

MICROFLUIDIC ION MOBILITY CHROMATOGRAPH

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This paper describes the development of a microfluidic ion mobility chromatograph (μ IC) for small inorganic ion analysis. This miniature analytical system, especially suited for water quality monitoring, separates ions based on their aqueous mobilities as they flow through patterned electric fields in a microchannel.

INTRODUCTION

In conventional ion chromatographic systems, the industry standard for aqueous-based inorganic ion analysis, ions separate by interacting with an ion-exchange resin as they flow in an acidic or basic eluent through a packed column. Different elution times of the analyte ions are detected by conductivity after eluent ion suppression to give sensitive qualitative and quantitative information. Recently researchers have begun to miniaturize the conventional benchtop systems with advancing microfluidic technologies and electrochemical eluent generation and post-column ion suppression. The novel μ IC offers several advantages over a miniaturized conventional system including elimination of acidic/basic eluent generation and post-column ion suppression, simultaneous cation and anion analysis in a single column, and possible improvement in separation definition and detection limits with precise manipulation of separation parameters.

DEVICE DESIGN

The prototype μ IC consists of a platinum electrode comb structure ($\sim 100\text{nm}$ thick) lithographically patterned on a quartz slide bonded to a microchannel bilayer structure fabricated in the silicon rubber polydimethylsiloxane by soft lithography techniques. Pneumatic valves incorporated into the bilayer structure control sample injection and pressure-based fluid flow. Application of an alternating potential to the electrode comb creates an electric field pattern in the microchannel separation region ($\sim 100\mu\text{m} \times \sim 40\text{mm} \times \sim 10\mu\text{m}$). The analyte ions screen the fields on a microsecond timescale as they move through the microchannel in deionized water. The ions' participation in screening events is dependent on their aqueous mobility resulting in characteristic velocities and exit times from the separation region. Conductivity measurements at the outlet can be analyzed to resolve peaks corresponding to specific ions separated by gradually increasing mobility.

MODELING/TESTING

Theoretical modeling suggests five-minute analysis of ppb analyte concentrations with application of 1V at 25kHz to the prototype electrode comb design and an eluent flow rate of $0.1\mu\text{L}/\text{min}$. Initial testing uses hydrostatic columns and on-chip valving for fluid regulation. LabVIEW controls operational parameters and data collection. The initial data set will be compared with the theoretical model identifying key parameters for separation optimization.

SUMMARY

A microfluidic ion mobility chromatograph is under development for small inorganic ion analysis of aqueous solutions. Its novel separation technique offers automated *in situ* capabilities unavailable from conventional ion chromatographic systems.

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