Paper ID: 33171
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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Advanced Materials and Structures for High Temperature Applications (4)

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IMPROVEMENT AND QUALIFICATION OF A PLASMA WIND-TUNNEL TO CO2 FLOWS FOR MARS ENTRY TESTING

Abstract

The entry by probes into the atmospheres of our neighboring planets, Mars and Venus, is of high research interest. Their gaseous shell consists mainly of CO2 (with a few percent of N2 and other trace gases). To enable testing on earth with (at least approx.) their atmospheric composition, the test gas should be CO2, if possible diluted by a few per cent N2, at relevant enthalpies. The flow was generated with an arc jet driven plasma wind tunnel, which is a part of HELM (High Enthalpy Laboratory Munich). Compared to the formerly prevailing air experiments at ambient pressure for material characterization, adaptions and improvements have been realized. In order to simulate relevant entry conditions for Mars, initial testing involved CO2 combined with N2 as test gas. These will be presented and the first results obtained will be described in the paper. Besides some infrastructural improvements (feeding the facility with CO2, an improved vacuum pump including a cooler and dilution of the exhaust gas) one of the main achievements was the design of a Ma=4 contoured nozzle. It was operated in different modes (under-expanded, pressure-matched and over-expanded) at relevant ambient pressures of some 600 – 1000 Pa corresponding to low altitudes. In order to obtain a second thermodynamic variable in the flow, the temperature was measured by Laser Induced Fluorescence. Measurements, initially at low enthalpies (1.5 MJ/kg), show the feasibility of applying a two-photon process for the excitation of the Hopfield Birge system B-X(0,0). For the determination of the rotational temperature, CO was used as the target molecule, which is produced in sufficient quantities even at low enthalpies applied up to now.