Fingerprint Analysis of Volatiles in Cars

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Abstract

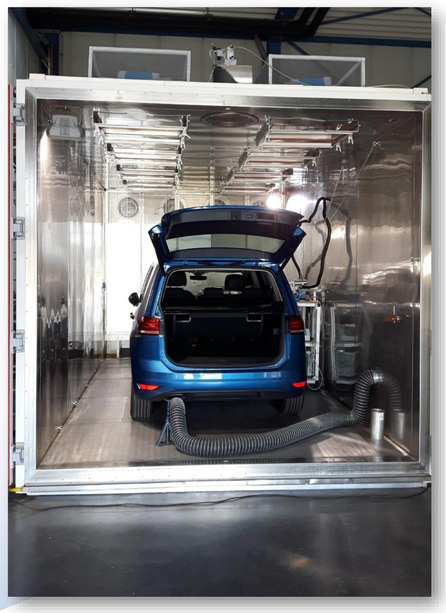
Car interiors consist of different components made of various materials, such as plastics, glue, lubricants or paint, exhibiting the potential for outgassing of volatile organic compounds (VOCs). Several studies depicted the appearance of VOCs in new cars, which is commonly known as “new car smell“. With its GC-IMS device G.A.S. makes a novel approach for detection and quantification of VOC outgassings by using the combination of automated analyte enrichment & desorption, gas chromatography (GC) and ion mobility spectrometry (IMS) combining excellent selectivity with extraordinary sensitivity within one measuring device.

Objective

- Detection of odour fingerprint of car interiors
- At-site measurement device
- VOC fingerprint analysis
- Comparison of different cars (age, model) at different conditions (temperature, radiation)

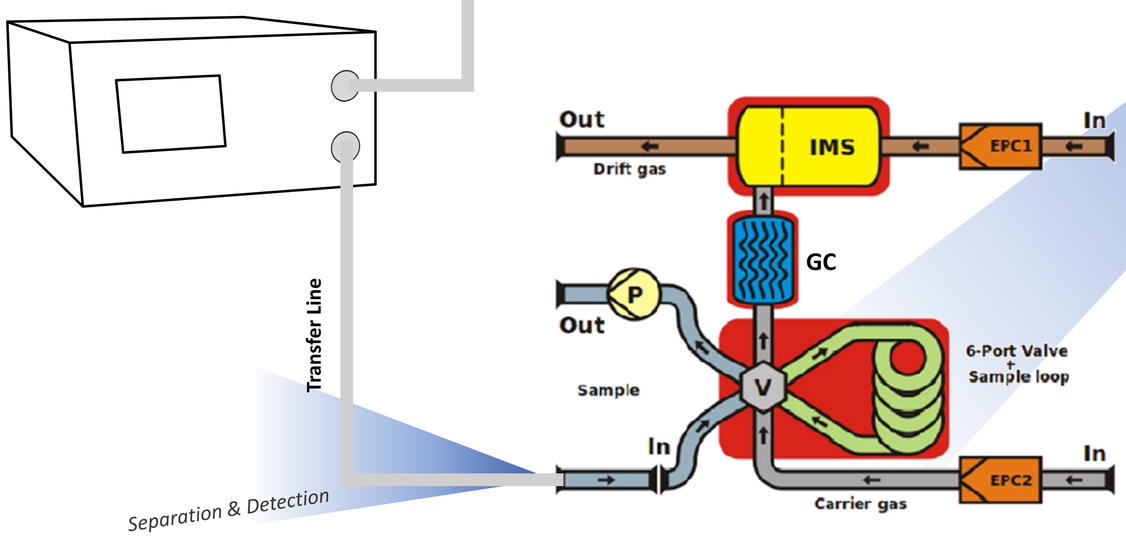
Set-Up & Workflow

In a first step (*Sampling & Enrichment*) the gaseous sample is sucked into the thermal desorption unit. During this phase the introduced compounds are focussed onto an adsorption tube at relatively low temperatures (slightly above ambient temperature). Afterwards the temperature of the adsorption tube is increased (>200 °C) in order to desorb the afore adsorbed compounds within a small volume. Then the pre-concentrated sample is directly injected into the GC-IMS device (*Separation & Detection*). While the sample is analyzed by the GC-IMS the thermal desorption unit is cleaned/cooled down and afterwards ready for a next cycle.



Exemplary picture of measurement chamber. Different vehicles were located in the temperature, radiation and humidity controlled measurement chamber based on ISO standard 12219-1.

Sampling & Enrichment

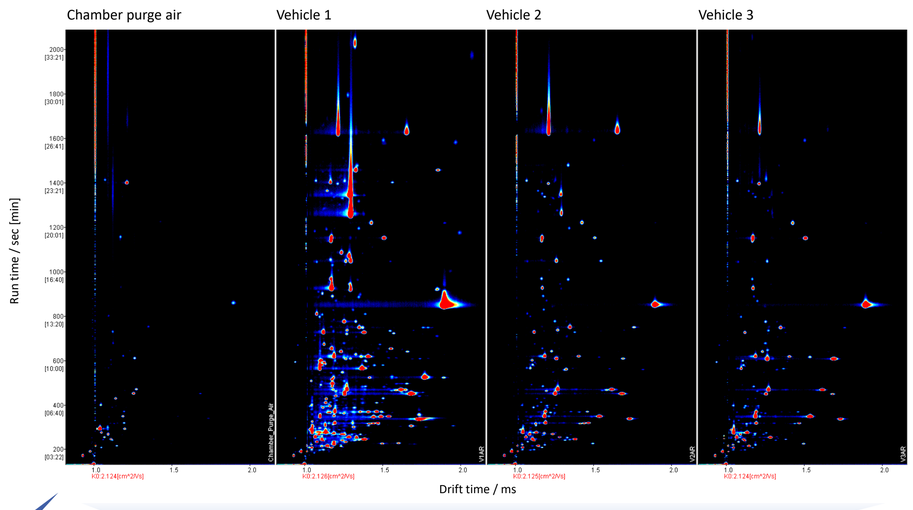


Combination of thermal desorption and GC-IMS technology (µTD-GC-IMS).

GC-IMS Device

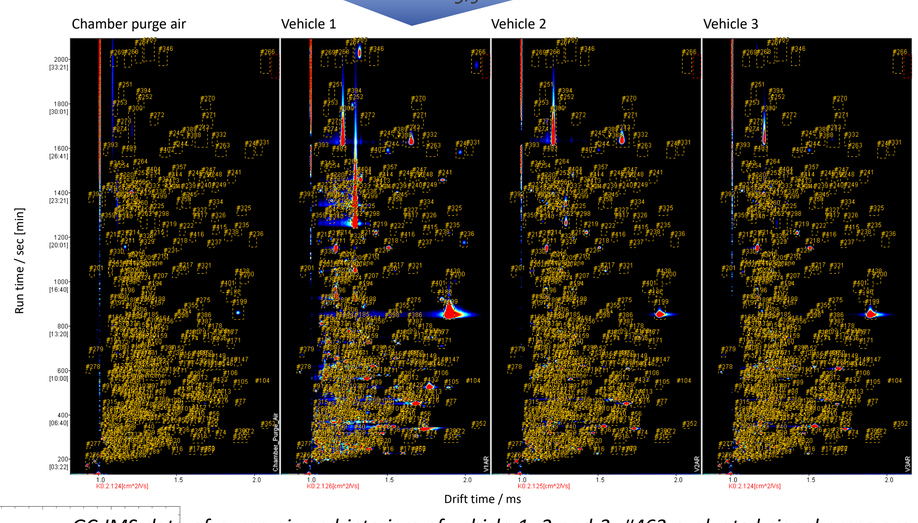
Separation & Detection

Data Collection

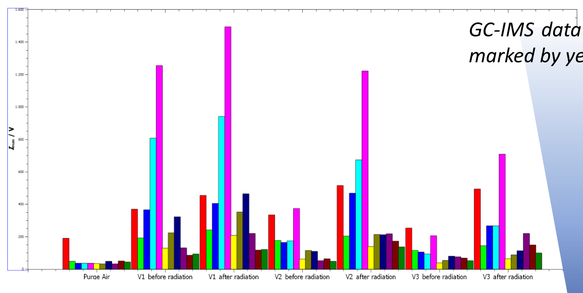


GC-IMS data of purge air and interiors of vehicle 1, 2 and 3.

Signal Definition



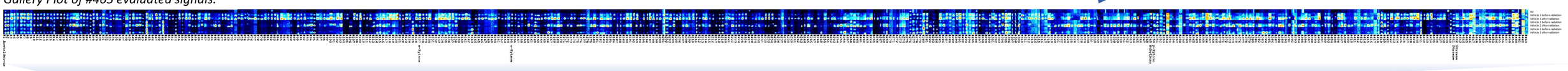
GC-IMS data of purge air and interiors of vehicle 1, 2 and 3. #463 evaluated signal areas are marked by yellow rectangles.



Exemplary evaluated signal intensities. Numerical Analysis.

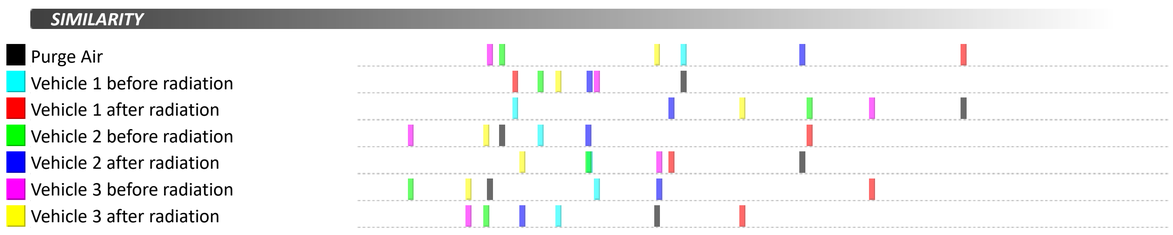
Signal Extraction, Evaluation / Visual Fingerprint Analysis

Gallery Plot of #463 evaluated signals.



Automatable Fingerprint Analysis

Similarity Analysis based on a set of #463 evaluated signals.



Data Processing

After the *Sampling & Enrichment* and *Separation & Detection* steps the data of the car interiors VOC composition are collected and can be analyzed by eye if desired. In this case #463 signals were detected/defined (*Signal Definition*) and analyzed by several methods. First, signals of interest were *extracted* and represented in the *Gallery Plot* simplifying a visual comparison of the different signals based on different samples (*Signal Extraction*). A numerical analysis/plotting of the evaluated signals is also easily realized by mathematical evaluation of the signal areas (maximum intensity, e.g.).

A very comprehensive approach for automated analysis of complex VOC patterns of different samples is achieved by using a software feature called *Similarity Analysis*. Hereby the GC-IMS VOC fingerprint data are numerically analyzed based on a set of areas defining the signals of interest. Afterwards a special software algorithm analyses the different samples with regards to their similarity (*Automatable Fingerprint Analysis*).

Results

- The outgassings of the interiors of three different vehicles were measured
- Age of vehicle: V1 < V2 < V3
- Measurements were also performed before and after radiation of the cars (mimicking sun light under defined conditions)
- The differences between the VOC fingerints of the three cars are detected in a qualitative and also quantitative way (s. *Numerical Analysis* & *Gallery Plot*).
- In general V1 exhibits the highest amount of VOC outgassings followed by V2 and V3
- After switching on the radiation in all cars signal intensities of almost all evaluated signals increased
- Results of Similarity Analysis:
  - Vehicle 3 before radiation is most similar to purge air (lowest outgassing)
  - Vehicle 2 and 3 exhibit a very similar VOC fingerprint and are also most similar to purge air (→ vehicles 2 & 3 were old and therefore VOCs were mainly outgassed)
  - Vehicle 1 after radiation is most different compared to purge air indicating the highest amount of outgassings (→ vehicle 1 was very new and therefore VOCs were not already outgassed)

Conclusion

- Based on thermal desorption and GC-IMS technology a stable and reproducible measurement system for the detection of car interiors VOC outgassings/fingerprints was adapted
- Different signal patterns/fingerprints of each car’s interior are clearly distinguishable
- Even measurements before and after radiation (mimicking sun light) clearly show an overall increase of outgassings

Perspective

- Classification of the fingerprint data by customers (correlation to sensory panels)
- Further analysis of the data by application experts from automotive industry
- Optmization of the measurement set-up to customers requirements

Acknowledgments

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