CThL31 **1:00 pm**

High resolution ambient formaldehyde detection

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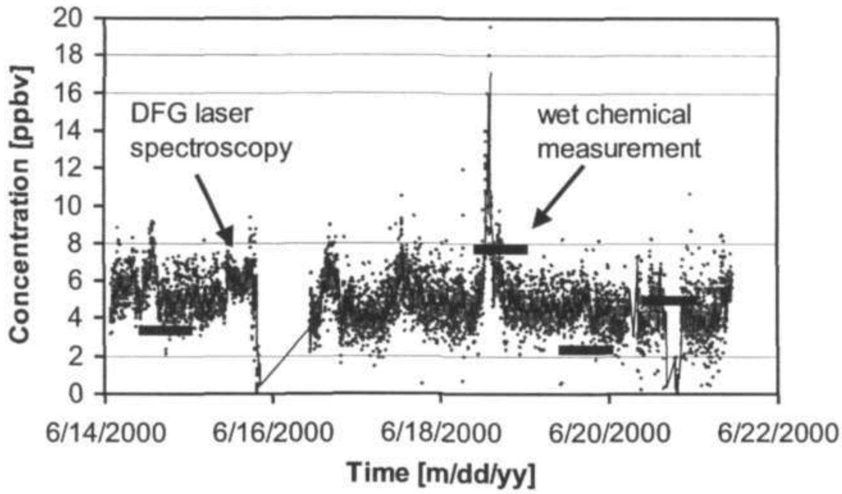
Formaldehyde is critically important to the chemistry of the urban atmosphere. During daylight, formaldehyde photolysis and decomposes to release the free radicals that drive photochemical ozone formation. With atmospheric lifetimes *of a few hours, formaldehyde is an important* contributor to the radical formation that leads to high concentrations of ozone observed in urban environments, such as Houston. In addition, formaldehyde is a frequently used industrial chemical used in the manufacture of numerous *building materials and household products.* Formaldehyde is also a byproduct of combustion devices. Hence continuous monitoring of formaldehyde at the ppbv is an important air quality assessment task.

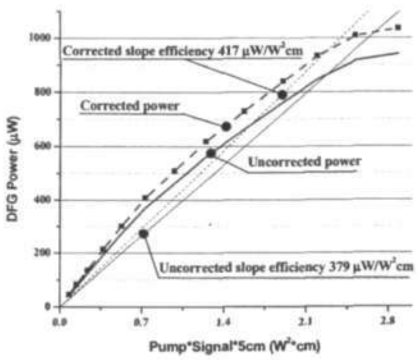
A fully-automated, portable, laser spectrometer designed for high-sensitivity detection of atmospheric formaldehyde at 3.5315 µm (2831.64 cm^{-1}) with accuracy of 0.6 ppb will be reported. The sensor is based on difference frequency generation (*DFG*) of two diode lasers operated at 1083 nm (pump) and 1561 nm (signal), in a 19 mm long periodically poled Lithium Niobate (*PPLN*) crystal.[1,2] The fiber-coupled seed lasers were amplified in two steps by means of *Yb* and Er^+ pre-, and *Yb* and Er^+/Yb main-amplifiers, respectively. The 1.6 W pump and 0.65 W signal beams were combined with a fiber beam coupler. The maximum infrared *DFG* power obtained was of 640 µW. The pump beams were filtered using a *Ge*-filter, and the mid-*IR* beam was then split into two beams to provide a probe and reference beam required for dual-beam detection. The probe beam passed through a 100 m long multipass cell and was detected by an *MCT* detector. Two formaldehyde lines around 3.53 µm were measured at reduced pressure (40 Torr). During the 9 day field campaign an overall formaldehyde concentration of 5 ppb was detected (see Figure 1). Besides the fluctuating background some high peaks can be also observed that can be attributed to either the changing weather conditions (the measured CH_2O concentration depended on the humidity, wind direction and sunshine) or the increased release of formaldehyde in the surrounding industrial area. The maximum mid-infrared power was increased 1 *mW* by using a longer (50 mm) *PPLN* crystal in the *DFG* architecture described above. To our knowledge this is the highest continuous wave *DFG* power generated by a single pass nonlinear optical parametric frequency conversion scheme. The generated *DFG* power as a function of the pump-signal power product and the crystal length is depicted in figure 2. The thick solid line shows the measured *DFG* power after a CaF_2 collimation lens and the *Ge*-pump filter (uncorrected curve), while the thick dashed line shows the corrected curve (taking into consideration a *10%* optical loss). The slope efficiency was measured to be around 380 $\mu W/W^2 \cdot cm$ and 420 $\mu W/W^2 \cdot cm$, respectively (see the thin solid and dashed fitted linear curves).

References

1. S. Friedfeld, M. Fraser, D.G. Lancaster, D. Leleux, D. Rehle and F.K. Tittel: "Field Intercomparison of a novel optical sensor for formaldehyde quantification", Geophysical Research Letters, 27(1) 2093–2096 2000.
2. D.G. Lancaster, A. Fried, B. Wert, B. Henry and F.K. Tittel: "Difference-frequency-based tunable absorption spectrometer for detection of atmospheric formaldehyde", Applied Optics 39(24), 4436–4443, 2000.



CThL31 Fig. 1. Time-resolved H_2CO concentration measurements taken during a nine day period in Deer Park, Houston, TX.



CThL31 Fig. 2. Measured *DFG* conversion efficiency in *PPLN*.