High resolution traveling wave ion mobility separations using Structures for Lossless Ion Manipulations (SLIM)

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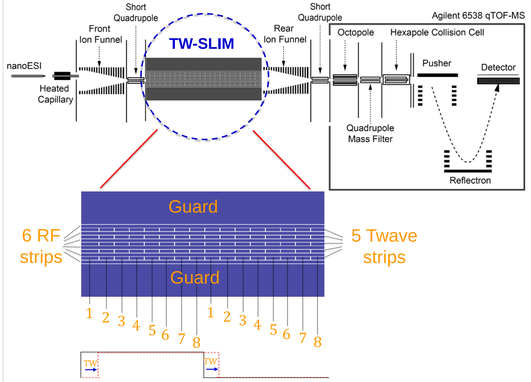
Overview

- This work presents a new SLIM device that utilizes a traveling waveform (TW-SLIM) leading to high resolution ion mobility separations.
- TW-SLIM section of 30 cm can achieve comparable resolution to that achieved by drift tube ion mobility spectrometry (DTIMS) of 100 cm.

Introduction

- Drift tube ion mobility instruments can achieve resolutions that are limited by their length; they require a higher voltage to provide the drift field as the drift tube length increases.[1] Alternatively, traveling waves can eliminate the need for increasingly high voltages as the drift path increases.[2]
- The ability of an ion to keep up with a travelling wave through the drift gas is dependent on its mobility; high mobility ions slip behind the waves less often than low mobility ions and so move through the device more quickly, thus enhancing mobility-based separation of ions.[2]
- SLIM can perform ion manipulations that include lossless ion transmission for a wide m/z range of ions, ion trapping, 90º turning and switching between alternative paths.[3,4]
- Herein, a novel approach using a new SLIM device that utilizes a traveling waveform (TW-SLIM) leading to high resolution ion mobility separations. Evaluation of different factors that affect the ion mobility resolution and resolving power are also presented.

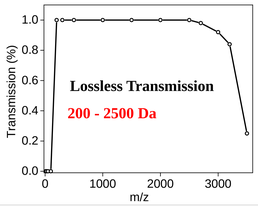
Methods



- Sample: Singly charged ions from Agilent tuning mix
- Gate width: 324 µs
- Mass spectrometer: Agilent 6538 QTOF MS

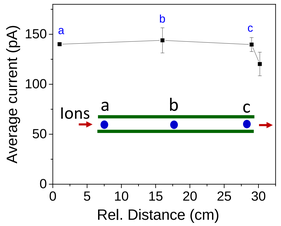
Ion Trajectory Simulations

SIMION 8.1 was used for ion trajectory simulations.



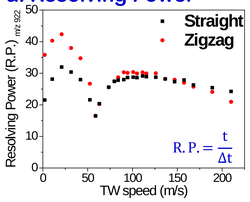
Results

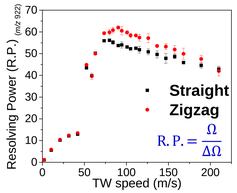
Transmission inside TW-SLIM



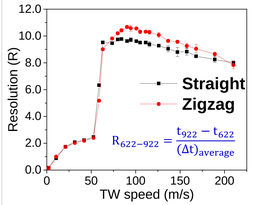
Traveling Wave Speed Effect

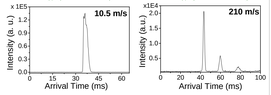
a. Resolving Power

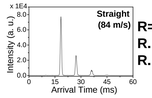




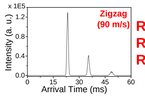
b. Resolution





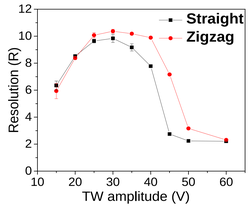


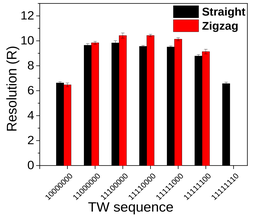
R= 9.8
$R.P._{(622)}$= 23.1
$R.P._{(922)}$=28.1

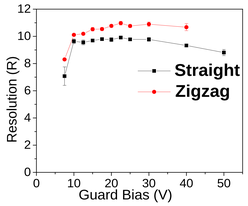


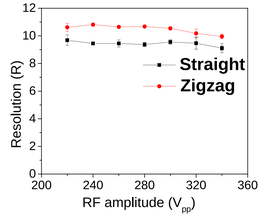
R= 11.1
$R.P._{(622)}$= 23.5
$R.P._{(922)}$=29.2

Other Factors Effecting Separation



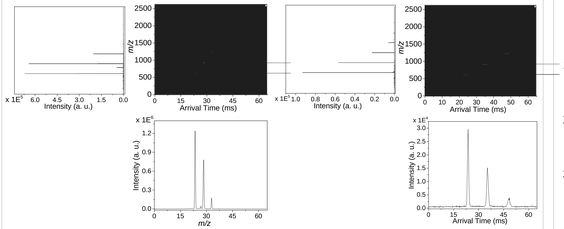






Comparison with Drift Tube IMS

DTIMS **TW-SLIM**



TW-SLIM section of 30 cm can achieve comparable resolution to that achieved by DTIMS of 100 cm.

Conclusions

- Lossless transmission of ions through the new TW-SLIM.
- High resolution can be obtained by using various configurations of TW-SLIM.
- The traveling wave speed and amplitude were optimized to achieve the maximum.
- RF amplitude and guard bias have negligible effects on the separation.
- Our results match the previous reports that investigated the traveling wave ion mobility
- This work offers a route for implementation of these devices in miniature ion mobility mass spectrometers.

Acknowledgements

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Career Opportunities: For potential openings in Integrative Omics Group at PNNL please visit http://omics.pnl.gov/careers

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