DEVELOPMENT OF A SUPERSONIC WIND TUNNEL FOR A CAVITY RINGDOWN SPECTROMETER

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A cavity ringdown spectrometer with a supersonic wind tunnel for measurements of excited species and radicals at low pressures and temperatures has been developed. The spectrometer has been used for measurements of metastable nitrogen molecules in the lowest excited electronic state, $N_2(A^3\Sigma_u^+)$, in the supersonic test section of the wind tunnel. The tunnel has been operated in nitrogen at plenum pressure of P_0 = 200-250 Torr, with the flow expanding through a two-dimensional contoured nozzle to the Mach number of M = 3.6-4.6. The steady-state run time of the tunnel is approximately 10 s. The flow in the tunnel is excited by a repetitive ns pulse discharge operated in the plenum or in the nozzle throat. In the supersonic test section, absolute $N_2(A^3\Sigma_u^+$,v=0-2) populations at P = 0.8 Torr and T = 70 K are measured by Cavity Ring Down Spectroscopy (CRDS), using a tunable pulsed laser system operated at 10 Hz. During each run, 50 single-shot ring down traces are acquired, demonstrating good shot-to-shot reproducibility. The results demonstrate that the cavity ring down time is not affected by the supersonic flow. Further measurements of more complex radicals, such as HO_2, using a narrow linewidth tunable optical parametric oscillator (OPO) coupled to the supersonic wind tunnel, are currently under development.