Dual Polarity Ion Confinement and Ion Mobility Separations in Traveling Wave-based Structures for Lossless Ion Manipulations (SLIM)

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Overview

- Ultra-high resolution ion mobility (IM) separations have been achieved in structures for lossless ion manipulations (SLIM).
- First experimental demonstration of a SLIM ion mobility device capable of performing concurrent cation and anion IM separations.

Introduction

- Simultaneous cation and anion IM separations and their combination with mass spectrometry are beneficial due to their complementary nature and the more extensive information obtainable from small sample sizes.
- The difference in ionization and fragmentation pathways potentially yields useful structural and mechanistic biological information.
- Traditional dual polarity analyses involves polarity switching of the instrument, which can result in unstable performance stemming from issues with the stability of the ion source, subtle changes in experimental and instrumental conditions, duty cycle, etc.
- We present the first experimental results from a SLIM device [1-3] capable of performing simultaneous positive and negative IM separations in the same ion path.

Methods

- The SLIM DC guard electrodes were replaced with RF guards to achieve dual polarity confinement.
- Agilent low concentration Tune Mix was used with a home-built nanoESI-SLIM IM platform coupled to an Agilent QTOF-MS.
- The nanoelectrospray, ion funnel, and the Agilent QTOF-MS were operated in either positive or negative polarity mode.
- RF guard-SLIM device conditions; 0.9 m path length, 3.2 mm board gap, TW: 45 Vpp at 200 m/s, RF_{board}: 310 Vpp at 0.8 MHz, RF_{guard}: 360 Vpp at 1.0 MHz, Pressure: 3.09 Torr N_2 .

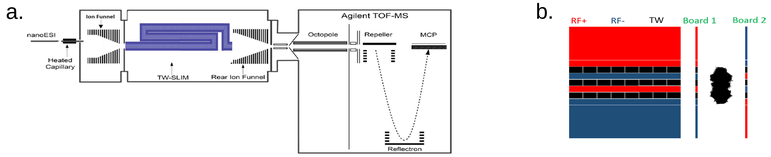

Figure 1: (a) Schematic of the instrument used for this work, showing the T-Wave SLIM device coupled to an Agilent 6538 QTOF mass spectrometer with a 1.5 m flight tube, (b) RF guard SLIM configuration optimized for dual ion polarity confinement and transport

Results

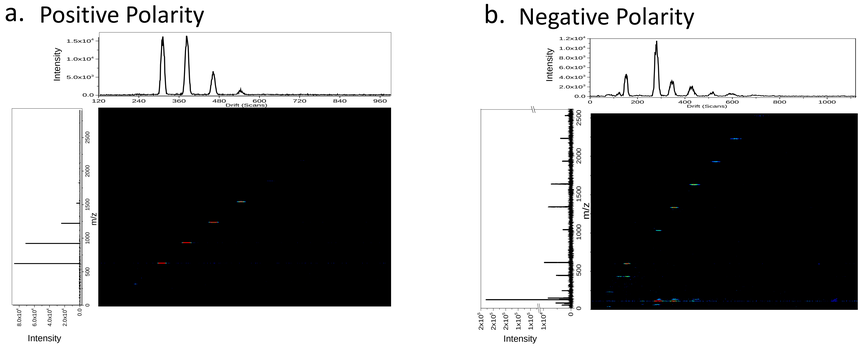

Figure 2: Nested mass spectrum and arrival time for the analysis of Agilent low concentration Tune Mix using the RF guard-SLIM device under the condition stated above in (a) positive ion polarity mode and (b) negative ion polarity mode. No change in the parameters of SLIM for either polarity.

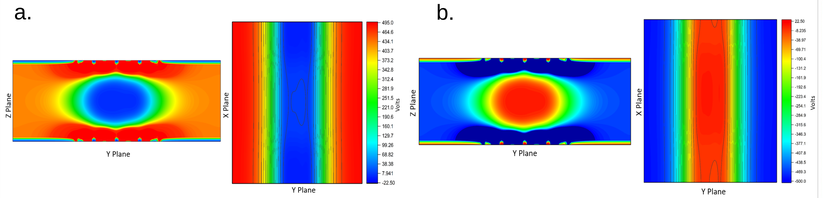

Figure 3: Effective potential contour plots for the RF guard-SLIM device used in this study, generated using SIMION by superimposing the RF fields on the DC potential of the travelling wave. (a) The effective potential experienced by a cation, 622 *m/z*, (b) the effective potential experienced by an anion at 622 *m/z*.

Conclusions

- First experimental demonstration of a SLIM module capable of performing both cation and anion IM separations simultaneously.
- Dual polarity ion confinement and IM separation achieved by replacing the DC guard potentials in the SLIM with RF potentials.
- Effective potential analysis show an inversion of the confinement fields observed by ions of the respective polarities under the same experimental condition, effectively separating the ion populations most of the time (and e.g. minimizing ion-ion interactions).

Acknowledgements

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