OFF-AXIS CAVITY ENHANCED ABSORPTION SPECTROMETER BASED ON A MID-INFRARED CONTINUOUS WAVE QUANTUM CASCADE LASER

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We present the design and construction of a mid-infrared off-axis cavity enhanced absorption (OA-CEAS) spectrometer equipped with a pulsed slit jet molecular beam expansion. A cw quantum cascade distributed-feedback laser operating at 5.6 μm at the carbonyl stretch frequency was employed. A high finesse optical cavity consisted of a pair of high reflective mirrors with R $> 99,9\%$ and separated at a distance of 55 cm was used as a sample cell. A computer program was developed to automate and to synchronize the timing of the cavity enhanced absorption experiments with the pulsed molecular beam.

The dominant source of noise in the CEAS experiments arises from incomplete averaging of the cavity mode structures. Several procedures were implemented to minimize the dominant noise due to incomplete averaging of the cavity mode structures: (1) Optimize off-axis alignment to ensure adequate output power and at the same time to excite as many higher order transverse modes as possible, therefore reducing the free spectral range considerably; (2) Modulate the cavity length using a piezoelectric actuator mounted on one of the cavity mirrors; (3) Introduce mechanical perturbation in the optical cavity to randomize the residual mode structures; (4) Optimize laser frequency scan speed to ensure more even intensity distribution of the cavity modes; (5) Apply wavelength modulation to the laser and demodulate the signal with a lock-in amplifier.

The CEAS experimental result measured with a static ammonia gas in neon will be presented and compared to that obtained with an astigmatic multi-path cell with 182 passes. The CEAS measurements of jet-cooled infrared spectra of larger organic molecules will also be presented.