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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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SHARP COMPOSITE UHTC LEADING EDGES FOR HYPERSONIC APPLICATIONS

Abstract

Hypersonic vehicles need sharp leading edges to improve flight performances during atmospheric exit and re-entry. During hypersonic flight leading edges are expected to be subjected to very demanding convective heat fluxes in corrosive plasmas from atmosphere, reaching temperatures in excess of 2000C. Such extreme conditions limit the field of material candidates to ultra-high temperature ceramics (UHTCs). These are typically non-oxides with melting/decomposition temperatures in excess of 3000C: Borides of the group IV transition metals like ZrB2 and HfB2 are currently the most studied systems. Bulk single-phase UHTCs for these high-temperature structural applications are limited by their poor oxidation resistance, as well as lacking damage tolerance. Recent development of composite UHTC systems has focused on additions of SiC in form of fiber in order to improve not only resistance to oxidation but also resistance to thermal shock. In the present contribution, leading edges with a sharp profile were produced in the system HfB2-SiC, the SiC component in form of particulate or short fiber. The dynamic response to oxidation was studied under aero-thermal (heating) environment generated through the arc-heated wind tunnel located at DIAS in Naples; the supersonic plasma flow (Mach number up 3, total enthalpy up to 20 MJ/kg) was generated operating an industrial torch with pure nitrogen (as plasma gas) and mixing oxygen to simulate air composition. The plasma flow in the test section is characterized measuring stagnation-point heat flux and impact pressure on-line and just before the insertion of the test model. During each test "bulk" total enthalpy (at torch and nozzle exit) and pressures (at inlet and outlet nozzle and in the test section) are on-line measured; temperature and surface emissivity were also on-line monitored. Microstructural modifications upon oxidation were analyzed and correlated to test conditions through Computational Fluid Dynamics simulations.