Comparison of FT-IR and Diode Laser Based Absorption Spectroscopy for Trace Gas Monitoring

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This work describes a comparison of the performance characteristics between a conventional Fourier transform infrared (FT-IR) and new mid-infrared gas sensors based on diode laser pumped difference frequency generation (DFG) in periodically poled lithium niobate (PPLN) at wavelengths between 3 to 5 microns. Minimum detectable concentrations of trace gases in air at sub ppm levels were obtained using this type of diode laser absorption spectroscopy [1].

The need to develop effective environmental monitoring strategies for assessing and reducing levels of air pollutants has spurred the development of spectroscopic sensing techniques. Of these, FT-IR and diode laser based system are capable of measuring a full or partial spectrum of the air and then analyze this spectrum to identify compounds and quantify their concentration. Both open-path and extraction monitoring configurations can be used to acquire absorption spectra [2].

The advantage of the FT-IR device is its broad spectral coverage to simultaneously measure different kinds of pollutants in the same scan and the well-developed commercial instrumentation and software. However, spectral resolution is easier to achieve with a DFG based spectrometer, on account of the narrow spectral linewidth of diode lasers. This intrinsic selectivity allows greater discrimination from interfering gases than a FT-IR sensor without resorting to considerable increase in complexity, physical size, and cost. The analysis time, which depends on the scan number of the Michelson interferometer in FT-IR spectrometer, in turn impacts the sensitivity or signal-to-noise ratio requirement. Hence, the DFG method can be exploited for applications requiring monitoring of fast concentration changes. Both spectroscopic technologies lend themselves to open air monitoring configurations, but diffraction-limited and the high spectral brightness of a mid-infrared DFG probe beam facilitates long-path sensitive, selective and rapid absorption measurements.

References

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