vacuum chamber has a size of 0.5 m in diameter and 1 m in length with an ambient Pressure of 45 Pa during operation in which a 20 mm diameter water-cooled Si3N4 sample holder clamps a 10 mm diameter specimen. The UHTC samples have been tested at two different conditions, including the utilization of an 80 A heating laser, reaching temperatures up to 3000 K. At the University of Stuttgart, experiments were performed at PWK3, a PWT driven by an Inductively heated Plasma Generator (IPG) operating with pure oxygen flows at mass-specific enthalpies up to 40 MJ/kg. The test chamber is 2.6 m in length and 1.8 m in diameter connected to a vacuum system capable of extracting 70 m3/s with a base pressure of 10 Pa. Specimens of 10 mm diameter are mounted in this case on a 50 mm diameter water-cooled copper probe. A CCD spectrometer and a pyrometer were used for the determination of the surface temperature. The mass of the samples was measured before and after the PWT tests to evaluate the area-specific mass-loss rate. Additionally, surface analysis was performed using EDX for a better understanding of the oxides formed during the tests. The thickness of the oxide layers was measured from microsection on the tested samples. The cooperation also aimed for a direct facility comparison by selecting cross-reference conditions between the LDPWT in Tokyo and PWK3 in Stuttgart, which should be seen as a verification activity for the obtained results at the same time that qualifies both techniques for the investigation of oxidation on UHTC.