

# CO-115GHz and 345GHz Concentration-dependent Absorption Measurement for In-situ Gas Sensor Development

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**1. Introduction** This study is intended to realize an in-situ gas sensor based on the principle of millimeter/submillimeter wave spectroscopy. The gas spectroscopic sensor installed at gas sources, thus termed as in-situ gas sensor, will have features such as gas selectivity, simultaneous measurement of concentration, temperature and pressure, and real time capability. The subjects in this paper are to experimentally characterize the concentration dependency of CO gas absorption at 115GHz and 345GHz, and to show the effectiveness of Downhill Simplex to diagnose gas parameters such as temperature and pressure from the measured absorption spectrum.

**2. Measurement System** The measurement system consists of a vector network analyzer and a Fabry-Perot resonator type gas cell [1]. From Q-factors with and without absorption gas, the absorption spectra are measured.

**3. Measurement** The measured spectrum at 115 GHz band is shown in Fig.1. The variance is small, indicating precision measurement, and the absorption responds well to the change of concentration. The reliability of the measurement is further verified by Beer's law, as shown in Fig. 2, in which the power plotted at each concentration is right on the linear track. This linearity is fundamentally required for accurate diagnose of gas concentration.

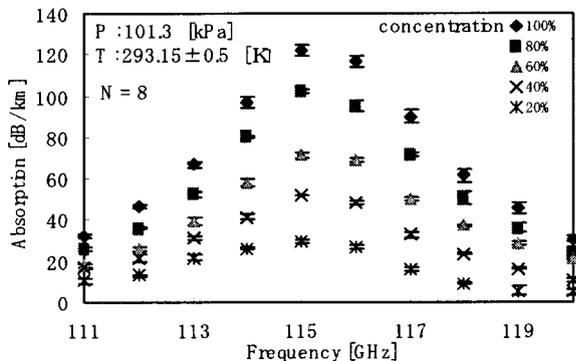


Fig.1: Concentration-dependent absorption.

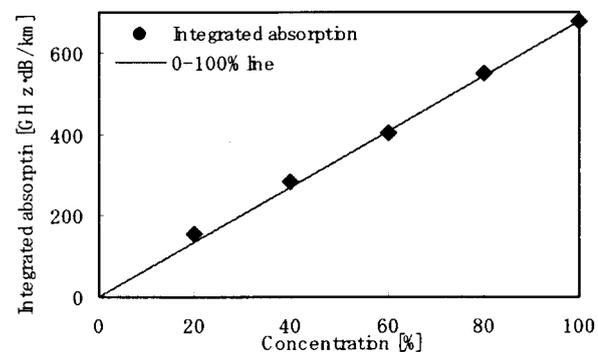


Fig.2: Concentration characteristics.

For the measurement of spectrum at 345 GHz, the data is slightly higher than the predicted at near the center frequency and the variance is large at several frequencies. The work toward improvement has been undertaken.

**4. Temperature and Pressure diagnosis by Downhill Simplex** Applying Downhill Simplex to the fitting between the measured spectrum at 115GHz and the theoretical model, the temperature and pressure have been diagnosed. The diagnosed errors are 16.12K (5.5%) and 7.12kPa (7.0%), whose result implies adequacy of both measurement and diagnosis method.

## References

- [1] Y. Watanabe and T. Suzuki, URSI XXVIIth General Assembly, F3.O.1, Aug. (2002).
- [2] Y. Teshima et al., IEICE. Gen. Conf. '03, No.SB-11-1, pp.SE-1-2, Mar. (2003).