HIGH ENTHALPY TESTING OF UHTC MATERIALS FOR SPACE APPLICATION

Burkard Esser, German Aerospace Centre, Supersonic and Hypersonic Technologies Dept., Cologne
Burkard.Esser@dlr.de
Ali Gülhan, German Aerospace Centre, Supersonic and Hypersonic Technologies Dept., Cologne

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Space vehicles are subjected to severe heat loads when entering a planetary atmosphere and require a powerful thermal protection system (TPS). The protection systems' thermal efficiency can strongly be enhanced by using surface materials with substantial radiative cooling capabilities, which are directly correlated to high operational temperatures. Accordingly, ablative and UHTC materials are well-suited for use in TPS structures. Due to their physical integrity, UHTC materials are an appropriate choice for future reusable space vehicles, which are requiring improved thermal efficiencies compared with state-of-the-art systems, resulting from demands on enhanced flight performance parameters [1].

Advanced stages of material development include experimental characterization and qualification at realistic environmental conditions. Arc-heated facilities, as e.g. DLR's arc heated facilities LBK with its two test legs L2K and L3K, are well suited for testing materials for thermal protection issues, since they allow for testing at realistic convective and catalytic heat fluxes. During the last decades, several test conditions have been established in L2K and L3K and were applied to both, ablative and UHTC materials. Heat fluxes range up to more than 10 MW/m^2.Typical test configurations for UHTC materials are illustrated in Figure 1.

In the frame the European project ABLAMOD and the ESA funded CHEF study, selected test conditions were further characterized by sophisticated spectroscopic measurement techniques. For the first time, Coherent Anti-Stokes Raman Spectroscopy (CARS) could be applied in the L3K reservoir. These measurements confirmed the common assumption that the reservoir conditions can be considered in thermal equilibrium. Free stream conditions at the test locations were characterized with CARS and LIF (Laser-Induced Fluorescence) measurements. Flow velocities were measured by Microwave Interferometry (MWI). Heat flux measurements and Pitot pressure profiles completed the characterization of the test conditions.

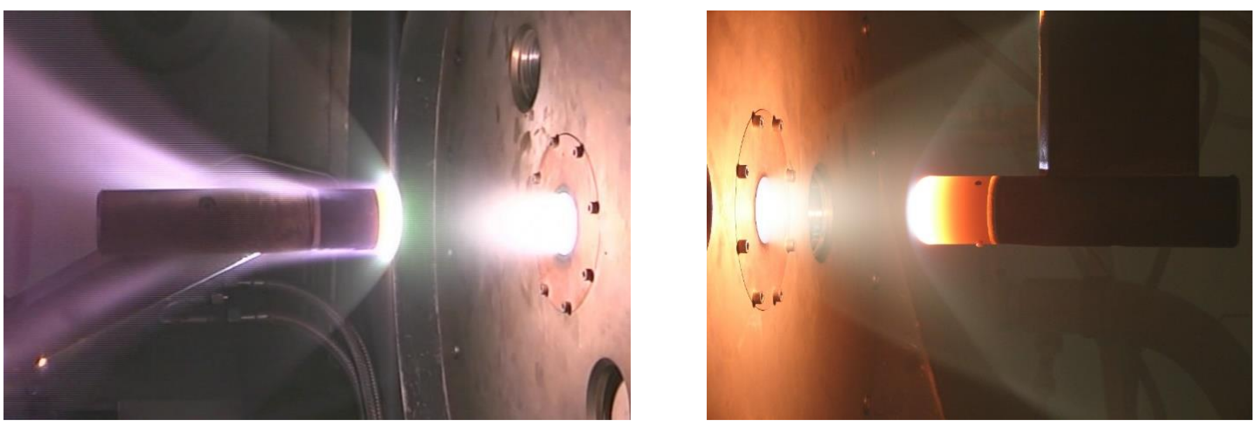

Figure 1 –UHTC test configurations in L3K (left) and L2K (right) facilities

[1] B. Esser et al., Innovative Thermal Management Concepts and Material Solutions for Future Space Vehicles. Journal of Spacecraft and Rockets, 53 (6), p. 1051-1060.