RAPID ANALYSIS OF EXPLOSIVES ON SURFACES USING NEW LDTD ION SOURCE IN LESS THAN 9 SECONDS PER SAMPLE

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OVERVIEW

Purpose

- Optimization of the parameters of the new LDTD ion source for analysis of explosives.

Method

- Surface collection with swab and transferred directly in Domino LazWell plate.
- Samples analyzed by LDTD-MS/MS

Quantification

- Precision results were lower than 25% CV using swab spotting.
- Samples analyzed with a runtime of 9 seconds using LDTD-MS/MS technique

INTRODUCTION

Aviation security is important for the safety of passengers during flights, which is why explosive detection is essential to achieve this goal. Border control entities around the world carry out random samples to detect explosives on different surfaces during security checks. When introducing a new explosives analysis device, it is essential to have an analysis time of less than one minute and detect quantities of less than one milligram on the sampled surfaces. Axino Ion Source technology is based on contact sampling and allows MS analysis in less than 9 seconds per sample. The objective is to reduce the false alarm rate, increase the selectivity, sensitivity, and analysis speed of the analysis to reduce the waiting time at the airport.

Axino Ionization Source:

The Axino Ion Source (**Figure 1**) is the new generation of sample introduction and ionization source based on the LDTD technology for mass spectrometry. The Axino Ion Source uses a Laser Diode to obtain unmatchable thermal uniformity giving more precision, accuracy and speed.

LDTD coupled to the Uplyft flow process begins by shaping a cone out of the well of a Domino LazWell plate and the dry samples which are rapidly evaporated using indirect heat. The cone shape improves the flow of the neutral molecules that were thermally desorbed from the surface into the corona discharge region. High-efficiency protonation and strong resistance to ionic suppression characterize this type of ionization and is the result of the absence of solvent and mobile phase. This thermal desorption process yields high-intensity molecular ion signal in a few seconds sample-to-sample and allows for very small volumes to be used.
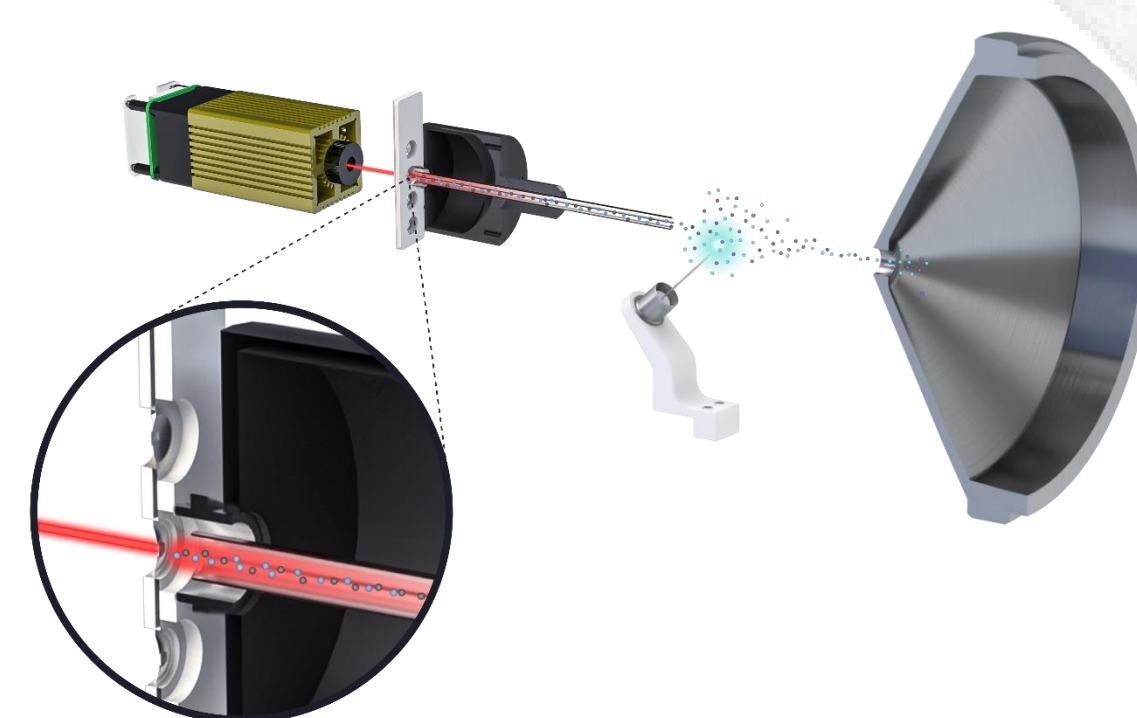

Figure 1 Axino Ion Source process

METHOD

Sample preparation

A stock solution of explosives (HMX, RDX, PETN and TETRYL) is prepared in a mixture of acetonitrile:water (25:75). Droplets of 0.5 µL are added uniformly on different surfaces (glass, electrogalvanized steel and polycarbonate) of 921 mm² using a Gyger Certus Flex (**Figure 2**) and evaporated to dryness.

Surface extraction

Explosives are extracted from the spiked surfaces using a polyurethane foam clean room swab (tips: 3/16" X 11/16"), (**Figure 3**), that is prewetted with a mixture of methanol:water (1:1) with 5 mM of ammonium chloride. Sample is transferred directly to a Domino LazWell plate (**Figure 4**) then evaporated to dryness. Swabbing is accomplished by a quick movement on an approximative 4 cm² surface that mimics a normal procedure in a real situation. Solution mixture for the tip wetting is optimized to get optimal explosive recovery from the surface and the addition of ammonium chloride in the solution is used in the ionization process to form a chloride adduct.

Instrumentation

- Ion source: Phytronix Axino Ion Source
- Mass spectrometer: Sciex Q-Trap, 5500

Axino Parameters

- Laser power pattern:
  - Increase laser power to 65% in 3 s
  - Carrier gas flow: 3 L/min

MS Parameters
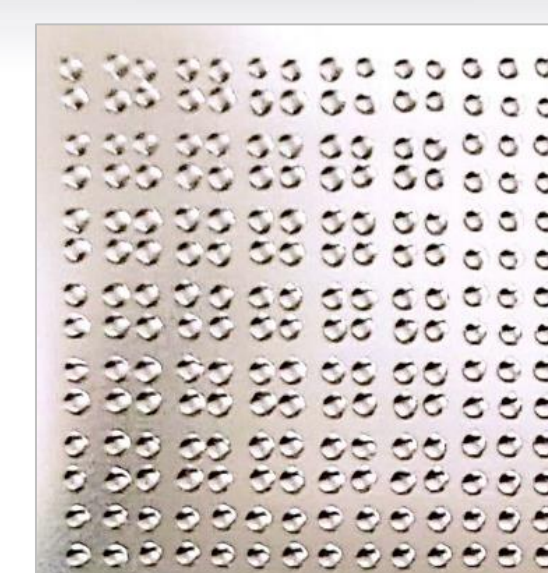
- APCI (–)
- Time: 20 msec
- MRM mode

Figure 2 Surface preparation before drying

Figure 3 Clean room swab

Figure 4 Domino LazWell plate

Figure 5 Axino Ion Source

Table 1 MRM transitions parameters

Compound	Q1 (m/z)	Q2 (m/z)	CE (eV)
RDX	257	46	-30
Tetryl	322	199	-10
HMX	331	109	-25
PETN	351	46	-45

RESULTS

Figure 6 AXINO-MS/MS system

Method Precision Evaluation

Replicate addition (three) of explosive stock solution were added on glass, EG steel and polycarbonate surfaces. For the precision experiment, the following explosive quantities were used:
- HMX (20 ng)
- RDX (50ng)
- PETN (100 ng)
- Tetryl (200 ng)

Peak area signals were used to evaluate the precision. **Table 3** shows precision results for all explosives on each type of surface.

Detection limit

Serial dilutions of explosive stock solutions are prepared and added on different surfaces. Standard solutions are evaporated to dryness. The surfaces are swabbed on an area of 4 cm², and each surface sample is transferred into a well of the Domino LazWell plate. The other three wells are used for quality control samples. The mean peak area signal of different explosive quantities are compared to the blank signal.

Detection limits are determined by choosing the total amount covering 4 cm² of the surface where signal are three times the blank level from a clean surface. **Table 2** shows the detection limit reached for each tested explosive.

Table 2 Detection limit of 4 cm² swabbed surface

Compound	Detection limit (ng)
RDX	5
Tetryl	100
HMX	2
PETN	50

Table 3 Method precision evaluation

Compound	Glass (%CV)	EG Steel (%CV)	Polycarbonate (%CV)
RDX	22	18	13
Tetryl	19	15	20
HMX	24	24	18
PETN	14	24	10

CONCLUSION

- **Surface swab extraction followed by direct transfer to Domino LazWell plate can be successfully used for direct explosives analysis.**
- **High-throughput analysis using AXINO-MS/MS**
- **Precision within the acceptance criteria.**
- **Sample-to-sample analysis of 9 seconds**