Simultaneous Laser-Induced Fluorescence of Nitric Oxide and Atomic Oxygen in the Hypersonic Materials Environment Test System Arcjet Facility

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Simultaneous nitric oxide (NO) and atomic oxygen (O) laser induced fluorescence (LIF) experiments were performed in the Hypersonic Materials Environmental Test System (HYMETS) facility at the NASA Langley Research Center. The data serves as an experimental database for validation for chemical and thermal nonequilibrium models used in hypersonic flows. Measurements were taken over a wide range of stagnation enthalpies (6.7 – 18.5 MJ/kg) using an Earth atmosphere simulant with a composition of 75% N₂, 20% O₂, and 5% Ar (by volume). These are the first simultaneous measurements of NO and O LIF to be reported in literature for the HYMETS facility. The maximum O LIF mean signal intensity was observed at a stagnation enthalpy of approximately 12 MJ/kg, while the maximum NO LIF mean signal intensity was observed at a stagnation enthalpy of 6.7 MJ/kg. Experimental results were compared to simple fluorescence model that assumes equilibrium conditions in the plenum and frozen chemistry in the isentropic nozzle expansion (Mach 5). The equilibrium calculations were performed using CANTERA v2.1.1 with 16 species. The fluorescence model captured the correlation in mean O and NO LIF signal intensities over the entire range of stagnation enthalpies tested. Very weak correlations between single-shot O and NO LIF intensities were observed in the experiments at all of the stagnation enthalpy conditions.