



### Autonomous Light-Weight Integrated Direct Sampling Mass Spectrometer for TIC and CWA Detection

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NEW THREATS. NEW THINKING.™

#### Overview



- Brief ICx and Griffin overview
- Discussion of Direct Sampling MS
  - ChemSense 600<sup>™</sup> air monitoring instrument
  - Ambient Ionization MS for surface sampling

#### **ICx Overview**



- Primary Industry Focus
  - Security
  - Transportation
- Although founded in 2003, numerous ICx Technologies business units have been in business for more than 20 years...as far back as 1975...more than 100 years combined
- 850+ Employees
  - 400+ Engineering and R&D
  - 70+ PhD
- Research, development and manufacturing in the US, Canada and Germany
- Headquarters in Arlington, Virginia, USA
- 2007 revenues over \$130M
- Global customer base
  - ICx debuted on NASDAQ (ICXT) in November, 2007









# Griffin (ICx Analytical Instruments)



## Timeline:

- Founded in 2001
- Partnered with ICx Technologies in 2005



# Griffin's Location:

- Purdue Research Park
- West Lafayette, IN USA

# Size:

- 14,000 Square Feet
- 47 full time plus 2 part time
- 2/3 staff is technical (scientists and engineers)

## Technology:

- Fieldable Mass Spectrometers
- Flexible Inlet Technologies
- Sophisticated Software







Applications & Testing Center





#### How did Griffin get its start?





On-Site Detection, Identification, and Confirmation of CWAs, TICs, and Explosives.

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#### **Continued Government Support**



#### **TECHNOLOGY DEVELOPMENT PARTNERS:**

- Environmental Protection Agency
- US Air Force
- US Marine Corps
- US Department of Homeland Security
- US Army
- National Science Foundation
- State of Indiana





# **DSMS for Facility Security**

#### ChemSense 600 - Fixed-Sited DS/MS/MS



- Direct Sampling MS for 24/7 continuous air monitoring for facility security applications
- Developed under the DHS S&T ARFCAM project
- Detection and alarming for target list of TICs and CWAs from PEL to IDLH levels (compound dependent)
- Dual inlet with direct leak and sorbent preconcentration for total coverage (no sampling gaps)
- Ionization via EI with electron generation from a rugged, long-life glow discharge cell



#### **Theory of Operation - Main Components**





### Methods - Complete Coverage Gas Phase Sample Inlet



- One common inlet providing 24/7 continuous vapor sampling
- Sample introduced directly into vacuum chamber of the mass spectrometer.
- At pre-determined time intervals, a pre-programmed software method automatically splits sample into a small diameter capillary (near immediate results) and solid sorbent packed tubes (<1 minute result).</li>

#### 1. Direct Leak

Proprietary - do not distribute or copy

 Capillary allows a small flow rate of gasphase sample directly into the vacuum chamber for ionization by electron ionization (EI).

#### 2. Solid Sorbent Pre-Concentration

- Sample is pre-concentrated on solid sorbent media.
- The Sorbent media, packed in tubes, is exposed directly to the vacuum chamber and heated under vacuum to desorb the analyte.
- Subsequent ionization is by EI.
- <u>Multiple sorbent tubes allow for</u> <u>concurrent sampling and analysis.</u>



#### Glow Discharge Electron Ionization (GDEI)



- Ions are generated via EI with electrons made using a GDEI source shown in Figure 1.
- The GDEI source is more rugged than traditional filaments and therefore more amenable for the application.





#### Mass Analyzer: Cylindrical Ion Trap



Advantages of the CIT

- Simplified geometry
- Ease of fabrication
- Reduced voltage requirements





#### ChemSense 600 - Software



#### Network monitoring software





#### Detection of arsine direct leak inlet



# Detection of phosgene with sorbents



#### Instrument Comparison













 $Cl_2$  calibration curve where  $N_2$  is the source gas for the glow discharge cell.



#### CWA Test Results - GA





#### CWA Test Results - HD











#### **Current Library**



- Current chemicals included in the ChemSense 600 library
  - Detection at IDLH for all compounds in the library
  - Detection at PEL for majority but not all targets

TICs		
1-Bromo-4-Fluorobenzene	Diethyl Malonate	
2-Chloroethyl Ethyl Sulfide	Dimethyl Methylphosphonate	
Acrolein	Ethyl Methyl Phosphonate	
Acrylonitrile	Ethylene Oxide	
Arsine	Methyl Acetoacetate	
Carbon Disulfide	Methyl Mercaptan	
Carbonyl Sulfide	Methyl Salicylate	
Chloro Acetonitrile	Phosgene	
Chloroacetone	Phosphorous Trichloride	
Cyanogen Chloride	Sulfur Dioxide	
Dibromomethane	Trichloroacetylchloride	
Diethyl Ethylphosphonate	Triethyl Phosphate	



Interferents		
Diesel Exhaust		
AFFF	11101101101101	

### Field Testing - airport installation

# Instruments were installed in several public venues and operated for 6 months

Sample Air Intake





#### Field Testing - subway station installation







# AI-MS for Surface Sampling

### The Griffin Phase 1 DESI-MS Prototype



 $H \times W \times L - 17$  in x 19 in x 19 in

Weight - 101.5 lbs

Power Consumption – 400 W, 110 VAC

Gas Consumption – 1 L/min. air (DESI/ESI source), 1 mL/min. high-purity helium

Solvent consumption – 5 uL/min. 50:50 water/methanol







#### Detection of triethyl phosphate on tree bark



#### *Simplified DESI source and sample presentation stage*

















- ICx Griffin has developed a fixed site, 24/7 continuous monitoring MS for facility security – the ChemSense 600
- System currently alarms in ~1 minute for 20 TICs and 3 CWAs
- Additional targets are being added to the library to expand threat coverage
- ICx Griffin is also developing DESI-MS for direct surface sampling



- DHS S&T for funding
- Prof. Graham Cooks and Rob Noll for consultation
- The Griffin Science and Engineering teams



# The end. **QUESTIONS?**