Laboratory Report
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Low ppt-level Detection of Ammonia (NH_3) by Dopant Assisted Ion Mobility Spectrometry

The ion mobility spectrometry technique offers advantages such as high sensitivity (ppt-ppb range), fast response (ms range), compact design, operation in atmospheric pressure and ability to separate the isomeric compounds. In this short report we demonstrate the sensitivity and fast response of IMS for Ammonia (NH_3) species.

The NH_3 is a small molecule with a molar mass of 17.03 g/mol. Ammonia is an inorganic compound of nitrogen and hydrogen. It is a colorless gas with a distinct pungent smell. Biologically, it is a common nitrogenous waste, particularly among aquatic organisms, and it contributes significantly to the nutritional needs of terrestrial organisms by serving as a precursor to 45 percent of the world's food and fertilizers. Monitoring of NH_3 is also important in semiconductor industry. In many semiconductors, applications need to be the presence of Ammonia monitored at low ppb and ppt levels.

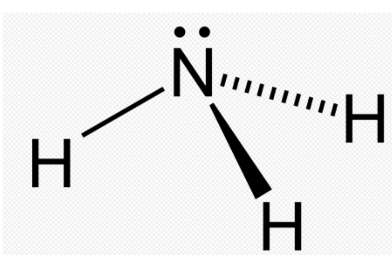

Figure1. NH_3

In this short **Laboratory Report,** we demonstrate the ability of Dopant Assisted **Ion Mobility Spectrometer** for detection of NH_3 at low **ppt** level.

Experiment

The **Portable-Advanced Ion Mobility Spectrometer** (**PAIMS**) was used in this experiment. The operating parameters of **PAIMS** are listed in Table 1.

Table 1. PAIMS operating parameters.

Operating pressure	**1000 mbar**
Operating temperature	**67 °C**
Drift Gas	**Zero Air**
Drift gas flow	**1000 mL min^{-1}**
Drift field intensity	**570 V cm^{-1}**
Sample gas flow	**600 mL min^{-1}**
Polarity	**Positive**

Figure 2. The PAIMS.

The gas dilutor from *Molecular Analysis series 7800* was used in this work, for generation of low ppb concentrations of NH_3 in zero air. The **PAIMS** operates at atmospheric

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pressure and continuous sample sniffing was set to 600 mL/min. The sample inlet sucks the atmospheric air. The air from the gas dilutor was sniffed to **PAIMS**. Dimethyl methyl phosphonate (DMMP) was used as a dopant for our **IMS**. Using of dopant increases sensitivity and selectivity of IMS but also strongly reduces interferences of other VOC presented in the atmosphere, thereby DMMP improving **identification** and **quantification** of Ammonia.

Results and discussion

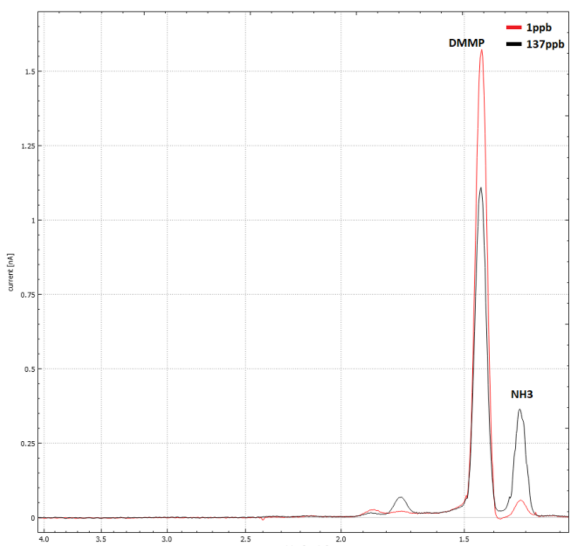

*Figure 3. **1ppb** and **137ppb** NH_3.*

The IMS response for 137 ppb of NH_3 is shown in figure 3 (black line). As we can see from this figure, the NH_3 results in the formation of the peak with reduced mobility of *1.31 $cm^2.V^{-1}s^{-1}$*. The red line in figure 3 represents the IMS response for 1 ppb of NH_3.

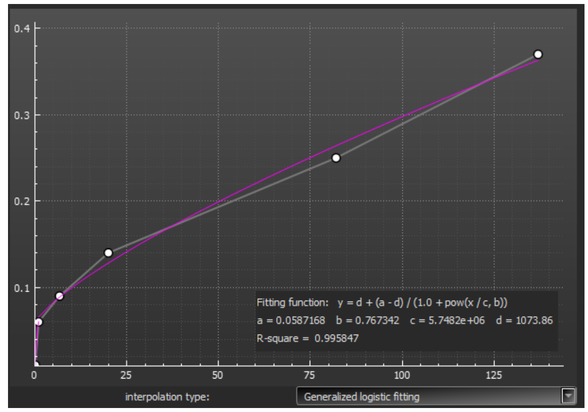

Figure 4. The IMS response for different NH_3 concentration.

Figure 4 shows the calibration plot of IMS response for 0.1, 1, 6.7, 20, 82 and 137 ppb of NH_3. The **MaSaTECH** software allows calculation of peak **volume**, peak **area,** as well as peak **intensity.** The peak intensity was considered for calculation. The *Generalized Logistic Fitting* with *R^2=0.995* was chosen as optimal. Considering the noise level of 3x, we calculate the **limit of detection (LOD) for NH_3** at a value of **60 ppt.** The upper detection limit was also calculated to be 1ppm.

Conclusion

In this short laboratory report, we demonstrate the ability of **PAIMS** to detect NH_3 at low ppt concentration. The **LOD** for **NH_3** was **60 ppt.** As the **MaSaTECH PAIMS** allows modification of experimental setups like sample gas flow and drift-gas flow, the improvements of sensitivity bellow **60 ppt** should be also possible.