CARS Measurements in Hypersonic Ground Test Facilities

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The physics of high-enthalpy hypersonic flight have seen renewed interest over the past decade. High-enthalpy ground-test facilities, such as inductively coupled plasma (ICP) torches, shock/expansion tunnels, and arc jets, present extreme temperatures in excess of 5000 K and associated nonequilibrium thermal and chemical conditions—all of which present a challenging environment for laser-based diagnostics. In this talk, we will summarize two recent CARS measurement campaigns in hypersonic ground-test facilities. Experiments in ICP torches [1,2], such as the University of Illinois CHESS Center's Plasmatron X, present temperatures up to 5500 K at reduced pressures from 55 to 200 mbar, placing coherent Raman signal photons at a premium. CARS measurements in the free plasma jet and in the stagnation region boundary layers of carbon ablators and cold catalytic copper surfaces are presented and previewed in the Figure below. Simultaneous temperature/CO and nonequilibrium rotational/vibrational temperatures in N_2 are demonstrated, and development of femtosecond CARS for combined T/CO measurements is briefly discussed. We additionally summarize development of noncolinear optical parametric oscillators for 100 kHz, single-laser-shot pulse-burst CARS detection of nonequilibrium N_2 and O_2 vibrational temperatures in the free stream of the Sandia reflected shock tunnel .

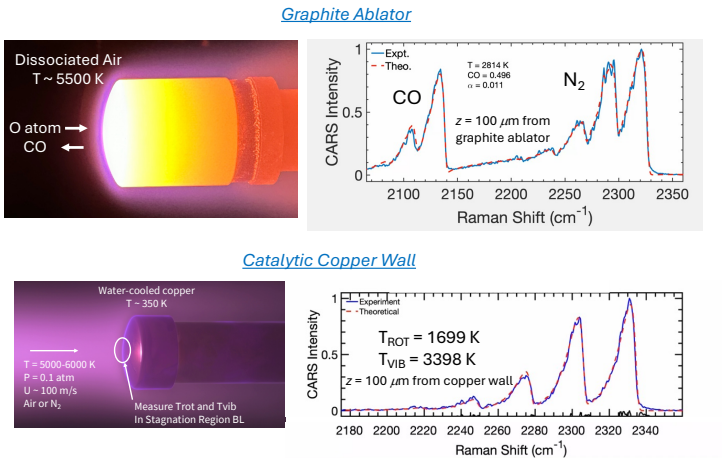

Figure 1. CARS measurements in stagnation boundary layer flows established in Plasmatron X. (upper) Graphite ablator and CO/N_2 temperature/concentration measurement; (lower) catalytic copper surface exhibiting nonequilibrium rotational/vibrational temperatures in N_2

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