Identification of Pollutant Gases from an Atmospheric Mixture Using High Resolution Dispersive Fourier Transformation Spectroscopy

Nawaf N. Almoayed[1], *Student Member, IEEE*, Golam R. Khan[1], *Student Member, IEEE*, Mohammed N. Afsar[1], *Fellow,* IEEE

[1]High Frequency Materials Measurement and Information Center

Tufts University, Medford, MA 02155, U.S.A

***Abstract*—Dispersive Fourier Transformation Spectroscopy technique allows us to accurately measure the refractive index and absorption coefficient of pollutant gases over a wide range of frequencies from 0.3 – 0.9 Thz. This spectrum can be used to identify and detect a gas in a mixture. In this study, the absorption and refractive index data of carbon monoxide mixed with air is presented. The peaks observed in the data set show similar trends with the dielectric data of atmospheric and carbon monoxide gases measured separately.**

I. Introduction And Background

FOURIER Transform Spectrometry is one of the best technique to obtain a high resolution broadband measurement of a substance [1]. The DFTS measurement set up, pioneered by Afsar, has been previously used to analyze gases individually. This is the first time it has been used on a mixture to demonstrate independence of absorption lines in the case of Carbon Monoxide and Atmospheric Gas.

The setup consists of a simple Michelson interferometer with a scanning mirror that causes the two beams to interfere to produce an interference pattern. [2] The active fixed mirror arm is used as a chamber for the gas, while a quartz enveloped mercury vapor lamp is used as a radiation source. The two beams reflected from the gas source and the scanning mirror interfere and is detected using a high resolution helium cooled InSb detector. The detector is connected to a computer where a Fourier transform analysis is carried out as a function of path difference to obtain a continuous absorption and refractive spectrum of the mixture at a resolution of 0.05 cm^{-1} [2].

The set up was first used to obtain the spectrum of atmospheric gas at 240 Torr. A mixture sample was then made by filling the chamber with 270 Torr of CO, before allowing atmospheric gas to fill up until total pressure was 580 Torr. The mixture was allowed to rest to facilitate complete diffusion. Previously published data of CO was used to compare with the mixture sample. [2]

II. Results

The absorption coefficient spectrum of both CO and atmospheric air is provided for the combined and separate sample measurements between 450 and 900 Ghz in Fig 1. The spectrum for the combined CO and atmospheric gas (air) sample show distinct rotational transmission lines at well defined frequencies. These lines are also present in the exact same location in the absorption data for air and CO measured separately. This can be verified using the dispersion pattern of the refractive index spectra shown in Figure 2 which also shows a remarkable degree of correlation with the lone samples along the absorption line frequencies. The difference in amplitude of the absorption data can be explained by the difference in pressure values used for the samples. However the frequency location of transmission lines are independent of pressure and hence does not hinder the identification process [2] The transmission lines remain at exactly the same position when gases are mixed, indicating the ease by which DFTS techniques could be used to identify gases in a blind test.

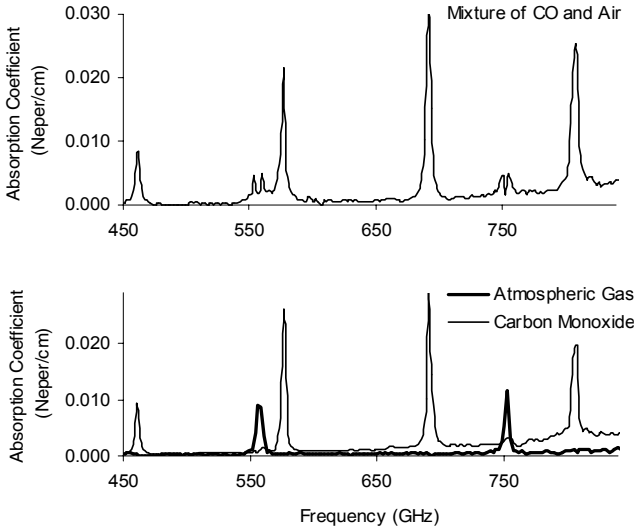

Figure 1: Absorption Coefficient Spectrum of Samples

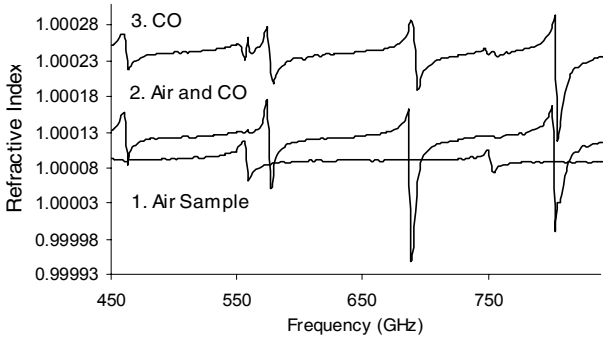

Figure 2: Refractive Index Spectra of Sample

References

[1] "High-resolution submillimeter-wave Fourier-transform spectrometry of gases," *IEEE Transactions on Microwave Theory & Tech.,* vol. MTT-22 no. 12, December 1974.

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