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Measurements of Vibrational Non-equilibrium in Supersonic Jet Mixing and Combustion[1] HEATH REISING, TIMOTHY HALLER, NOEL CLEMENS, PHILIP VARGHESE, The University of Texas at Austin — A new experimental facility has been constructed to study the effects of thermal non-equilibrium on supersonic mixing and combustion. The facility consists of a Mach 1.5 turbulent jet issuing into an electrically heated coflow. The degree of non-equilibrium in the jet shear layer is quantified using high spectral resolution time-averaged spontaneous Raman scattering. Since the Raman spectra are time-averaged, they are susceptible to non-linear weighting effects induced by temperature fluctuations. The effect of local turbulent temperature fluctuations on the Raman fitting procedure is quantified by using spectral simulations that use the actual temperature fluctuations present in the flow measured by instantaneous Rayleigh scattering thermometry. It is shown that the temperature fluctuations are not large enough to induce significant errors in the vibrational temperature fitting results. Vibrational non-equilibrium is shown to occur in the jet shear layer, and its magnitude and trend are shown to be similar to recent large-eddy-simulation results. Since CO_2 is known to cause faster vibrational relaxation of N_2, a series of experiments were conducted to verify that the non-equilibrium effects could be controlled by CO_2 addition. This work is being extended to reacting flows, to assess the impact of non-equilibrium on supersonic shear-layer combustion.

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