



Griffin 460 Mobile GC/MS Analysis of Explosives Utilizing Prepress Sample Introduction (PSI) Probe

Aaron K. Thompson, MS
Steven B. Shaull, BS

Terrorism takes innocent lives on a daily basis. With an average of 608 improvised explosive device (IED) attacks per month, the number of global attacks are alarming. These occurrences serve as a stark reminder of the importance of trace explosive detection technologies that offer high specificity, extraordinary sensitivity, fast analyses, and very low incidence of false alarms.

FLIR Systems has developed a solution to this complicated analytical challenge, which utilizes the robust GRIFFIN™ GC/MS system and integrated PSI-Probe™ (Prepress Sample Introduction). Within several minutes, the system is able to conclusively identify a wide variety of explosives such as those found in **Table 1**. These determinations can be made not only on bulk materials, but also via residues including those left behind on steering wheels, car door handles, human hands, cellular phones, etc. Using a very simple software user interface (GSS™ Level 1), the FLIR solution is ideal for military and law enforcement personnel who require a rapid, high-confidence determination of chemical identity at security and border patrol checkpoints.

No sample preparation is required for rapid screening of explosives due to the simplistic Touch-and-Go (TAG™) technology (**Figure 1**). TAG offers a simple 4-step process to collect a solid sample and introduce it to the GC/MS.

- 1) Simply touch the suspicious sample using the TAG
- 2) Snap the TAG off inside the microvial
- 3) Drop the microvial directly into the PSI-Probe
- 4) Transfer the PSI-Probe to the injector for thermal extraction and analysis

With the simple press of the start button, sample analysis begins with ensuing real time identification of explosives. The nature of the TAG sample collection mechanism ensures preservation of the original sample for subsequent analyses that may be required for forensic purposes.

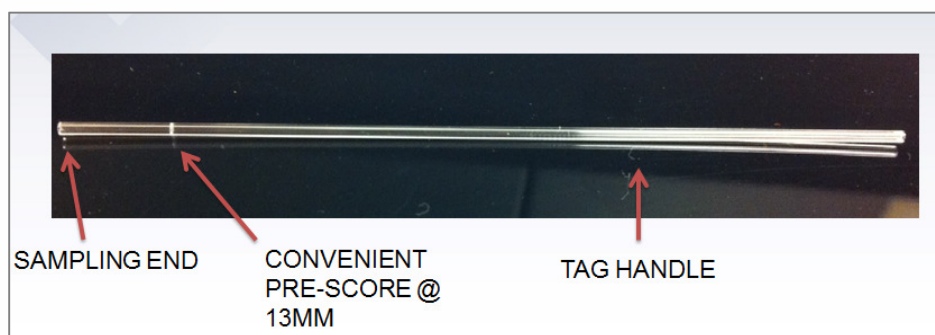


Figure 1: TAG sampling device

INSTRUMENTATION

- PSI-Probe Kit
- GRIFFIN GC/MS system
- Griffin System Software – GSS 3.9
- The Griffin GC/MS was powered by a 2300W Power Inverter (PowerBright) connected to a Ford F250 Diesel truck, with a portable tank of helium gas (Matheson) providing carrier flow to the system (**Figure 2**).

Gas Chromatograph Operating Conditions: Temperature program is 65° C hold for 2.0 min, then increase at 25° C per minute to 250° C, increase at 50° C per minute to 300° C.

Column	LTM-GC Rtx-TNT, 15m X 0.18mm X 0.18µm (an LTM-GC DB-5MS, 15m X .18mm X .18um may also be used)
Carrier Gas	Helium, 1 mL/min
Injector	200C, 90% split

Mass Spectrometer Operating Conditions

Mass Scan Range	m/z 40-350
Analyzer Temperature	150° C



Figure 2: The rugged Griffin GC/MS operating at the FLIR explosive testing facility.

SAMPLE ANALYSIS

A mock-up, real world scenario was established at the FLIR explosive testing facility to evaluate the utility of the Griffin system for field identification of explosives. Various components of an abandoned car were contaminated with trace residues of explosives. The outer door handle was contaminated with Semtex 1A and the steering wheel was contaminated with Red Dot Gunpowder. Residue from RDX detonation cord was used to contaminate the keypad of a cellular phone and a sample of nearby water was dosed with TNT at a concentration of 50 ng/mL.

All of the contaminated surfaces were sampled via the use of TAG technology, while the sample of contaminated water (5mL) was extracted via Twister for a period of 30 minutes (**Figure 3**). Visit www.flir.com or [YouTube](https://www.youtube.com) to view the Twister demonstration video.



Figure 3: Sampling of explosive residue via TAG, with subsequent analysis by Griffin GC/MS.

Analysis of steering wheel residue resulted in three threat alarms including nitroglycerin, diphenylamine and ethyl centralite; all constituents of Red Dot gunpowder (**Figure 4**).

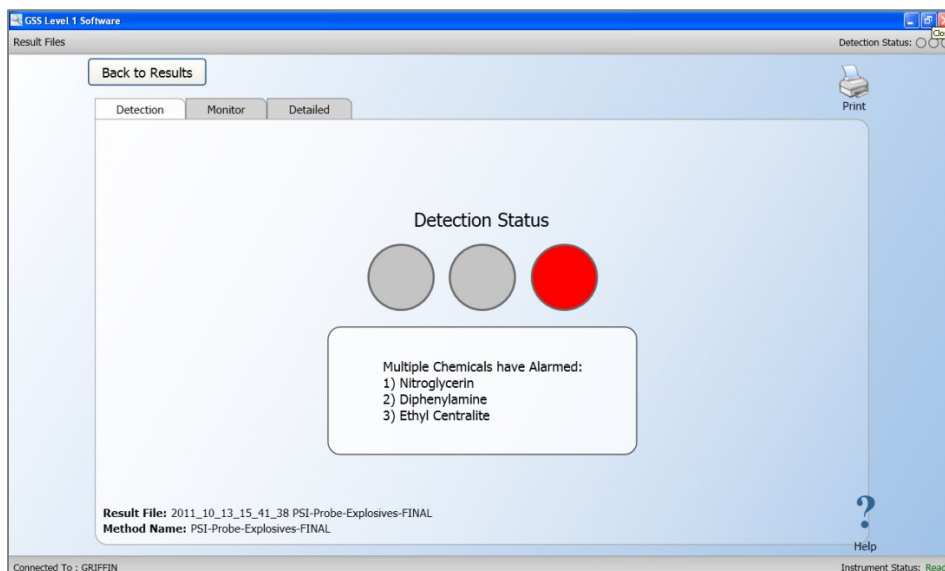


Figure 4: Real-Time Detection of smokeless gunpowder (Red Dot) constituents displayed in GSS Level I.

Positive alerts were further generated for subsequent sample analyses including RDX (cellular phone keypad), PETN (car door handle), and TNT (water). The GSS explosive detection method has been optimized for identification of explosives as well as commonly used stabilizers and plasticizers to better assist users in discriminating explosive classification. Below is a table containing explosive chemical classifications identified using the Griffin GC/MS:

Table 1	
Explosive Name	Constituents
Composition B	TNT + RDX
DetaSheet	PETN + Tributyl Acetylcitrate
C4	RDX + Methenamine + DMNB + Dioctyl Adipate
Semtex	PETN + DMNB
Wabox	2-Nitrotoluene, 3-Nitrotoluene, 4-Nitrotoluene, Nitroglycerin, 2,6-DNT, 2,4-DNT, TNT
Dynamite	EGDN + Nitroglycerin
Detonation Cord	PETN or RDX
HiSkor 700 Gun Powder	Nitroglycerin, Ethyl Centralite, Dioctyl Adipate
IMR-4350 Gun Powder	2,4-DNT, Diphenylamine, Dioctyl Adipate
Pyrodex P Gun Powder	Sulfur (S6 + S8), Dioctyl Adipate
Red Dot Gun Powder	Nitroglycerin, Diphenylamine, Ethyl Centralite, Dioctyl Adipate
Vihta Vouri Gun Powder	Diphenylamine, Ethyl Centralite

In the case of explosives consisting of many constituents, such as Wabox (**Figure 5**), the explosive detection method is capable of separating and identifying all components. The mass spectrum generated for each explosive and stabilizer is a unique fingerprint providing the end user with high confidence, in-field detection allowing for actionable intelligence (**Figure 6 and 7**).



Figure 6: Real-Time Detection of Wabox Constituents displayed in GSS Level I.

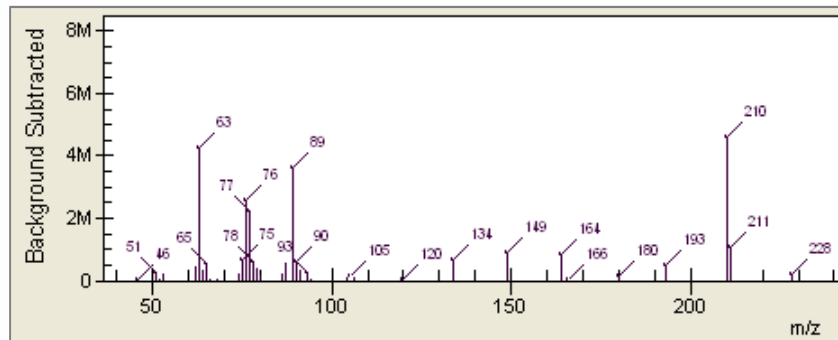


Figure 7: TNT Mass Spectrum

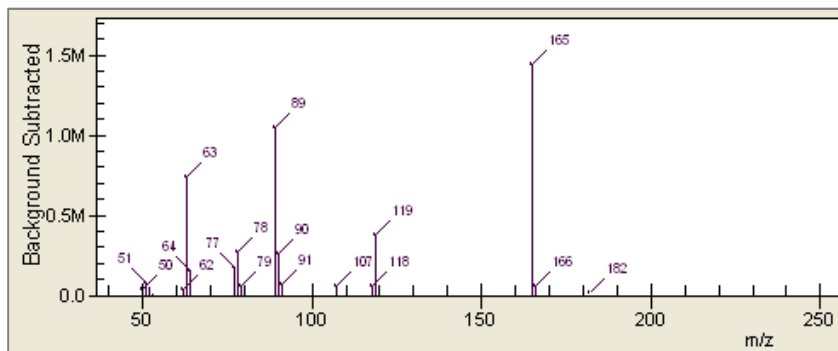


Figure 7: 2,4-DNT Mass Spectrum

RESULTS AND DISCUSSION

The TAG sampling technology enabled our field technicians to collect trace residue samples directly from multiple surface types that are associated with handling by an end user. These surfaces are common points of inspection for field officers. The Twister sampling technology provided additional utility to the scenario due to its ability to extract chemical components from water samples. Both the TAG and Twister sampling technologies are directly compatible with the PSI-Probe, giving the FLIR solution a broad operational applicability.

Utilization of the PSI-Probe, in conjunction with the Griffin GC/MS, permitted real time detection of explosives contamination across a number of surfaces and sample types. A variety of explosive compounds, such as RDX, PETN, and TNT, were identified and alarmed using GSS Level 1 interface. The simplicity of the “Level 1” interface uniquely positions the field-ready Griffin GC/MS to be used by virtually anyone to obtain “gold standard” mass spectral data. Compared to other technologies, such as Ion Mobility Spectrometry (IMS), the Griffin GC/MS operates in one standard mode of detection for all explosives, has no radioactive components, and is powered by information rich software which is tailored for high confidence sample determinations.

FLIR Systems
1024 S. Innovation Way
Stillwater, OK 74074
USA

P: 1.405.372.9535

www.flir.com