COMBINED ROTATIONAL AND VIBRATIONAL CARS SPECTRA OF O_2 FOR SIMULTAENOUS TEMPERATURE AND PRESSURE MEASUREMENTS

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Coherent anti-Stokes Raman scattering (CARS), a four-wave mixing parametric process, is used for flow diagnostics due to its excellent spatial and temporal resolution. In this work we present a dual-pump combined CARS (DPCC) system for simultaneously obtaining the pure-rotational and vibrational spectra of O_2. O_2 is a an important molecule in combustion as well as in many high-speed non-reacting aerodynamic flows. Excellent temperature accuracy, in DPCC, is obtained via sensitivity in Boltzmann distribution of the pure-rotational CARS spectra. Pressure information, in DPCC, is obtained via relative sensitivity of the rotational and vibrational CARS spectrum to collision dynamics. As pressure increases, at a fixed temperature, the frequency of molecular collisions also increases. Only the vibrational spectra of O_2 undergoes collisional narrowing due to mixing between the closely-spaced Q-branch transitions. We employed the DPCC system in an underexpanded jet outside the exit of a converging nozzle. Figure shows a single spectrum, obtained 250 μm downstream of the nozzle exit, along the jet centerline. We compared different Raman lineshape models for extracting temperature and pressure from the DPCC spectra. The rotational diffusion model for collisional narrowing predicts a higher pressure compared to the Voigt model.