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Measurement of Gaseous Species at Trace Levels with MIRICO's Laser Dispersion Spectroscopy

Graham Leggett, Damien Weidmann, Arun Kunnath, and Johnny Chu
MIRICO Ltd., Oxford, United Kingdom (graham@mirico.co.uk)

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Here, I describe the Laser Dispersion Spectroscopy (LDS) technique and present both open-path, and extractive configurations. I go on to detail the development and testing of LDS instruments for the measurement of key gaseous species of interest, at concentrations ranging from parts-per-trillion to %; NH3, SO_2¬/SO_3, HCl, CH4, CO_2.
Developed by UK's Rutherford Appleton Laboratory, Space Division, LDS is just one of several, novel laser spectroscopy techniques pioneered by Damien Weidmann's Laser Spectroscopy group. This robust, mid-infrared laser-based technology, originally designed for space applications, is now being commercialised by MIRICO Ltd., with a focus on gas metrology applications requiring high-sensitivity, high accuracy, and long-term stability and reliability. The company is targeting market sectors that will benefit from this next-generation laser technology, with an emphasis on emissions monitoring applications for a wide range of industries, where as I will explain, the benefits of LDS are significant versus other laser-based techniques, and other incumbent gas measurement methods.
Environmental, atmospheric science applications, including measurement of background and emissions measurements of ammonia, can be served by LDS technology packaged as either an extractive system, or in an open-path configuration.
Laser Dispersion Spectroscopy (LDS), is a new gas sensing technique that applies a novel approach to tuneable diode laser spectroscopy. Established laser absorption techniques depend on measuring detected intensity to derive concentration. This significantly impacts measurements in "dirty" atmosphere environments where detected intensity of the transmitted light is bound to fluctuate, due to rain, snow, fog, etc., or when using techniques where high-finesse optics must be protected from particulate contamination and hazing. MIRICO's LDS-based instruments derive concentration using the phase of light. This makes it highly immune to intensity fluctuations received at the photodetector. The instrument enables precise, real time measurements of trace gas molecules in demanding environments. Furthermore, compared to absorption techniques, the analyser can measure gas concentrations within a very wide dynamic range (typically about five to six orders of magnitude), meaning for example from parts per trillion all the way to sub-percent concentrations without the requirement for dilution.
In a long open-path, multi-direction configuration, coupled with a retroreflector array, and anemometer, the LDS analyser is capable of measuring gas concentrations associated with large area sources, and locating and quantifying of point source emissions within said area. In a simpler arrangement, the fenceline of large facilities can be monitored continuously, identifying emissions at concentrations equivalent to just ppb/metre, over path-lengths in excess of 500 metres.
In an extractive configuration, operation in the mid-infrared spectrum delivers ppt sensitivity without the need for high-finesse optics, such as those required for cavity enhanced techniques, simplifying instrument design. Since the LDS signal is unaffected by signal intensity, minimal sample preparation and filtration is required, potentially delivering fast response and clear-down time.