A150 GCIR as a Tool for Analysis of Smokeless Powder Residues From IEDs

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After attending this presentation, attendees will gain an appreciation for the applicability of GCIR for the analysis of forensic samples and in particular organic constituents of smokeless powders.

This presentation will impact the forensic community by enabling the forensic analyst working in explosives analysis an additional tool in the individualization of post-blast explosive residues.

Improvised explosive devices (IEDs) are often used in domestic and foreign terrorist attacks as well as in more traditional homicides and property damage crimes. They are simple to construct with easily obtained low explosives, black powder, black powder substitutes and smokeless powders. Typically only a portion of the powder is consumed in the explosion leaving unburned or partially burned powder at the scene. Comparison of this powder residue with samples found in the possession of a suspect can provide probative associative evidence. Traditionally comparison of morphology between smokeless powder grains has been used to narrow down to a few possible brands of powder. Chemical analysis of the extractable organic components enables the criminalist to further individualize the powder to perhaps a specific lot of powder.

Smokeless powders are mixtures of various energetic materials, plasticizers and stabilizers. Energetic materials include nitrocellulose (NC) and nitroglycerin (NG). Plasticizers, including dimethylphthalate and dibutylphthalate, are added to aid in the fabrication process, while stabilizers, such as ethyl centralite (EC) and diphenylamine (DPA) help to prevent powder decomposition during storage. DPA and EC incorporate nitrates as they are released from the propellant, forming nitrated derivatives of the stabilizers, such as N-nitrosodiphenylamine (NnDPA). Additional components such as trinitrotoluene, dinitrotoluene isomers, and camphor have been reported.

There exists a substantial body of literature on the use of capillary electrophoresis (CE), high performance liquid chromatography (HPLC) and gas chromatography-mass spectrometry (GCMS) for the analysis of organic components in smokeless powder. In this presentation we will present another complimentary technique for analysis, gas chromatography-infrared spectrometry (GCIR). GCIR provide another molecular identification technique which can be used to differentiate compounds which give very similar mass spectra (i.e., isomers of DNT). Comparison between GCMS and GCIR for a series of extracts from smokeless powders will be given as well as a comparison between pre- blast and post-blast powder residues.

With both GCMS and GCIR, the presence of nitroglycerine (NG) was determined without the use of 'cold on column' techniques by reducing the injection port temperature to 150°C which substantially reduced thermal decomposition of NG but did still high enough to volatilize higher boiling compounds. Acceptable resolution of all compounds (including 2,4 DNT and 2,6 DNT) was achieved with a total run time of less than 12 minutes. NnDPA was not detected by either GCMS or GCIR but was seen in HPLC and CE analyses of the same powder.

It has been found that different lots of the same powder can have very different formulations. The different formulations primarily came from manufacturers in different countries. This was especially true of the Hodgdon powders. These differences in formulations may be useful in further individualizing a forensic sample of smokeless powder. A database of organic component composition (both qualitative and quantitative) and morphological characteristics is being developed for use in establishing the statistical significance of a match between any two powder samples.

Smokeless Powder, GCIR, GCMS

 ** Presenting Author*