MINIATURE ION MOBILITY SPECTROMETER DETECTOR WITH A PULSED IONIZATION SOURCE

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Abstract

We demonstrate a miniature ion mobility spectrometer (IMS) detector that uses a pulsed corona ionization source. The gas phase detector shows high sensitivity and moderate resoltuion, essential for possible interfacing with other μTAS devices.

Keywords: Ion mobility spectrometry, pulsed ionization, corona discharge, atmospheric pressure chemical ionization

1. Introduction

Miniaturization of ion mobility spectrometry has many advantages for the separation of chemical species at atmospheric pressure and as a detector for other miniature instruments[1]. We have studied a miniature ion mobility spectrometer (IMS) that employs a pulsed corona-discharge ionization source. The drift channel has a diameter of 1.7-2.5 mm and a length of 35-50 mm. The device demonstrated high sensitivity and moderate resolution in detecting ions of H_2O clusters, methyl iodide, SF_6, and DMMP.

2. Experimental

The miniature IMS channel consists of a stack of electrodes separated with insulating spacers and connected by miniature resistors, as shown in Fig. 1. A Ni corona tip is mounted at the end of the drift channel. A high voltage pulse with a width varying from 40 ns to 400 μs is applied to the electrode relative to the drift potential. During the high voltage pulse period, ions are generated and confined to the vicinity of the tip. After the pulse, the ions move in the drift field and separated according their mobilities in the drifting gas. The corona discharge pulse also serves as the ion injection

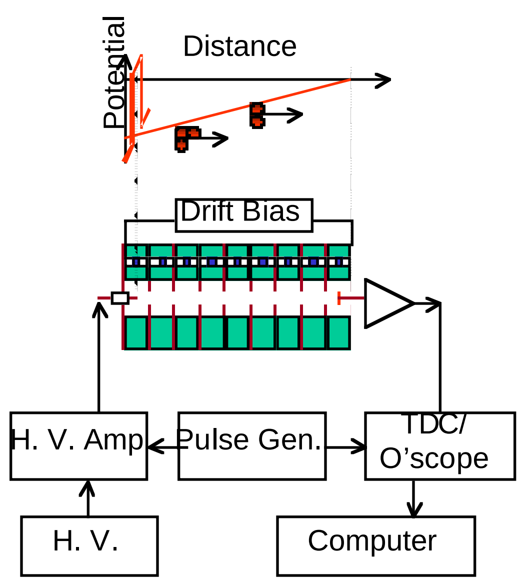

Fig. 1 Experimental setup. Top illustrates the drift potential and the corona pulse.

process to start the mobility measurement.

3. Results and discussion

IMS spectra of negative ions generated by pulsed corona discharge ionization of air were measured as a function of drift bias, as shown in Fig. 2.

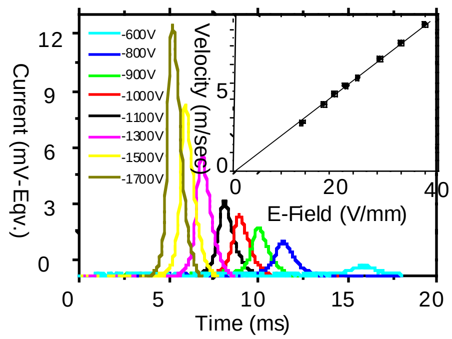

Fig. 2. Mobility spectra of negative ions generated by pulsed corona discharge as a function of drift potentials. The upper corner plots the ion velocity as a function of the drift field.

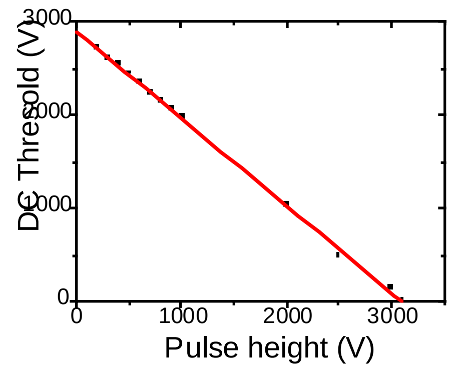

Fig. 3. DC potential threshold for generating IMS ions as a function of pulse height applied to the corona electrode.

A combination of pulsed and DC corona voltage was explored. For a given pulse height, IMS current was measured as a function of dc bias. A threshold for ion production was observed. The DC threshold was found to linearly decrease as the pulse height increased, as shown in Fig. 3. These measurements suggest that the high voltage of the pulse can be reduced by compensating with a DC bias. The pulse height could be reduced to as low as 200 V for a detectable response and as low as 1000 V for a stable response. As pulse height was lowered, the current decreased as the DC voltage was increased to above 2700 V. This decrease is believed to be due to reduction of initial free electrons in the high DC field in the vicinity of the tip.

IMS spectra of both positive and negative ions were measured as a function of pulse width and showed a clear difference between positive ions and negative ions. For positive ions, the ion current increased with pulse width and saturated. For negative ions, the ion current peaked rapidly and then decayed as the width increases. A theoretical model has been developed based on electron ionization and attachment, trapping of electrons and negative ions induced by the pulse bias. The model explains the kinetic data and provides many insights into generation and movement of ions under the pulsed corona discharge conditions used in miniature IMS.

Acknowledgements

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Reference

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