THz frequency technology: a nice tool for gas analysis?

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Abstract

Despite the THz frequency domain is often denoted as « spectral gap », this region has been actively used for many years for fundamental rotational/vibrational spectroscopy. Strongly polar stable and unstable chemical compounds (such as OH, H2CO, HF, HCN, H2O to cite a few) have intense rotational spectra, and then, should ensure their detection at trace level. Moreover, the translation of the measured fractional absorption into absolute concentration does not require the use of a calibration gas, provided that the spectral parameters are well known. Also, at low pressure, the Doppler linewidth offers a very high degree of selectivity that even a complex mixture should be identified and quantified [1]. The THz/Far InfraRed (FIR) region is not confine to investigations of light polar molecules via their rotational spectra. Lowest energy vibrational fingerprint associated to delocalized (or collective) modes can be also explore in this "spectral gap" and then obtain relevant structural and conformational isomers discriminations [2].

The nearby absolute selectivity of THz/FIR gas phase spectoscopy can provide a basis for analytical systems with unique identification, and quantification capabilities very attractive for various fields including medical diagnostics, purely scientific investigations or industrial applications.

During the last decade, we have implemented a range of techniques for trace gas analysis in the THz region. For example, THz Time domain measurement along with high resolution investigations by means of photomixing have been performed for trace gas analysis of cigarette smoke [3]. Also, a specific THz synthesizer based onto a frequency comb enables fundamental investigation of various radicals [4,5]. Presently this optoelectronic conversion technique presents the largest spectral coverage associated with a relatively good linewidth but requires strong skills in many fields and then hampers its routine use. To reduce expertise level, commercial solids states elements working at room temperature have been used to implement a versatile sub THz spectrometer. By this means, industrial samples have been analyzed and we confirmed the role of some catalysers to reduce the emission of SO_2 [6]. Besides, those high resolution investigations, vibrational FIR / THz gas phase spectra of some key compounds involved in the security domains, such as NitroToluene and Dinitrotolune gives relevant values about the potential this frequency region.

We propose for this conference the specifications of those different spectrometers in the context of trace gas analysis along with promising applications. Without doubts some techniques developed would be transferred to real life applications in the near future.

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978-1-4673-5225-3/14/$31.00 ©2014 IEEE