Determination of water vapour concentration in atmosphere with a drone mounted frequency domain THz spectrometer

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THz spectroscopy is a useful tool for gas analysis because very specific rovibrational transitions for a large variety of molecules occur in this frequency domain. Under the right conditions, these transitions may be used to measure the presence and concentration of different molecules in a gas sample, like volatile organic molecules [1] that cannot be detected or monitored in other spectral domains. Moreover, absorption lines are less broadened by Doppler effect and thus THz spectral selectivity is better than in VIS or IR. Finally, THz spectroscopy is less sensitive to fog, smoke or dust in the atmosphere. While a significant effort has been made to prove the ability of a laboratory based frequency domain THz spectroscopy to quantify different gases [2], very little has been done in the field regarding atmosphere because of the lack of portable THz spectrometer. Here, we report on the first in-situ study of water vapour concentration in atmosphere using a CW THz spectrometer attached to a drone (Fig. 1). The drone is a DJI-S1000 Octocopter, which has a maximum lift-off weight of 11 kg (6 kg allowance) and a flight time of 15 minutes. The THz spectrometer was a PB7220 system from Bakman Technologies, specially adapted in size and weight to be carried by the drone. The spectrometer is based on photomixing in photo-conducting antennas and homodyne detection [3]. A test flight was performed at Paramount Ranch Park in Agoura Hills, CA, with reported humidity levels in the 75 to 85% range [4]. The absorption coefficient of air was measured 10-m above ground. Fig. 2 shows the recorded absorption spectrum, together with absorption spectra calculated with the model by Slocum *et al.* [9], for 2 different humidity percentages (50 and 90%). By fitting the experimental data with the model at 1185 GHz (at this frequency, data are not perturbed by the spectral resolution and are largely over noise), we found that the humidity of the tested atmosphere is 81% (± 15%).

Fig.1. The modified PB7220-2000-T air-born spectrometer attached to the drone.

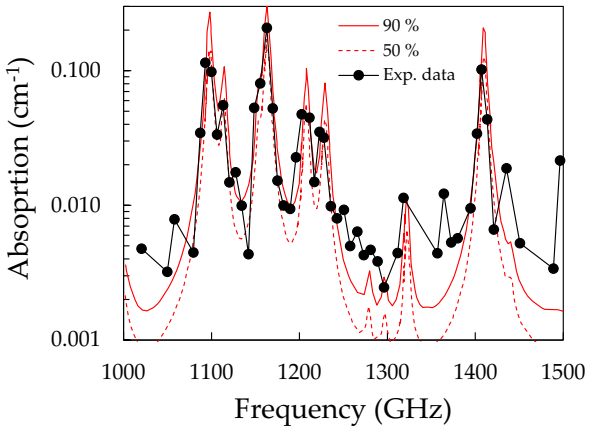

Fig.1. Recorded and calculated absorption spectra of air.

References

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