Performance Characterization and Field Testing of a Portable Tandem Mass Spectrometer

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Griffin Analytical Technologies Inc. West Lafayette, IN www.griffinanalytical.com Technology transfer from Purdue's top-tier Analytical Chemistry Department

Griffin Analytical Technologies

- Exclusive license in all fields of use
- Developing miniaturized, portable mass spectrometer-based instrumentation

that provides bench-top performance

in a portable package

"Chemistry Happens Outside the Lab...
 So Should Analysis."





Field MS Applications

- Homeland Security/Defense
 - Detection surrounding potential terrorist targets
 - Transportation security
 - Forward-deployed protection of troops
- On-site Environmental Monitoring
 - Water quality
 - Continuous air monitor

R&D Tool for Chemical Warfare Testing

 Advantages of the Cylindrical Ion Trap
 Operation under relatively high vacuum
 ~10⁻⁴ Torr

MS/MS capabilities
 Selectivity

Ease of machining/manufacturing

Reduced voltage requirements







Result of Difference

electrodes	Hyperbolic radius = 10 mm	Flat radius = 2.5 mm	Simplified machining, lower operating voltage
req'd. voltage	~8000 V (at 1.1 MHz)	~600 V (at 1.1 MHz)	Smaller electronics, lower power consumption
mass range	1000 amu (typical)	350 amu (typical)	Range for target applications
mass resolutio	n unit (typical)	unit (demonstrated)	Performance comparable
MS ⁿ capability	MS ⁴ (typical)	MS ³ (demonstrated)	Performance comparable

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Minotaur Instrument



Minotaur Specifications: Mass Analyzer: Cylindrical Ion Trap Sample Inlet: Internal Membrane **Ionization:** Internal Electron Ionization (EI) MS³: Demonstrated **Sensitivity:** LODs of ppb to pptr, compound specific Mass Range: 350 Da/charge **Resolution:** ~unit **Bath Gas:** ambient air (~10⁻⁴ Torr) **Detection:** positive and negative ions **Size:** 60 cm x 45 cm x 20 cm (~1.9 cu. Ft.) Weight: under 50 lbs. (with case and pumps) **Power Consumption:** ~100 W

Griffin Analytical Technologies Instrument Control Software

Scan Editor - development software

Advanced Waveform Editing



Data Collection





Data Analysis



Griffin Analytical Technologies Inlets and Sources

Currently In Use

- Silastic[®] PDMS tubular membrane (0.64 mm i.d., 1.19 mm o.d.), ~2 cm long
- Sampling flow rate 0.5 L/min
- Onboard sampling pump
- Internal El

In Development

- SPME inlet
- GC interface
- Other interfaces are under development including external ionization sources



Dynamic VOC Standards





Bag Standards







Toluene LOD = 15 ppb



Minotaur Performance: Trap-and-Release of Semi-Volatiles Methyl Salicylate LOD = 300 pptr



Minotaur Performance: Field Testing



Methyl Salicylate with Sorption Tube Sampling









Challenges with Current Analyzer Vacuum Requirements Traps Sectors Quads TOF **ICR** $B \equiv$ <u>___</u> 0 10-3 10-8 10-9 10-5 10-6 10-7 10^{-4} pressure (Torr)

Challenges with Current Technology

Vacuum Pumping – power consumer, delicate



Challenges with Current Technology

Miniaturization of High Voltage Electronics
 Size limited by HV line separation and component

- spacing
- Relatively high quiescent power consumption

Broadcast/Electromagnetic Interference (EMI)



Future Directions

- Develop innovative sample introduction/ionization techniques
 - Tailored to specific applications
 - Increased selectivity
 - Funding secured
- Refinement of instrument package
 - □ Volume: ~1.5 cu. ft.
 - □ Weight: ~40 lbs
- Further Ruggedization for field use



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