MID-INFRARED DIODE-LASER DIAGNOSTICS OF THE GAS FLOW IN HIGH-MACH-NUMBER WIND TUNNELS

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A rapid-scan, lead-salt, diode-laser spectrometer has been constructed to investigate infrared active gases in high Mach number (8 - 14) wind tunnels for measurement of temporal temperature, pressure, and velocity profiles. The spectrometer is capable of capturing 4000 sweeps of a 0.2 cm^{-1} spectral window at a sampling rate of 10,000 sweeps/s with a minimum detectable fractional absorption of $\sim 1\%$ per sweep. For room-temperature Doppler-limited absorption by CO, this corresponds to a detection sensitivity of $\sim$ 5 x 10^{-4} Torr-cm in a 100 μs. In addition to a spectral channel, the 12 bit data acquisition sampling system alternately captures an etalon trace to determine scan linearity and dispersion and a standard gas trace for correcting for frequency drifts. The choice of infrared chromophore to monitor is guided by real-time collection of a sample of the flow stream followed by laboratory analysis using Fourier-transform infrared spectroscopy. Testing of the spectrometer is presently being undertaken on a Mach 8 wind tunnel.