



# Measurements on a miniaturized FAIMS-Chip for deriving optimal operating parameters

 Nils Funke<sup>1,2</sup> | Alexander Graf<sup>1,2</sup> | Jessy Schönfelder<sup>1,3</sup> | Olaf R. Hild<sup>2</sup>
<sup>1</sup> Fraunhofer Project Hub "Microelectronic and Optical Systems for Biomedicine", Erfurt, Germany; <sup>2</sup> Fraunhofer Institute for Photonic Microsystems IPMS, Dresden, Germany; <sup>3</sup> Fraunhofer Institute for Cell Therapy and Immunology, Leipzig, Germany

 Nils Funke  
 ✉ [nils.funke@ipms.fraunhofer.de](mailto:nils.funke@ipms.fraunhofer.de)  
 ☎ +49 361 66338-154

## Introduction

In many applications, e.g. biomedicine and environmental sensing, the detection of volatile organic compounds (VOCs) is in great demand. Ion mobility spectrometry offers a fast and sensitive way of detection. The purpose of hand-held systems asks for a miniaturization of the IMS setup, which can be achieved with the help of microtechnologies.

Two VOCs, acetone and 2-pentanone, which are found in human breath [1], are used to determine the influence of operating parameters of a commercially available FAIMS system on the measured data. In order to distinguish both analyte peaks in the measured spectra, the humidity and pressure of the carrier gas were adjusted.

## High-field asymmetric-waveform IMS (FAIMS) Basics

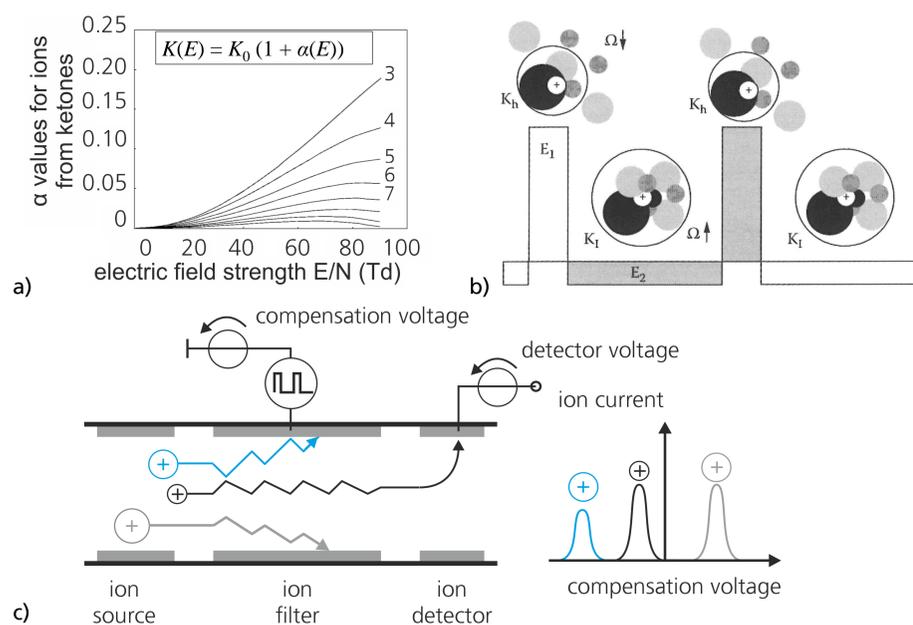


Fig. 1 - a) typical  $\alpha$  curves show the field dependency of the ion mobility of ketones [2], b) de- and re-clustering of ions during high and low field conditions [2] and c) characteristic ion trajectories in the ion filter due to field dependent ion mobility  $K(E)$  and the resulting spectrum.

## Dependence of concentration, moisture and pressure

The mixture of acetone and 2-pentanone was examined. To analyze the influence of the concentration of the mixture, the moisture and the pressure of the carrier gas (nitrogen) on the resulting spectra, measurements with different settings were made. Figure 2a) shows the heatmap of the "standard" measurement with 192 ppb acetone and 37 ppb 2-pentanone with dry carrier gas at ambient pressure. The acetone monomer peak is not clearly visible. Figure 2b) shows the same measurement with a higher acetone concentration of 4 ppm. The acetone monomer peak increases, the 2-pentanone monomer peak decreases.

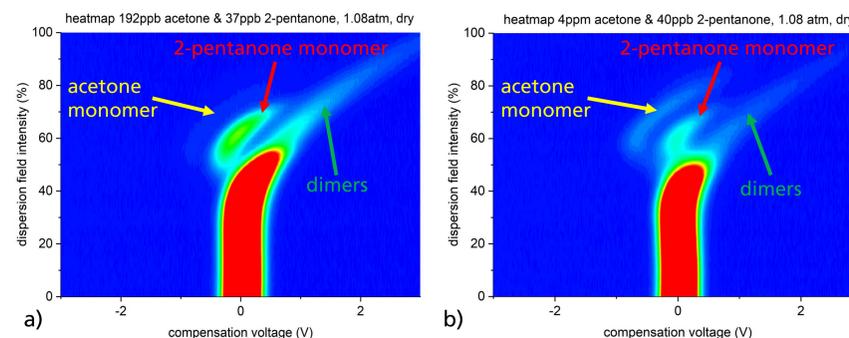


Fig. 2 - "standard" heatmap with 192 ppb acetone and 37 ppb 2-pentanone with dry carrier gas at nearly ambient pressure 1.08 atm in a). b) shows the heatmap of the same measurement with a higher acetone concentration of 4 ppm.

Increasing the moisture up to 2300 ppm leads to increased monomer peak intensities (fig. 3a)). Increasing the pressure leads to a displacement of the peak position and decreased peak intensities (fig. 3b)).

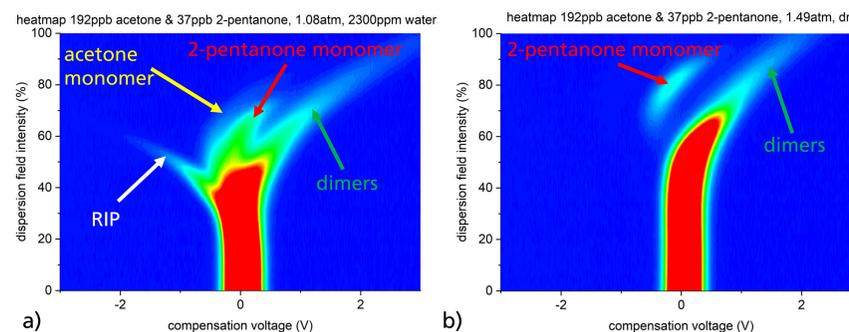


Fig. 3 - In a) the moisture of the carrier gas was increased to 2300ppm water. The pressure of the carrier gas was increased to 1.49 atm in b).

## Optimizing the acetone to 2-pentanone peak ratio

To optimize the ratio of the acetone and 2-pentanone monomer peak intensity, both the moisture and pressure of the carrier gas were modified, which results in two distinct monomer peaks, as seen in figure 4a).

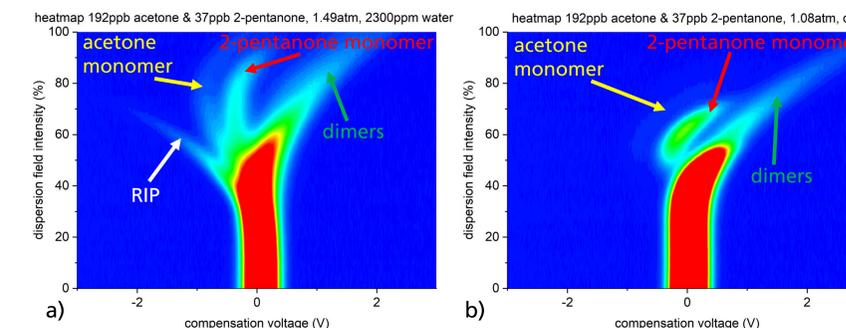


Fig. 4 - The combination of elevating the carrier gas pressure and increasing the moisture leads to a distinct separation of acetone and 2-pentanone monomers in a). For comparison, the "standard" measurement is shown in b).

## Conclusions and Outlook

By changing the pressure and moisture of the carrier gas we were able to detect both monomer peaks in the acetone and 2-pentanone mixture. The moisture and pressure had an effect on the intensity and the placement of the monomer peaks of both analytes in the measured spectrum. Furthermore we investigated the effect of the concentration of both analytes in the mixture. We showed a strong influence on the detected monomer peak ratio between both analytes.

This evaluation focusses on the properties of the monomer peaks, since the reactant ion peak (RIP) and dimer peaks needs further investigations. For future measurements we want to measure more analytes and analyte mixtures, e.g. p-xylene, acetaldehyde and toluene, which are relevant in the biomedical application.

[1] Van den Velde, S., et al.: GC-MS analysis of breath odor compounds in liver patients, J. Chromatogr. B, 2008, 875(2): p. 344-348

[2] Eiceman, G. A.; Karpas, Z.; Hill, H. H., Jr.: Ion Mobility Spectrometry. 3. ed. Boca Raton : CRC Press, 2014

This work has received funding from the Free State of Thuringia, Germany.